

Oran O'Doherty,  
Beaver Row,  
Donnybrook,  
Dublin  
August 11, 2011

[Recipient Name]  
[Title]  
[Company Name]  
[Street Address]  
[City, ST ZIP Code]

Dear [Recipient Name]:

My name is Oran O'Doherty. I am a recent Chemistry graduate from Trinity College Dublin, and I am now pursuing a Ph.D. in Organic Chemistry. I am an Irish citizen, a constituent of Dublin South-East and a diligent voter.

Recently I learnt of exploratory licenses given to Lough Allen Natural Gas Company (Langco) and Australian-based Tamboran Resources to assess the Lough Allen Basin for natural gas (methane)<sup>1</sup>. This basin has a band of rock containing methane stretching across Cavan, Donegal, Fermanagh, Leitrim, Mayo, Monaghan, Roscommon, Sligo and Tyrone. It covers an area of 8,000 square kilometres, ~1/10th of Ireland<sup>2</sup>, and is the source of many of Ireland's rivers including the R. Shannon.

I learned also that this methane would have to be extracted by a new method of horizontal hydraulic fracturing (fracing)<sup>3</sup>. After researching this method I am incredibly concerned that the clear and evidenced dangers of this process might not be fully known or recognised.

It has already been banned in all of France<sup>4</sup> and a move is underway to ban it in the state of New Jersey<sup>5</sup>. French environment minister Nathalie Kosciusko-Morizet said

*"I'm against hydraulic fracturing. We have seen the results in the U.S. There are risks for the water tables and these are risks we don't want to take.... "It was an error," Kosciusko-Morizet said of the permits given last year. "These never should have been granted. '4.*

A moratorium has been brought upon all fracing in the state of New York<sup>6</sup> in a realization of the apparent dearth of the comprehensive long term, independent, peer-reviewed studies needed to understand this complex mix of geology, ecology and engineering<sup>7</sup>. This has been illustrated in the reports of people harmed, the court cases they have taken and the new, independent scientific studies outlining the dangers (cited below in each case).

I wish to bring to your attention to risks, those proven and those more than likely, that fracing necessitates. I hope you will reason as I have, that a ban to these methods is necessary to protect our Ireland's clean water, health, economy, communities and, in fact, all its life that is completely dependent on our water's purity for generations to come.

I intend to summarise and evidence the following,

- How fracing works
- Risks to the water table of Methane gas
- Risks to the water table of toxic chemical pollutants
- Other associated risks

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## How fracking works

Traditionally natural gas (methane) extraction involves drilling a relatively small number of deep wells into a large deposit of methane and extracting the gas.

Horizontal fracking however seeks to extract methane that formed in innumerate small bubbles in rock formations. To release these bubbles from the bands of rock, horizontal wells are burrowed, stretching kilometres underground. These extend from the bottom of numerous vertical wells (it requires so many, 9 out of 10 resource extraction wells drilled in the US are for fracking <sup>8</sup>, 99,000 in New Mexico <sup>9</sup>). The wells are drilled down through the water table and then concrete casings are made in the shaft. The rock around the gas is then fractured with gun charges and under huge pressure, >10,000 psi, <sup>10</sup> a mix of water, sand and chemicals is forced into the wells in pulses to completely shatter the rock and release the gas for extraction.

The process requires millions of gallons of fresh or grey water to be mixed with chemicals as these help remove the gas from the rock. This fracking mix is often left in non watertight, open air containers and troughs (**image 4**) once removed from the wells, though a vast quantity <sup>11</sup> can be left in the well underground. The process can involve scores of trucks to deliver water to the site and can make the process highly intensive on local road networks and communities.

(I included several illustrations of the fracking process. I feel the industry used images are very clean, void of any natural rock fissures, cracks or permeation in rock bands that would illustrate the greater complexity of the geology underfoot than a pure band of colour might suppose. I feel the anti fracking images do display some of these complexities and show areas of risk but for fairness I included a few different images as they clearly lean different ways.) **See Appendix**

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## Risks to the water table of Methane gas

Fracing liberates methane for extraction but if it leaks into the water table it can poison the water for wildlife, human consumption and use. There is also no way of telling for how long the methane will leak and the water table will remain polluted. The fracing industry grew rapidly when controversially it was exempted from many safe water and drinking water statutes in 2005, a move which the US congress is trying to repeal<sup>12</sup>. The industry has maintained all this time that there is no evidence the process releases methane gas into local water<sup>13</sup>.

This contradicts local households near fracing wells, who say their problems only arrived after fracing began (such as Dimock, Pennsylvania), by saying their problem was a form of near the surface methane labelled, biogenic, and not the methane they mine deep underground labelled, thermogenic<sup>14</sup>. From what I have seen these denials are inaccurate and appear to be blatant falsehoods.

The first independent research that I could find was conducted by scientists at Duke University. It was published in the acclaimed peer-review journal Proceedings of the National Academy of Sciences regarding fracing. They sampled hundreds of kilometres of wells and found 'systematic evidence for methane contamination of drinking water' associated with gas extraction. They noted levels of flammable methane gas in drinking water wells and aquifers increased to dangerous levels when those water supplies were close to natural gas wells. They also found that the type of gas detected at high levels in the water was the same type of gas that energy companies were extracting from thousands of feet underground, (thermogenic), strongly implying that the gas is seeping underground through natural or manmade faults and fractures<sup>14</sup>.

The methane levels are so high they have caused explosions of drinking water wells<sup>15</sup> and a home<sup>16</sup> as well as homeowners whom can light their drinking water on fire (**image 5**).

Land and homes are immediately devalued by these risks. Court cases have been taken<sup>17</sup> however it is difficult for anyone, to prove exactly what was happening with the geology. Relocating<sup>18</sup> or having water shipped in at expense<sup>18</sup> seems to be the only options. Some people financially crippled have signed gagging orders in exchange for clean water shipments<sup>18</sup>. For me these findings give formal weight to the harm so many people have reported by this process but have not had the expertise or funds to verify themselves.

I hope with these instances and this study you can begin to understand my trepidation in the early stage exploration of fracing that has begun in Ireland. If fracing is complacent here and companies (see list<sup>19</sup>) could maintain a line of innocence they were either knowledgeable but denying risks to communities, lands and lives for their own ease of profit or indeed truly ignorant of consequences this process involves. I find both these possibilities reproachable. I believe I'm founded in then saying these are not the types of activities we can allow in Ireland and so should halt fracing's progress until more is known.

## Risks to the water table from toxic chemical pollutants

In researching the chemical additives I found that the fracing method involves the use of hundreds of chemicals (certainly greater than 700) <sup>20</sup> mixed with billions of gallons of clean water that are then, unfortunately, spoiled for other use

*“Between 2005 and 2009, the 14 oil and gas service companies used more than 780 million gallons of hydraulic fracturing products – not including water added at the well site “<sup>20</sup>.*

These chemicals must be present to help remove the gas from the ruptured ground. The list of chemicals known is extensive but incomplete. Due to the previously cited exemptions the exact composition of these chemical is regarded as a proprietary trade secret <sup>21</sup>. So I will do my best to outline what I came across.

As a chemist I am not easily startled by chemicals used in large scale industrial processes, if done safely. Just saying ‘chemicals’ seems to startle some people but everything is a chemical, even water is a ‘chemical’. That said, I feel I am also more aware how dangerous some can be and I was bewildered by some of the substances that have been being pumped into the ground, some remaining there permanently. I would also look very closely at how well these can be reprocessed and at whose expense.

Of a mix of hundreds of chemicals being used liberally and on industrial scale in proximity to the water table I was very surprised that >65 <sup>22</sup> are known as hazardous, toxic, highly toxic and carcinogenic (cancer causing) chemicals. It contains toxins <sup>23</sup> to the liver, heart, kidney, neural function and carcinogens. With the proximity to the water table, the huge area and scale fracing operates in I found the use of these substances very worrying. Just a few substances in the fluid that the process needs are;

- **Methanol** (as little as 10 ml of pure methanol can cause permanent blindness) <sup>24</sup>;
- **Formaldehyde** (Ingestion of as little as 30 ml (1 oz.) of a solution containing 37% formaldehyde has been reported to cause death in an adult <sup>25</sup>, that’s not considering smaller wildlife, plants or soil biota);
- **Lead, Arsenic, Chromium, Mercury** (all heavy metals <sup>26</sup>);
- **Benzene** (a maximum contaminant level (MCL) for benzene in drinking water at 0.005 mg/L (5 ppb) <sup>27</sup>. It is a potently dangerous carcinogen and as an undergraduate it was deemed so unsafe that its use was forbidden in well controlled specially ventilated teaching labs, even though the volumes would have been less than 100ml.
- Fracing companies have even admitted to mixing in **diesel**, in spite of an explicit provision against its use. <sup>28</sup> The industry had promised they were enforcing this law but were not, even with it being a federal crime in the US <sup>28</sup>. This gives me very little faith in the industry’s assurance on other matters.

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Fracing companies have indicated the fluid requires only ~ 1% of the fluid mix used to constitute these chemicals (though companies maintain the quantities and substances used are proprietary so this is not easily verified). This along with the fact that I had yet to see a more exact break down of the substances used and that the companies were maintaining no methane could leak made me think the process's damage was likely to be controllable.

Now, however, having read more and seen the instances and scientific study cited below, I hope you will reason as I have that no confidence can be had whatsoever in the harmlessness of this fracing fluid even at only 1% pollutants.

- Mary Beth Adams, an independent U.S. Forest Service researcher reported on this subject in the peer-reviewed Journal of Environmental Quality. She studied what happened when 75,000 gallons of fracing fluids, a tiny portion of the millions or billions used, were spread on the ground in a 0.2 hectare section of the Fernow Experimental Forest in West Virginia.

Within two days, all ground plants were dead. Within 10 days, leaves of trees turned brown. Within two years, more than half of the approximately 150 various hardwood trees were dead<sup>29</sup>. Aquatic life would likely be even more sensitive in Lough Allen and the rivers of its basin to this poisoning. It is difficult to estimate the massively destructive impact this could have on our clean water and ecosystems if it leaked into the water table when left in the well after drilling or during the process.

- Sixteen cows died<sup>30</sup> within hours of drinking from puddles tainted with fluid in a pasture next to a fracing well site. Chesapeake Energy, the company that owned the rig, refused to identify the chemicals in the fluid and refused to admit any spill took place. The farmer in the report who lost this portion of his herd and income commented that it was a leak from near the well hole. This fatal poisoning of these large mammals by this fracing fluid counters the supposed harmless and dilute nature of this unregulated substance.

- I feel the case of Laura Amos is worth mention. Fracing began close to her home near Silt, Colorado. In her words<sup>31</sup> the fracing company

*'Encana sent to our home a nice old gentleman who sat at our kitchen table and told us more or less, "I feel for you, but you own the surface, we own the minerals and we're coming in to drill. Here's the Surface Use Agreement, you can sign it, but you don't have to. If you sign it you get a check for \$3000. If you don't sign you get no financial reimbursement for any damages that may occur." In 2001 their water well exploded from methane and 'our water turned gray, had a horrible smell, and bubbled like 7-Up... Tests of our water showed 14 milligrams (mg) per litre of methane. That's almost as much methane that water will hold at our elevation '.*

She was told not to drink the water but told bathing was fine. After that in 2003 she developed a very rare adrenal cancer (~1 person per 1 million diagnosed/year<sup>32</sup>). One case of cancer did not say anything particular to me but I learned also that 2-butoxyethanol is used widely in fracing additives. This has specifically been cited to cause rare adrenal cancers in mammals<sup>33</sup> and was used in the well near Laura Amos's property though initially denied by the Encana fracing company<sup>31</sup>.

I do not consider this direct proof of cancer linked to the fracing well. It is proof though of direct drinking water and water table contamination that could last indefinitely and that has removed the land and resale value in the

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area. It is for me a very suspicious, unnerving case and illustrative of the helplessness, disregard and harm felt by people in the actions of the process of fracking.

It also highlights the issues of mineral rights not benefiting the homeowner and them having no say. Privatisation of profit whilst the risks remain social.

- Cathy Behr, an emergency room nurse spent around 10 minutes with worker from a gas well site upon his initial entry to the hospital. He had been caught in a chemical spill. Despite this limited exposure, she immediately lost her sense of smell and rapidly became gravely ill as multiple organs failed<sup>34</sup>. As doctors fought to save Behr's life, the company that used the fracking chemicals refused to reveal the composition of the fluid calling the formula a trade secret<sup>34</sup>. She was lucky to survive and it was only slowly and reluctantly after her doctor signed a confidentiality agreement were the nature of the toxins revealed to him alone.

The brevity of her exposure and the severity of her reaction truly startled me and highlighted the seeming danger of even minor human exposure to these substances.

- As cited large quantities of the fracking fluid are left in the ground at each site. The fracking industry holds that water table pollution could never occur from a fracked well. I cannot have any faith in their position as it stands. This is especially frightening when you take into account the irreversibility a contamination to ground water, aquifers and from these the soils, rivers and ecosystems.

As methane has been leaking into drinking water despite the years of assurances from the fracking industry, I think that it is highly plausible, that these fluids could seep into the soil and water table.

88 out of 220 municipal water wells tested near fracking wells in the Sublette County, Wyoming area tested positive for contaminants, including benzene. Some were so full of gas they were explosive risks.<sup>35</sup> These are indicative of fracking as the source of this pollution but alarmingly it's just not known how they got there. This again indicates a likely denial of known hazards in fracking or the lack of understanding of the processes involved in the geology and engineering.

I'll remind you also of the scale of fracking fluid used and its toxicity mentioned; a thousand gallons a minute into a well for 4 days (as in multi-frack wells)<sup>36</sup>; hundreds of million gallons, a tiny fraction of that to poison and kill a half acre of forest and a drink of it to kill large mammals).

I do not agree with the opinion expressed in the Irish Independent<sup>37</sup> that called these just a 'few chemicals' and spoke of the water usage as minimal. For me if it were clean water usage maybe yes, but sullied toxic water giving rise to the worrying instances above, and that must be specifically reprocessed? I think it is inaccurate and could be seen as biased for the chairman of a gas company to brush these aside as harmless. It is not for any industry that is to gain to define what is safe when it concerns everyone's health. (I found it strange that a man understandably biased to his industry and sector should be the only one given this national platform in this newspaper).

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The fracking industry relies heavily on a 2004 EPA study. However that 424-page report's conclusions appear, on close examination, to ignore some of its own findings. The report actually notes that fracturing fluids migrated unpredictably through rock layers in half the cases studied in the U.S. The agency characterized some of the chemicals as biocides and lubricants that "can cause kidney, liver, heart, blood, and brain damage through prolonged or repeated exposure." The report also noted that as much as a third of injected fluids used in hydraulic fracturing remains in the ground and that there is risk as it's "likely to be transported by groundwater".<sup>38</sup>

If water contamination were to happen in Ireland, the affect would be catastrophic. Fracing covers huge areas, requires huge numbers of wells and could be in use over possible ~1/10<sup>th</sup> of the land. If allowed, it is a very real possibility that the groundwater and aquifers than feed into the rivers that spread out across Ireland will be permanently polluted, and if so possibly beyond use.

Aquifers are wet underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be usefully extracted. They drain at remarkably different speeds from decades to centuries<sup>39</sup>. It could be years before it started to be released but once this fracing fluid has started seeping downstream it could be generations before it was all expelled. They would generations of irrevocable pollution if this fluid was present in the water table.

I think of the damage from the colliform contamination in Connaught and how the EU is enforceing strict regulations on diffuse pollution from septic tanks and it appears boggling that we may not recognise the threat of this quantity of pollution to our water and act to stop it.

Some of the toxins included are cumulative poisons meaning once in an organism they remain and collect over time. Bioaccumulation is when an organism or ecosystem absorbs a toxic substance at a rate greater than that at which the substance is lost, the organisms can thus be suffering poisoning even if environmental levels of the toxin are not very high. Even a small amount continually pervading the water table could do this. Also of concern is the biomagnification of toxins in these ecosystems.

I trust you can now see the justification for my serious alarm over the prospect of fracing, certainly with it proceeding without serious long term studies before hand and without the realisation of the stringency of regulation required if it is, in fact, independently proven to be manageable.

I cannot support the benign nature of the fracing fluids. It appears to be very destructive to any life it encounters and acting over a long period of time. Given the risks outlined, this process should not be allowed to force underground hundreds of millions of gallons of this fracing fluid. Without the studies to ensure its safety it would seem it's just a hope the water table will not be ruined beyond repair.

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## **Other associated risks**

### **Volatile Organic Compounds (VOCs):**

These are released from the open air fracing fluid storage pit (**image 4**) and from the well itself of the gas. Considering the harmful compounds in the fracing fluid it is easy to see the dangers of their aerosol and vapour. These have been linked to a string of sterilities in farm animals as well as numerous animal stillbirths<sup>40</sup>. It has also prompted the EPA to launch an enquiry to the air quality in Texas<sup>41</sup>

### **Trucks and Traffic**

All drilling equipment – machines, tanks, drilling rig, supplies of diesel fuel, etc. – is brought in on tractor trailers. Each fracing requires 550 to 2,500 tanker truckloads of water. Plus there are tanker trucks for the sand and chemicals to do the fracing. Many of these trucks are “oversized loads” and could get stuck on our winding back roads. Traffic jams and mishaps have blocked roads from a few hours to days. Road damage is unavoidable and at the cost of the taxpayer.<sup>42</sup>

### **Increased seismic activity**

The widespread and constant large scale shattering of rock formations has increased the likely hood of shifts and movements in the rock layers in and around fracing wells. There are investigations underway to ascertain the exact cause in increased earthquakes of a magnitude greater than 3 in the US<sup>43</sup>. A similar investigation is underway in the UK<sup>44</sup>. I think the risks of the earthquakes reaching dangerous levels for buildings above ground are small but possibly dangerous for foundations if numerous continue for a long time. I am worried though that a shifting rock structures could exacerbate the methane leaks or indeed fracing fluid leaks by creating new fissures or cracking well structures.

### **The fracking process itself**

The nature of dealing with such large volumes poisonous fluid make spills and mistakes regular (Pipes jam or crack, connections break, casings rupture etc). Thousands of regular mishaps and violations have been recorded in recent years alone<sup>45</sup>. Most of these faults leading to water contamination and environmental pollution. Water storage pits (**Image 4**) often overflow and leak. To drill a gas well, you have to drill through the water table. The industry claims that layers of concrete ensure that no toxic chemicals or flammable methane can enter the aquifers we depend. However some quoting drilling data show that 1/20 wells suffers an immediate failure of the concrete casing. The failure rate of casings and other parts of the well will only grow with time.<sup>46</sup> This is a concern as many of the toxins will not degrade in the wells but the casings containing them will.

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I am incredibly concerned by the information I have come across. I agree with the French government's ban as I do not feel there has been enough independent research done to insure the safety of this process. There is mainly one, heavily cited, small EPA report in 2004 (mentioned above) about mining in coal formations. (One of the report's three main authors, Jeffrey Jollie, an EPA hydrogeologist, said that the research has been misconstrued by the industry. The study didn't consider the impact of above-ground drilling or of drilling in geological formations deep underground, where many of the large new gas reserves are being developed)<sup>38</sup>

It was based on this insufficient study the US Congress's politicians bizarrely pushed through a bill giving full green light to the industry and exempted it of all EPA restrictions for safe drinking water and water tables. It was left to each state to manage. However such a huge industry has been impossible to oversee or control, for example, 18 inspectors are all there is funding for to test 99,000 wells in New Mexico.<sup>9</sup> Again with this fact I find the blanket statement that fracking is causing no damage unfounded. I idea that with this sort of supervision we could even know what was taking place is unbelievable. I don't think companies ever self-regulate properly if it risks profits and independent bodies can't check up on them. Fracking companies illegally used diesel when no oversight was given despite claiming the contrary.

All agricultural use, tourism based on Ireland's clean beauty, schools, towns, families, businesses using water for consumption, sport fishing, water sports on lakes and rivers, any economy or life that relies on water could be put at risk from the methane, the potent fracking fluid and the volatile organic chemicals (VOCs) and for an indefinite period into the future.

Given all this, the infractions by the industry as well as the numerous cases of irreversible harm this industry has already caused a ban on its use anywhere in Ireland is necessary. The nation's long term clean water interests will always be of superior economic and social importance over this immediate exploitation. We can continue to live happily and productively without this methane exploitation. We can never begin to function as an economic or social society with a polluted water table.

If in say 10 or 20years time a new method is available or if indeed independent studies on fracking can prove it to be completely safe this methane will still be present. Until such a time any permanent risk of this pollution to the health of our land should not be allowed.

Our inaction is surely inexcusable when it comes to the water table that has and will sustain all of us, our families and livelihoods (and so taxes) for all of Ireland's future. We must protect the Lough Allen basin, the source of so much of our country's fresh water, first. Only under a weight of independent evidence would and strict regulation could I ever see this extraction as reasonable.

I hope my recent research into fracking has been informative. I look forward to hearing what opinions you have on this topic and would appreciate your thoughts on how best you think this can be raised on a national, local and community basis.

Fracing has lacked the evidence and openness required entirely but is however littered with evidence against it. The water in this country is the under righting base of all we do. We must protect Irelands sustainable future, not jeopardise it because a few companies are in a rush to make their fortune from our resources.

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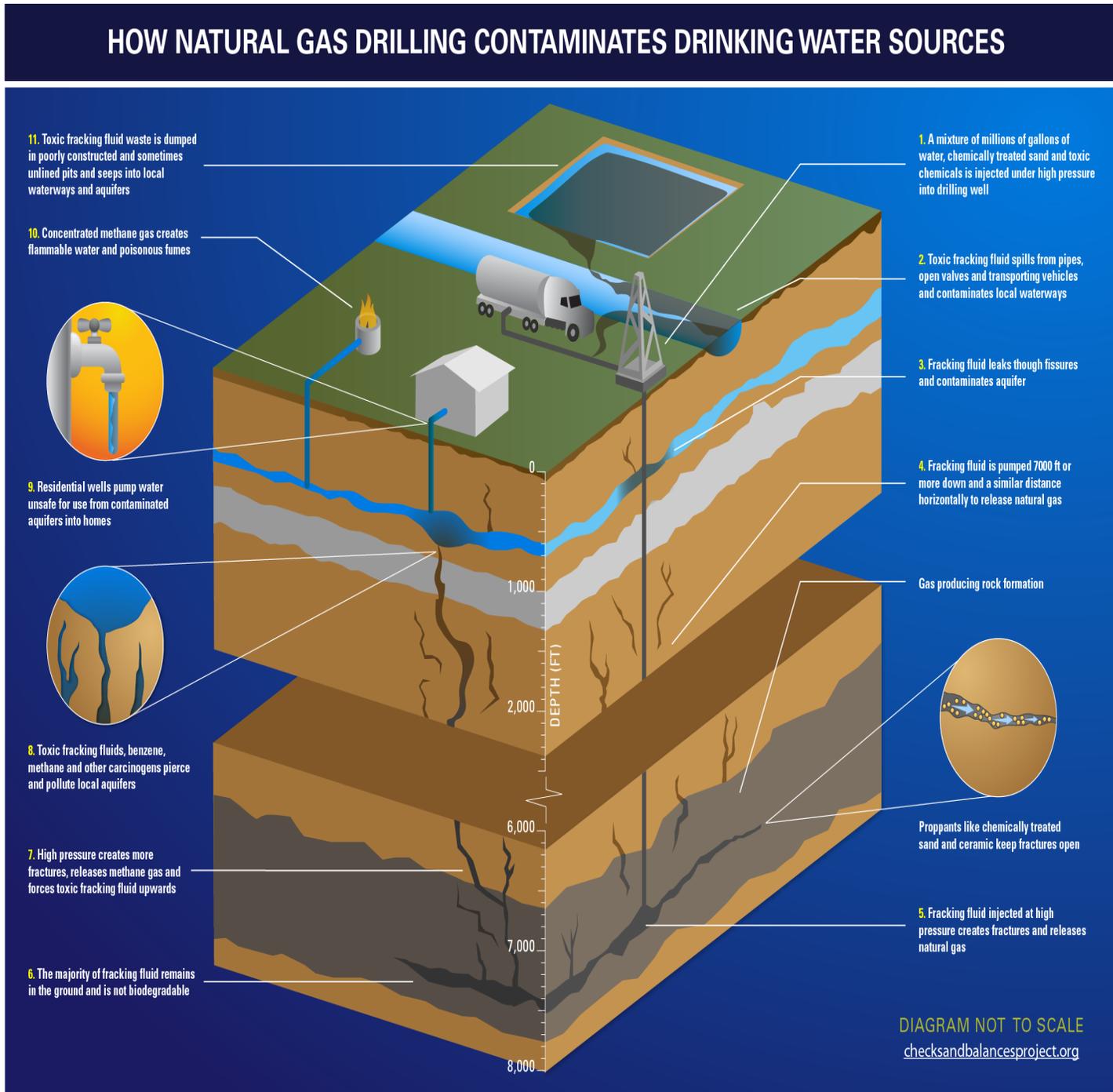
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Thank you for your time and attention,

Oran O'Doherty, Chemistry BA (Mod) TCD, Sch.

## Appendix



**Image 1**

From <http://checksandbalancesproject.org/?s=thyne>

By the Checks and Balances Project. A group calling for greater awareness to the risks of fracking.

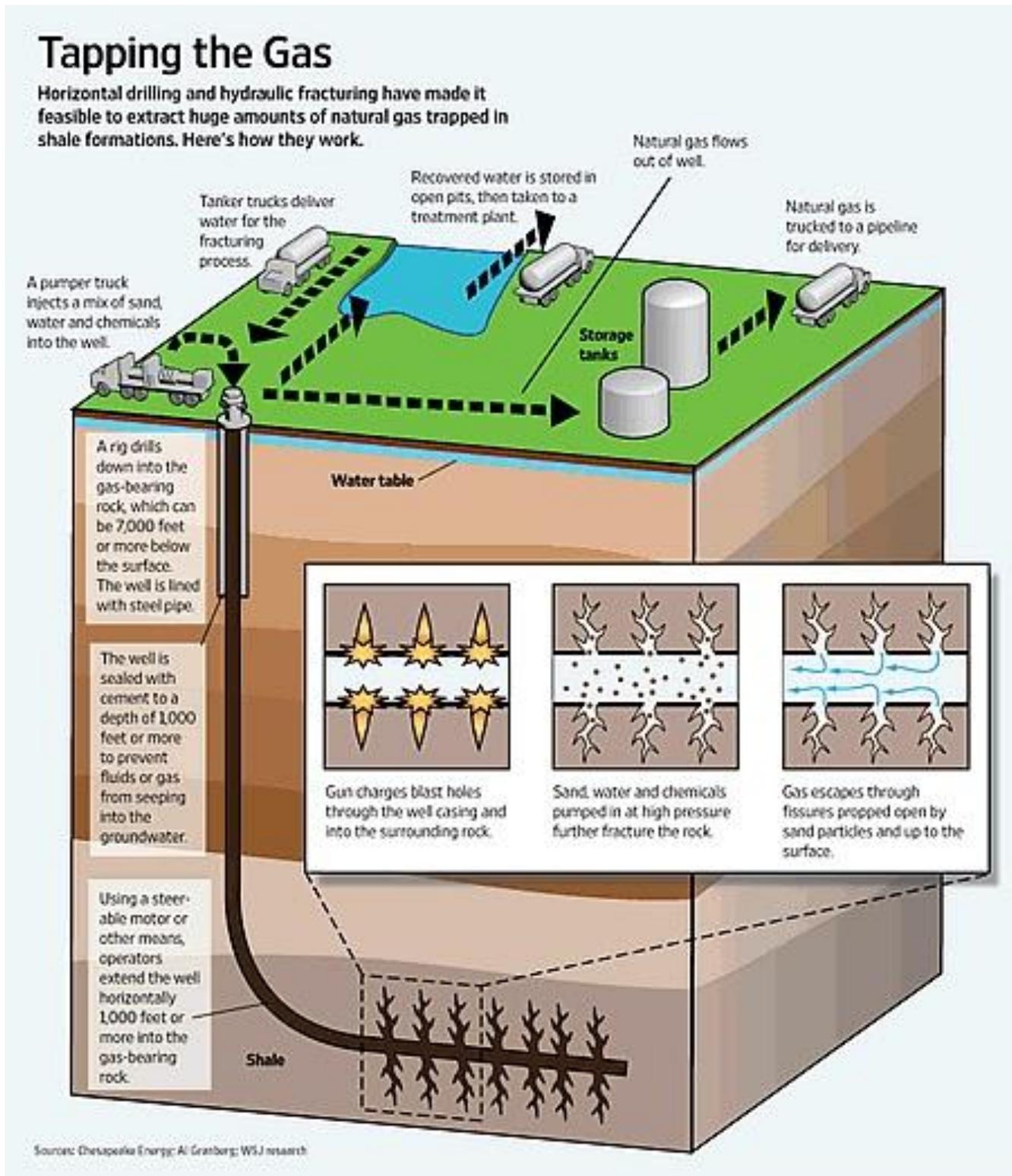
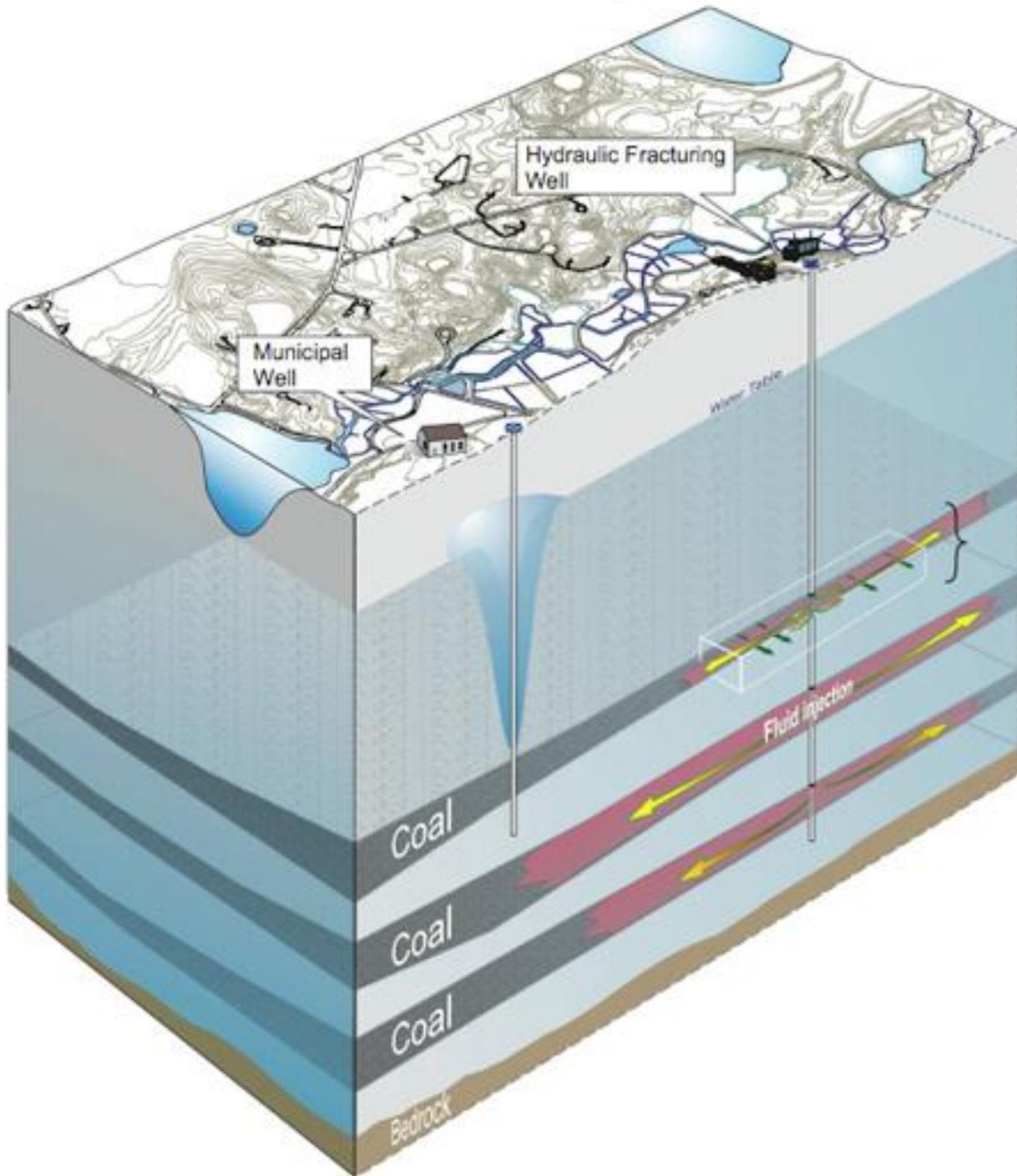


Image 2

From <http://thewmeacblog.org/tag/natural-gas/>

By Chesapeake Energy a hydraulic fracturing extraction company



From <http://frack.mixplex.com/fracing>

**Image 3**



**Image 4**



<http://skeenawatershed.com>  
**Image 5**

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