Risks of Unconventional Gas Extraction in the Lake Eyre Basin

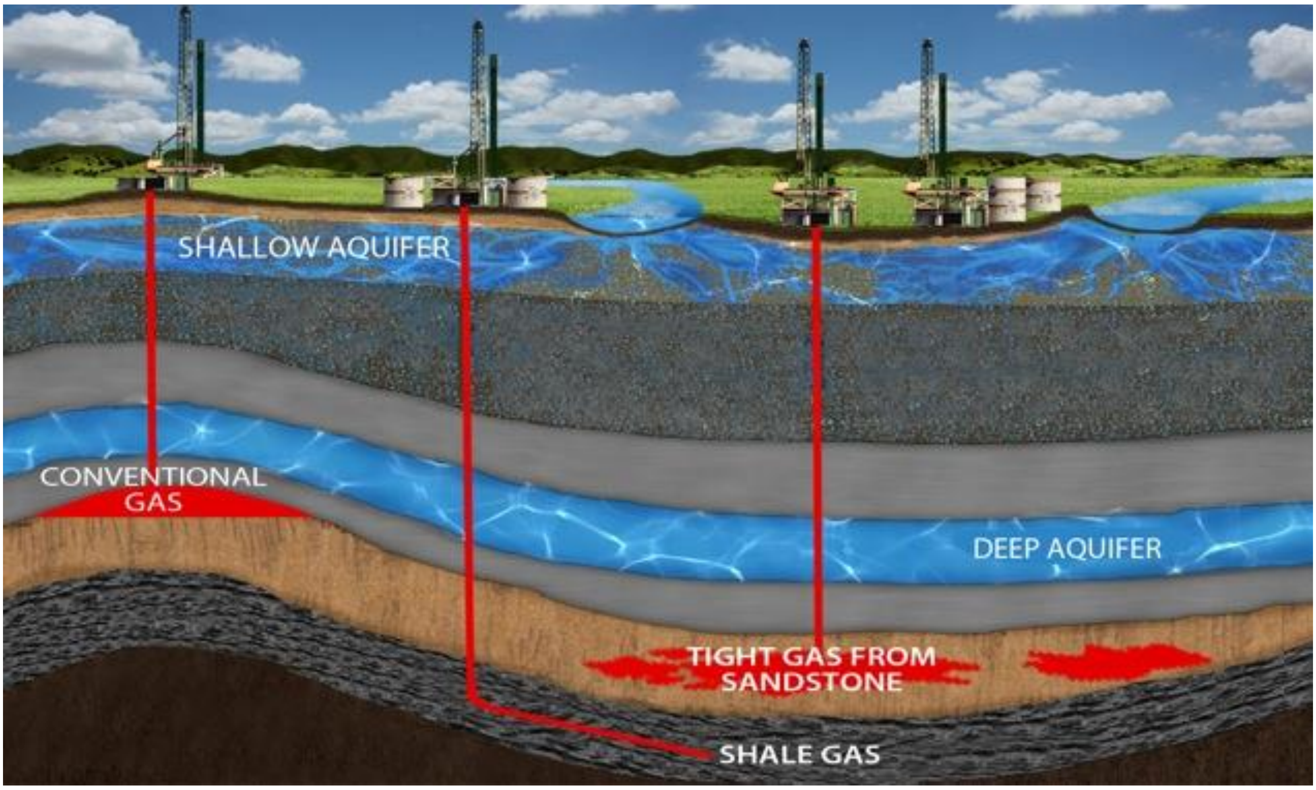
Unconventional gas is harder to extract than conventional

The difference between conventional and unconventional gas is the geology of the reservoirs from which they are extracted and which therefore require different extraction techniques to obtain commercial quantities of gas. Unconventional gas includes tight gas, coal seam gas (CSG) and shale gas.

Conventional gas extraction has existed in the Lake Eyre Basin since the 1960s, but it is completely different from unconventional gas development in terms of scale, intensity and impacts. The gas industry is now targeting the Channel Country, including its sensitive rivers and floodplains, for the development of unconventional gasfields. The most prospective unconventional resources identified in the Channel Country include shale oil and gas, tight gas and deep coal gas.

Conventional gas is usually found in relatively large permeable rock reservoirs. In a conventional gas deposit, once drilled, the gas can usually be extracted relatively easily via vertical wells. Conventional gas has been extracted in Australia for many decades.

Unconventional natural gas is found in less permeable deposits or spread more diffusely throughout the rock substrates, not in discrete pockets or reservoirs. This gas is more difficult to extract and therefore requires specialized (i.e. 'unconventional') extraction techniques and processes. The methods required for the extraction of unconventional gas may include hydraulic fracturing (fracking), horizontal drilling, multiple drilling, and acidation.



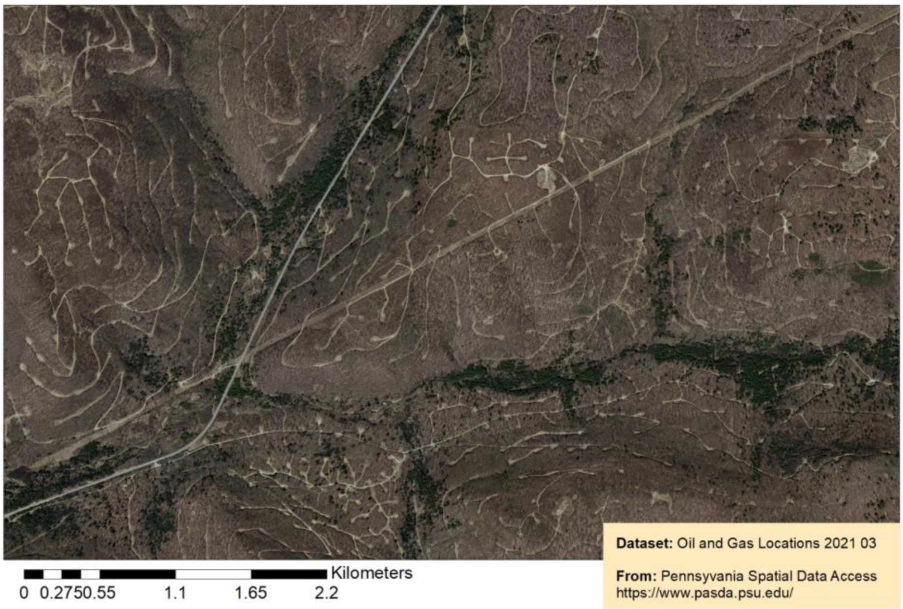
Conventional vs Unconventional Gas Reservoirs

Shale gas and tight gas are generally held in very tight rocks, in very deep strata, and therefore generally require what is known as 'high pressure, high volume hydraulic fracturing'. Coal seam gas is generally held at shallower depths and does not always require fracking, however in the Cooper Basin it is deep coals that are a prospective resource.

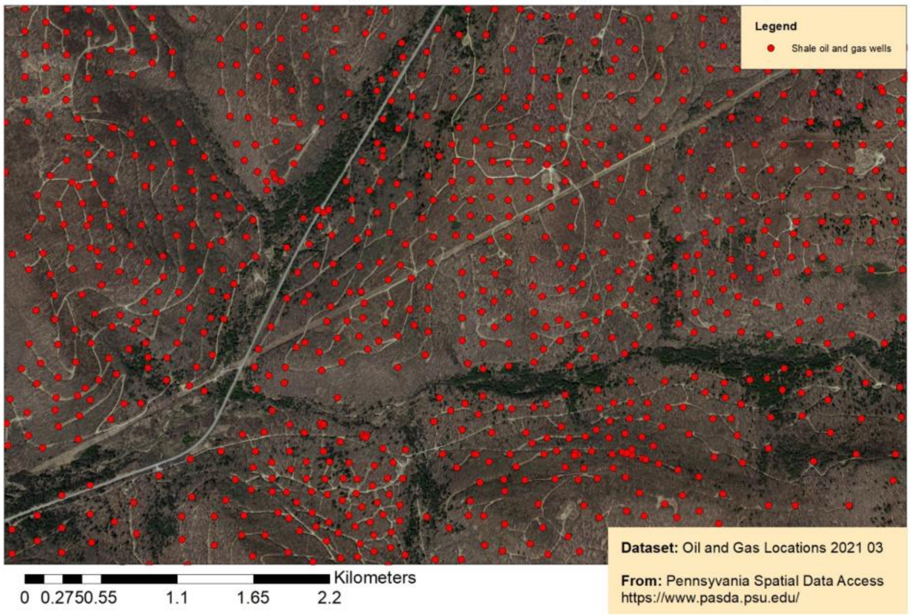
Unconventional gas drilling now frequently also involves horizontal drilling, where a vertical well is turned horizontal at depth to drill along the target seam and may involve numerous radiating lateral wells from single pads.

Unconventional gas requires thousands of wells, roads, pipelines

Shale oil and gas drilling in Bradford County, Pennsylvania, USA



Shale oil and gas drilling in Bradford County, Pennsylvania, USA



Because unconventional gas resources are not concentrated like conventional gas in discrete reservoirs and are spread out across landscapes, they require a vast networks of gas wells, roads and pipelines in order to extract the gas, as well as compressor stations, processing plants, and wastewater dams/storages.

It is currently unknown what the full scale of gas development in the Channel Country might be. In 2013, a report prepared for the Australian Council of Learned Academies predicted that there could be as many as 9,483 gas wells developed in the Cooper Basin across both Queensland and South Australia[1]. A recent assessment, however, assumed between 1,000 and 1,500, although there was no explanation provided for the use of that figure[2].

[1] Frogtech 2013. Potential geological risks associated with shale gas production in Australia. A report prepared for the Australian Council of Learned Academies. This assumed well spacings of 800m and fairways making up 5% of Basins.

[2] Holland KL, Brandon C, et al (2020) Geological and environmental baseline assessment for the Cooper GBA region. Geological and Bioregional Assessment Program: Stage 2. Department of the Environment and Energy, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.

There are no estimates of likely wells in the remainder of the Lake Eyre Basin outside the Cooper Basin.

Recent government assessments in the region estimate that cleared well pads will be up to 4 hectares in size in the Cooper Basin, and that wells will be approximately 2000m deep[3]. The study also predicts the wells will be drilled horizontally for up to 3,000m.

These estimates match the US experience. A North American study found that oil and gas well pads generally '*destroy vegetation on about 10 acres*'[4]. Other studies confirm this, with reports generally of shale gas well pads being 5 to 10 acres in size in the US[5].

The density of wells is high and increases over time. Gas well density has reached as high as 3,000 wells per 1,000 square miles in at least one county in the Barnett shale formation, which equates to more than 1 well per square kilometre[6]. According to a government report, the CSG industry in Qld has densities of approximately 1.1 well per square kilometre. The Geological and Bioregional Assessment of the Cooper Basin predicts a lower density of wells but provides no explanation for how it was derived (0.125 wells/km^2). It appears to be based on assumptions about the length of lateral drilling extensions, but it also estimates that length could vary between 500m to 3000m.

Jonah Field, Tight Gas Production, Wyoming, USA

Production of gas from unconventional gas wells declines rapidly after drilling. The business model is therefore based on drilling more and more wells. It includes infill drilling within existing fields seeking to extract gas not reached during the first round. Schlumberger states that 60% of new drilling in the US is infill drilling[7].

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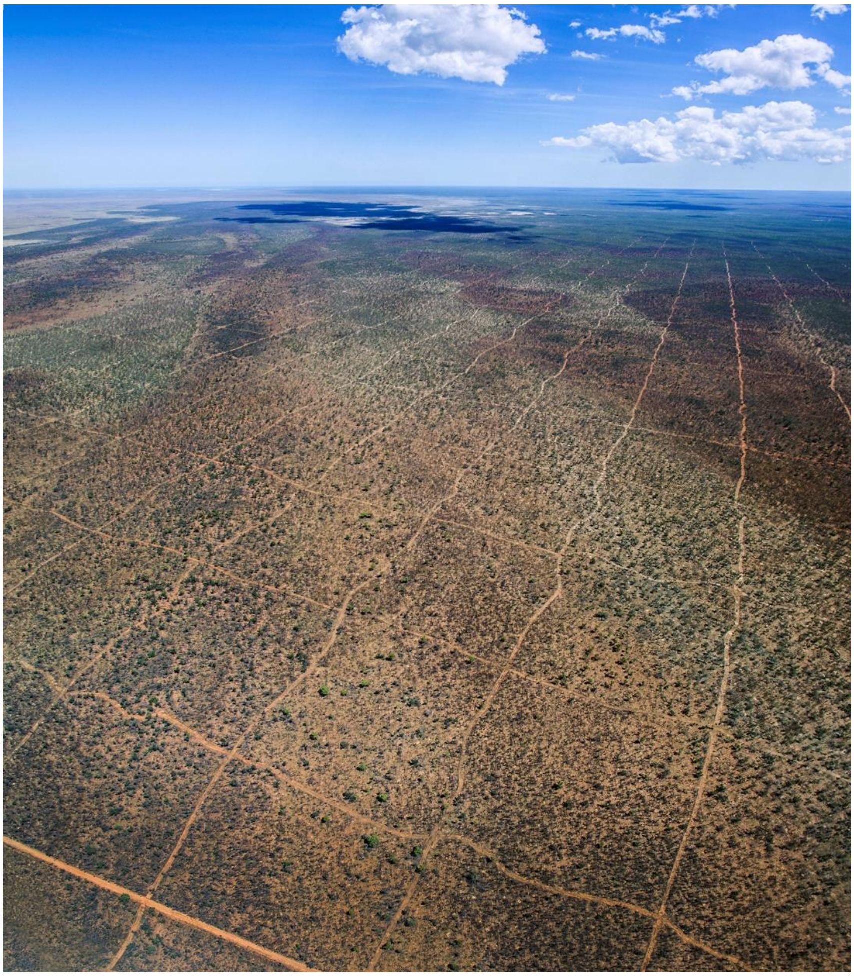
[3] Holland KL, Brandon C, Crosbie RS, Davies P, Evans T, Golding L, Gonzalez D, Gunning ME, Hall LS, Henderson B, Kasperczyk D, Kear J, Kirby J, Lech ME, Macfarlane C, Martinez J, Marvanek S, Merrin LE, Murray J, O'Grady A, Owens R, Pavey C, Post D, Rachakonda P, Raiber M, Sander R, Stewart S, Sundaram B, Tetreault-Campbell S, Williams M, Zhang Y and Zheng H (2020) Geological and environmental baseline assessment for the Cooper GBA region. Geological and Bioregional Assessment Program: Stage 2. Department of the Environment and Energy, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.

[4] https://energynews.us/2015/04/24/midwest/study-oil-and-gas-drilling-consuming-millions-of-acres/

[5] Health Impact Assessment of Shale Gas Extraction https://www.ncbi.nlm.nih.gov/books/NBK201901/

[6] Hazen and Sawyer 2009. Appendix B - Final Impact Assessment Report: Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed.

[7] https://www.slb.com/business-solutions/infill-well-optimizatio



Seismic Lines for Unconventional Gas Exploration, Kimberley WA.

Last year, the University of Wyoming's Enhanced Oil Recovery Institute described this business model very clearly, as follows:

"Horizontal wells drilled in unconventional [fracked] reservoirs experience rapid production decline and are only economic at relatively high oil prices….As long as oil prices remain low, there will be little, if any, significant drilling of unconventional reservoirs in the foreseeable future. Without new wells to offset the rapid production declines characteristic of these wells, tax revenues from unconventional reservoirs will decrease substantially."[8]

The Geological and Bioregional Assessment for the Cooper Basin estimates that approximately 5km of new access roads are required per gas well, and that approximately 3km^2 of new three-dimensional seismic lines are also required per well.

Even if just 1,500 wells were drilled, that would equate to 7,500km of new roads and 4,500km of seismic lines in the Cooper Basin alone. No estimates are currently available on the scale of new pipelines, but each well needs to be linked via gas pipelines back to gas compression facilities and via water pipelines to water treatment plants.

Gasfields require large volumes of water for fracking

Extraction of shale and tight gas requires high volume, high pressure hydraulic fracturing and usually involves horizontal drilling[9]. These newer fracking processes are different to fracturing techniques previously used in the gas industry and pose much more significant risks.

[8] https://county17.com/2020/04/29/two-prominent-wyoming-gas-drillers-in-financial-peril/
[9] A Comprehensive Guide to Different FracturingTechnologies: A Review: https://www.mdpi.com/1996-1073/13/13/3326

Shale Pad, Pennsylvania, USA

Fracking for shale and tight gas is an extremely water-intensive practice. Each well may require up to ten fracks[10] over its production life. The Australian gas industry provides a figure of 11 million litres per shale or tight gas frack[11] whilst the baseline assessment for the Cooper Basin estimates 30ML per well[12].

Other sources suggest that water use is often much higher[13]. According to one UN report, a single frack operation on a shale gas well will use between 11 and 34 million litres of water, roughly 360 – 1100 truckloads[14].

An Australian study estimated that demand for water to undertake fracking in the Cooper Basin (across Queensland and South Australia) could amount to 5.7GL per year, which the report concluded would exceed sustainable yield[15].

Fracking Wastewater Pond, Kimberley WA.

In the US, towns and pastoral properties that must compete with fracking operators for scarce water supplies have been seriously affected. In Texas, extraction of water for fracking has contributed to serious problems of ground and surface water depletion during drought conditions[16]. To maintain profitability and production, gas companies will not suspend extraction during a drought.

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[10] European Parliament, Economic & Scientific Policy Dept, Impacts of shale gas and shale oil extraction on the environment and on human health.

[11] APPEA: The Natural Gas Revolution- Natural gas from shale and tight rocks.

[12] Holland KL, Brandon C, Crosbie RS, Davies P, Evans T, Golding L, Gonzalez D, Gunning ME, Hall LS, Henderson B, Kasperczyk D, Kear J, Kirby J, Lech ME, Macfarlane C, Martinez J, Marvanek S, Merrin LE, Murray J, O'Grady A, Owens R, Pavey C, Post D, Rachakonda P, Raiber M, Sander R, Stewart S, Sundaram B, Tetreault-Campbell S, Williams M, Zhang Y and Zheng H (2020) Geological and environmental baseline assessment for the Cooper GBA region. Geological and Bioregional Assessment Program: Stage 2. Department of the Environment and Energy, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.

[13] Kargbo D, William R & Campbell D, (2010) Natural Gas Plays in the Marcellus Shale: Challenges and Potential Opportunities, Vol. 44, No. 15 *Environmental Science & Technology;* CIWEM UK, 2012 Policy Position Statement 'Hydraulic Fracturing (Fracking) of Shale in the UK';

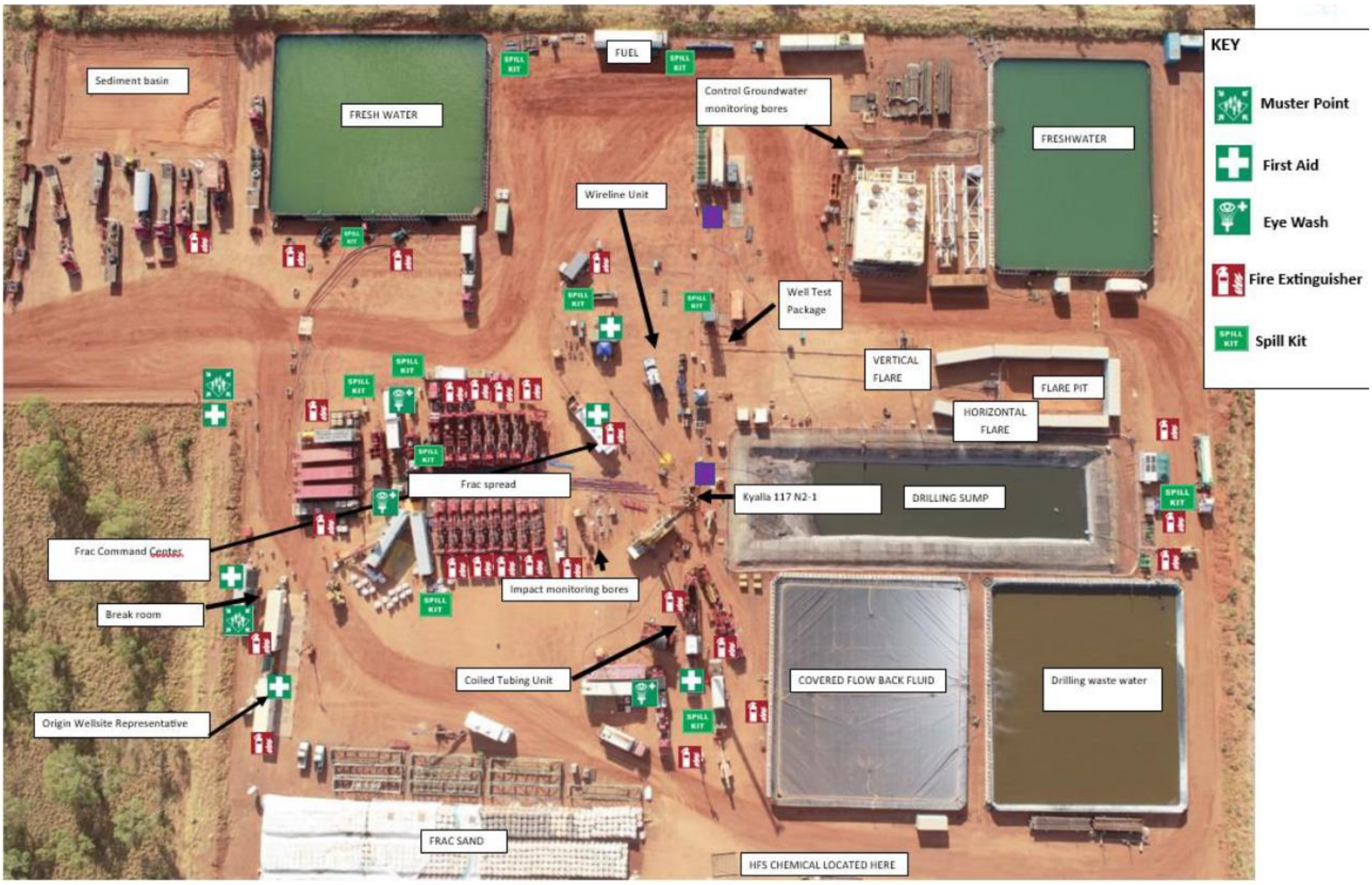
[14] UNEP Global Environmental Alert Service: Gas Fracking: Can we safely squeeze the rocks?

[15] Frogtech 2013. Potential geological risks associated with shale gas production in Australia. A report prepared for the Australian Council of Learned Academies.

[16] *Frackers guzzle water as Texas goes thirsty*: http://nation.time.com/2013/09/29/frackers-guzzle-water-as-texas-goes-thirsty/; Western Organization of Resource Councils: *Watered Down: Oil & gas production & oversight in the west.*

Gasfields are a contamination risk on floodplains

Chemicals constitute from 0.5 to 2% of fracking fluids[17], and while this is a small proportion relative to the large volumes of water used, it translates to very large quantities of chemicals. A typical 15 million litre fracturing operation would use 80 - 330 tons of chemicals[18].



Kyalla Shale Well Pad Layout, Northern Territory

The National Industrial Chemicals and Notification Scheme reviewed 113 chemicals used by the CSG industry for drilling and fracking in Australia, and found that 52 of them were likely to cause harm to the environment if spilled or leaked at high volumes[19].

As much as 30% of fracking fluids may flow back to the surface[20]. The dewatering of shale layers to enable gas to flow also produces wastewater, which may amount to 300-4,500 litres of water per day for a typical shale gas well[21].

[17] Hazen and Sawyer, December 22, 2009. Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed.
[18] Ibid (Notably APPEA use the lower figure of 0.5% - see APPEA: The Natural Gas Revolution- Natural gas from shale and tight rocks)
[19] Department of Environment and Energy, Department of Health, NICNAS. National assessment of chemicals associated with CSG extraction in Australia: overview.
[20] APPEA: The Natural Gas Revolution- Natural gas from shale and tight rocks.
[21] Bill Chameides, *"Natural Gas, Hydrofracking and Safety: The Three Faces of Fracking Water,"* National Geographic, September 20, 2011.

This wastewater can contain a range of naturally occurring contaminants from the deep shale layers. These include, heavy metals, naturally occurring radioactive materials (NORMs), volatile and semi volatile organic compounds (VOC's) and high concentrations of salts[22].

There are several serious examples of flooding leading to contamination and leakage from unconventional gasfields in the US. These include:

- In 2014, flooding in Colarado affected more than 2,650 oil and gas wells and associated facilities. Many of these storm-damaged facilities and storage tanks leaked uncontrollably. The Colorado Oil and Gas Conservation Commission estimated the flooding resulted in the release to the environment of 48,250 gallons of oil or condensate and 43,479 gallons of fracking wastewater from 50 different spill sites across the state[23].

- In 2016, as part of an investigation based on aerial photographs taken by emergency responders during spring flooding in Texas, the El Paso Times documented plumes and sheens of chemicals from tipped-over storage tanks and inundated oil wells and fracking sites entering rivers and streams[24].

- In 2017, in flooding due to Hurricane Harvey in Texas, Eagle Ford shale operators reported 31 spills at oil and gas wells, storage tanks, and pipelines[25]. It is considered likely that many more went unreported. A 2019 study documented over 600 hazardous chemical releases from gas installations and offshore oil facilities and pipelines triggered by Hurricanes Rita and Katrina[26].

Tight Gas Frack Site, Kimberley, WA

Failures and leaks do happen, from both conventional and unconventional oil and gas operations. In 2013, there was a major leak of 250,000 litres of oil from a Santos well in the Channel Country[27]. It took 6 days to stop and required a specialist team from the US to be flown in to contain it[28].

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[22] Ibid

[23] Lepore, M. (2014, March). "Lessons Learned"in the front range flood of September 2013: a staff report to the commissioners of the Colorado Oil and Gas Conservation Commission. Retrieved from http://cogcc.state.co.us/Announcements/Hot_Topics/Flood2013/FinalStaffReportLessonsLearned20140314.pdf

[24] Schladen, M. (2016, April 30). Flooding sweeps oil, chemicals into rivers. El Paso Times. Retrieved from http://www.elpasotimes.com/story/news/2016/04/30/flooding-sweeps-oil-chemicals-into-rivers/83671348/

[25] Environment Texas. (2017, September 12). Report:Environmental and health concerns about oil and gas spills after Hurricane Harvey.Retrieved from https://environmenttexas.org/sites/environment/files/reports/Harvey%20Oil%20Gas%20Spills%20-%20Env%20TX%20-%209.22.17.pdf

[26] Flitter, E., & Valdmanis, R. (2017, September 15). Oil and chemical spills from Hurricane Harvey big, but dwarfed by Katrina.Reuters.com.Retrieved from https://www.reuters.com/article/us-storm-harvey-spills/oil-and-chemical-spills-from-hurricane-harvey-big-but-dwarfed-by-katrina-idUSKCN1BQ1E8

[27] https://theconversation.com/dishing-the-dirt-on-santos-queensland-oil-spill-15170

[28] Ibid

Despite the environment department acknowledging that it had 'sufficient evidence to lay charges', it chose to take no action[29], highlighting the weakness of Queensland's regulatory regime for oil and gas.

The wastewater produced from shale and tight gas mining are likely to be reinjected into aquifer formations, partially 'treated' and reused or released into waterways, or trucked to holding ponds for storage and 'evaporation'[30].

Shale gas field, Ponder, Texas, from Google Earth imagery

Gas fields require vast networks of roads and all-weather access. Raised infrastructure on floodplains such as roads, pipelines, fences and culverts interfere with natural flood flows leading to erosion and sedimentation of water courses and to some areas being deprived of life-giving floodwater from overland flow altogether. These areas suffer declines in pasture productivity. High pressure gas pipelines are particularly risky on cracking clay floodplains.

Gasfields are not properly insured and bring additional risks, including weeds

In relation to insurance, the NSW Chief Scientist found that "*traditionally oil and gas companies have a higher risk appetite than other large industries. This means they generally take on their own risk, that is, self-insure or underinsure*"[31].

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[29] https://www.abc.net.au/news/2015-10-01/queensland-government-failed-charge-santos-2013-oil-spill/6819984
[30] National Toxics Network: Toxic Chemicals in the Exploration and Production of Gas from Unconventional Sources.
[31] NSW Chief Scientist and Engineer. 2014. Environmental Risk and Responsibility and Insurance Arrangements for the NSW CSG Industry.

Furthermore, landholders themselves are unable to get insurance to cover their businesses and operations for all of the risks posed by unconventional gas activities[32]. Therefore, producers are being forced to do business with an industry that operates at the opposite end of the risk spectrum from them.

Moreover, evidence is increasing of barriers to obtaining finance for purchase of properties with unconventional gas infrastructure, with banks unwilling to take on the financial risks of these assets. Examples include the Commonwealth Bank advising a landholder in Queensland that the presence of 4 gas wells on their property made the security unacceptable for residential lending purposes[33].

In terms of direct impacts, spatial modelling from CSIRO found that the direct alienation of productive farmland for CSG infrastructure in Queensland results in losses in gross economic returns of up to 10.9%[34].

The spread of weeds is a major risk from unconventional gas mining. The Northern Territory Fracking Inquiry found that each gas well is associated with an average of 3,000 truck movements. There will also be a similar or even greater number of regular vehicle movements with each well, highlighting a massive threat of weed contamination.

Gasfields do not create large numbers of jobs

Coal Seam Gas Production, Chinchilla, QLD

The oil and gas industry is a very small employer in Australia, employing around 0.2 percent of the workforce[35]. Gas companies operating in Australia have announced major job cuts through the pandemic. ABS Labour Force figures show that average employment in oil and gas extraction has declined by over 10% from 2019 to 2020, despite record production[36].

The gas industry delivers very few spill over jobs or indirect employment in other industries, with research into the economic impacts of CSG in the Surat Basin showing that non-mining spill over employment has been ‘negligible’ in local retail and manufacturing[37].

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[32] Farmonline National: CSG Too Risky For Insurers http://www.farmonline.com.au/story/3365648/csg-too-risky-for-insurers/

[33] Retail Credit Decisioning email, 1.7.2016

[34] Marinoni, O., and Navarro Garcia, J. 2016. A novel model to estimate the impact of Coal Seam Gas extraction on agro-economic returns. Land Use Policy 59 (2016), pp 351 – 365.

[35] https://australiainstitute.org.au/wp-content/uploads/2021/02/P1012-Gas-job-cuts-WEB.pdf

[36] Ibid

[37] Fleming & Measham (2014). Local economic impacts of an unconventional energy boom: the coal seam gas industry in Australia, *Australian Journal of Agricultural and Resource Economics* 59 (1), 78-94

The same research concluded that agricultural jobs had been negatively impacted by CSG, with 18 jobs lost in agriculture for every 10 jobs created in CSG.

The majority of jobs in unconventional gas occur during the construction phase, with experience of CSG in the Surat Basin showing that jobs are slashed dramatically once construction ends. The industry, especially in remote areas, is entirely dominated by fly-in/fly-out workforces[38]. Skilled jobs rarely go to locals, and if they do, they tend to poach scarce skilled workers from existing businesses because they can pay more.

Shale Oil Field, Midland, Texas, USA

[38] House of Representatives Standing Committee on Regional Australia. Cancer of the bush or salvation for our cities? Fly-in, fly-out and drive in, drive-out workforce practices in regional Australia.