Centre *for* Environmental Rights
Advancing Environmental Rights in South Africa

Department of Forestry, Fisheries and the Environment
The Director General
Attention: Dr. Dee Fischer
By e-mail: dfischer@dffe.gov.za

25 August 2022

Dear Dr. Fischer

PROPOSED REGULATIONS PERTAINING TO THE EXPLORATION AND PRODUCTION OF ONSHORE OIL AND GAS REQUIRING HYDRAULIC FRACTURING

1. Thank you for the opportunity to make input on the proposed regulations pertaining to the exploration and production of onshore oil and gas requiring hydraulic fracturing (fracking) published for comment on 11 July 2022 in Government Gazette 47112 under GN 2273 (the Draft Regulations) by the Department of Forestry, Fisheries and the Environment (DFFE). The draft regulations have been read together with the Consultation on the Intention to Prescribe Minimum Requirements for the Submission of Applications for an Authorisation, Right, Permit, or Licence for the Onshore Exploration of Oil and Gas Intending to Utilise Hydraulic Fracturing[1] (the Requirements).

2. These comments are prepared by the Centre for Environmental Rights (CER). We record that our comments are endorsed by groundWork, and The Green Connection.

3. Given the transection of fracking, across various government departments, we include herein our comments submitted to the Department of Water and Sanitation (DWS) dated 7 June 2021, on the Draft Regulations for the Use of Water for Exploration and Production of Onshore Naturally Occurring hydrocarbons that require stimulation, including hydraulic fracturing and underground gasification, to extract, and any activity incidental thereto that may impact detrimentally on the water source as published in Notice 406 in Government Gazette No. 44545 of 7 May 2021 (hereinafter referred to as the draft DWS Regulations for Gas).

4. Our general and overriding submissions are summarised below:

    4.1. The Draft Regulations have failed to consider the implications of providing a framework to enable fracking in the context of, inter alia, the climate emergency; South Africa's policy position on addressing the climate emergency; government's international obligations in terms of the United Nations Framework Convention on Climate Change[2] and the Kyoto Protocol[3], and government's obligations per the Constitution of the Republic of South Africa, 1996 (the Constitution)[4], to uphold the Bill of Rights, and in doing so, to refrain from exposing the people of South Africa to the harms of the climate crisis. Temperatures in the region are increasing at twice the rate of the global [5] average. It is the government's constitutional imperative to

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[1] Revision 0, May 2022.
[2] United Nations Framework Convention on Climate Change, New York: United Nations, General Assembly, 1992.
3 UNFCCC (1997) Kyoto Protocol to the United Nations Framework Convention on Climate Change adopted at COP3 in Kyoto, Japan, 11 December 1997
[4] Act 108 of 1996.
[5] South Africa First Nationally Determined Contribution under the Paris Agreement, September 2021. See at https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/South%20Africa%20First/South%20Africa%20updated%20first%20NDC%20September%202021.pdf

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protect the people of South Africa against the impacts of climate change. This includes committing to the transition away from fossil fuels. As a default position (and to avoid additional cost and exposure to climate risk) government should **not**[6] be investing in fossil fuels, such as oil and gas exploration and production. The International Energy Agency said in a recent report[7] that if the world is to avoid irreversible, catastrophic climate change, no new oil or gas fields should be developed as at 2021, i.e. no new investments should be made in gas production fields.

4.2. Furthermore, water use and energy production are closely connected to each other, with both seeing an increase due to economic development and population growth. Water demand will continue to increase in a world where 40% of the world's population already live in water-scarce areas. South Africa is one of these water scarce regions. The impacts that fracking, a water-intensive procedure, will have on water resources will only serve to exacerbate the water scarcity that South Africa is already facing. More strain will be put on the water supply through the large scale utilisation of water for fracking and also through the contamination of ground and surface water during the fracking process. More detailed and stringent regulations are called for to regulate the potential contamination of vital water resources.

4.3. That fracking operations create a large amount of hazardous waste is well documented. As will be detailed below, these wastes contain chemicals that create a bevy of adverse health impacts for human beings and the environment. The Draft Regulations attempt to regulate this with several strong provisions. While this is commended, we call for more detail on several aspects, which will be discussed below.

4.4. Because fracking does not operate within a vacuum, it is paramount that the regulations consider cumulative impacts in their entirety. A vigorous cumulative impact assessment of water quantity and quality, biodiversity, socioeconomic contexts, air quality, and greenhouse gas emissions, strategic environmental assessments, long-term regional monitoring plans and water quantity and quality, biodiversity, socioeconomic contexts, air quality, and greenhouse gas emissions. Furthermore, consideration should be given to a project's contribution to impacts across the region, looking at the cumulative impacts of not only industry projects on water quantity and quality, biodiversity, socioeconomic contexts, air quality, and greenhouse gas emissions, but also considering the rest of the contributors from the region to these key indicators of ecosystem and human health.

4.5. The Draft Regulations support fossil fuel development which will have far reaching implications for people both nationally and globally, ranging from environmental impacts to the displacement of people and their livelihoods[8][9] in the affected areas, to increasing our greenhouse gas (GHG) emissions, which will in turn contribute to climate change. Consultation processes - and further consultation processes in developing this plan, should it proceed despite our objections - therefore need to be meaningful, accessible and inclusive of all communities on a national scale.

4.6. On the basis of the above, the Department and government more broadly, should not be embarking on a process of enabling fracking for oil and gas exploration and production at all. Such regulations are not only reckless and unnecessary, but it also flies in the face of the rights enshrined in the Constitution, and is contrary to Government's own policies and plans.[10]

5. In our comments, we seek to provide a more comprehensive picture of the climate crisis context; gas's harmful impacts and contributions to climate change.

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[6] https://www.iea.org/reports/net-zero-by-2050

[7] https://www.iea.org/reports/net-zero-by-2050

[8] See reference to such impacts: https://www.aljazeera.com/opinions/2020/2/24/gas-rich-mozambique-may-be-headed-for-a-disaster

[9] Adam,A.B & Owen,J & Kemp, D (2015) Households, livelihoods and mining-induced displacement and resettlement. The Extractive Industries and Society.2. See at: https://www.researchgate.net/publication/278049856_Households_livelihoods_and_mining-induced_displacement_and_resettlement

[10] Including but not limited to the National Climate Change Response White Paper, National Climate Change Adaptation Strategy, Low Emission Development Strategy 2050, the National Development Plan 2030, the draft National Infrastructure Plan 2050, the Just Transition Framework

Part A: General Comments on the Draft Regulations in the context of climate emergency - the case for abandoning the use of fracking entirely

6. We note that, through the Draft Regulations together with the Requirements, the South African Government and the DFFE seek to minimise harm and risk from fracking and associated oil and gas exploration and production activities, while allowing reasonably regulated commercial activities to proceed.

7. However, fracking operations in oil and gas exploration and production have significant known, well-documented, and generally acknowledged societal and environmental impacts[11] that cannot be negated entirely nor sufficiently mitigated by legislation. We submit that a broader consideration of whether the fundamental underlying premise is reasonable: that minimising harm and risk is sufficient justification to allow fracking for oil and gas to proceed.

8. Our submissions include that before a decision to promulgate legislation such as the Draft Regulations can be made, appropriate consideration must be given to the impacts that legislation enabling fracking will have on the climate crisis. In light of the scientific consensus on the impacts of the climate crisis and South Africa's own vulnerability thereto, the enablement of gas exploration and production in South Africa poses a serious threat to the rights, including the health, livelihoods and futures of rural and poor communities, women, children and future generations.

9. Specifically, the harms of gas exploration and production, for which there is already conclusive evidence, need to be weighed in. We draw attention to the findings of the Strategic Environmental Assessment (SEA) for Shale Gas Development in the Central Karoo conducted by CSIR, SANBI and the Council for Geoscience for a big group of government departments and agencies, including the DMRE, between 2015 and 2017. In particular, we highlight the cumulative risks identified in the Scientific Assessment of the Opportunities and Risks, "A Summary for Policy Makers, 2nd Edition, published in 2017".[12]

10. We submit that any regulations that seek to unlock gas exploration and production (using any technology, but especially fracking) in the current circumstances will give rise to serious harmful impacts, not only from a climate change perspective, but environmental, health and social harms as well. Given South Africa's extreme vulnerability to the impacts of climate change - arguably any decision to lock the country in to more harmful GHG emissions, through fossil fuel exploitation, which is neither necessary nor desirable, would be in direct contravention of the state's constitutional obligations to protect the rights of the people of South Africa, and the duty of care embodied in section 28 of NEMA. On this basis, the Draft Regulations, in their entirety, should be reconsidered.

Part B: Comments on the Draft Regulations and the Requirements based on specific harms

Climate

11. The government has confirmed South Africa's extreme vulnerability to the impacts of climate change.[13] These impacts will largely be felt through: significant warming (as high as 5–8°C, over the South African interior by the end of this century, as a conservative estimate); impacts on water resources, such as decreased water availability; and a higher frequency of natural disasters.

12. Already the impacts of drought, extreme weather events, and fires in South Africa have cost the country hundreds of human lives and billions of rand. Virtually every province in the country has recently experienced, or is currently experiencing, severe, extended drought. The impacts of climate change are crippling livelihoods and jobs, and will

[11] Physicians for Social Responsibility, Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking and Associated Gas and Oil Infrastructure, Eighth Edition (April 2022), https://psr.org/wp-content/uploads/2022/04/compendium-8.pdf.

[12] This summary can be accessed here : http://seasgd.csir.co.za/wp-content/uploads/2017/06/Summary-for-Policy-Makers_2ndEdition_05June2017.pdf

[13] The National Development Plan, the National Climate Change Response White Paper, the National Climate Change Adaptation, the Low Emission Development Strategy 2050.

have long-term impacts on food security, food prices, human settlements, and health. Government is having to subsidise these high costs, and will increasingly have to do so. A recent report titled "Climate Change Implications for SA's Youth" by Nicholas King states that "South Africa … will suffer enormous negative physical, socio-economic and ecological impacts, under all scenarios. These will include extreme heat stress, extreme weather events, including storms, flooding and droughts, sea-level rise and coastal damage, crop failures and food insecurity, water stress, disease outbreaks, various forms of economic collapse and social conflict and mass migration to informal settlements around urban areas. Impacts do not rise linearly with rising temperature, but with an ever-steepening curve, rapidly making large parts of the interior of the country, as well as vulnerable low-lying coastal areas, uninhabitable. All of these impacts together will dramatically alter the lives and prospects for today and tomorrow's youth, who will suffer significant harms, in a combination of detrimental physical health and wellbeing, mental trauma, social upheaval and reduced opportunities for self-advancement." The United Nations International Children's Emergency Fund (UNICEF) released their global report titled "'The Climate Crisis Is a Child Rights Crisis: Introducing the Children's Climate Risk Index' in August 2021. This report highlights how children and young people in South Africa are among those most at risk of the impacts of climate change, threatening their health, education and protection.

13. The United Nations' Intergovernmental Panel on Climate Change (IPCC) has confirmed a dramatic increase in risk and impact severity if the global average temperature increase exceeds 1.5°C for our climate. South Africa's Nationally Determined Contribution (NDC) under the Paris Agreement states that South Africa "warmly welcomed the IPCC's special report on global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways", and "considers the IPCC reports to be of the highest importance in guiding our actions". However, South Africa is already falling behind on its global and constitutional obligations to address climate change. The NDC falls outside the fair share range; and is not consistent with the Paris Agreement 2°C target – let alone the 1.5°C benchmark set by the IPCC. This, while it has been recognised that Africa and South Africa, are warming at a rate that is about twice the global average temperature increase rate. The effects of this will be catastrophic – impacting particularly on the most vulnerable sectors of South African society.

14. It is the constitutional imperative of the government to ensure that people in South Africa are protected against these impacts – that their rights enshrined in the Constitution are upheld and protected. There is no justifiable basis on which the rights to life, dignity, and environment not harmful to health or wellbeing could be limited by plans to develop further fossil fuel extraction, where less harmful alternatives are available. Further, (socio) economic development and sustainable livelihoods will be compromised in a country devastated by the effects of climate change, and it should be noted that, ultimately, there will be no jobs on an uninhabitable planet.

15. We attach an expert report by Dr. Lawrence D. Meckel, titled "Professional Opinion regarding Draft Regulations pertaining to the exploration and production of onshore oil and gas requiring hydraulic fracturing in South Africa" (hereinafter referred to as the Expert Report which we attach hereto as Annexure A). The Expert Report lays out the common issues relating to fracking operations, including environmental impact, personal safety, water use, proppant acquisition and use, aquifer/groundwater discharge, surficial subsidence, induced seismicity, and waste. The report also provides an opinion on the Requirements.

16. The Expert report states that "emissions from gas leaks and venting, diesel generators and truck traffic, and flaring are a known problem, and require careful monitoring, and either correction or mitigation. **These emissions include volatile organic compounds, methane, particulate matter (including black carbon), and nitrogen oxides [emphasis added].** These have a global impact, because they are primary or secondary greenhouse gases that contribute to climate change, and also a local impact, contributing to poor health outcomes, including respiratory and cardiovascular disease and increased risk for some cancers, as well as adverse birth outcomes for those living near fracking operations. They also affect health and ecosystems at a regional level, as a result of their contributions to harmful ground level ozone."

17. Methane, which is the principal component of gas, does not persist in the atmosphere as long as carbon dioxide, but its climate impact is more than 80 times stronger in the short-term (20-year) time frame and 28 times stronger

over the long term (100-year) time frame; it is the second-biggest driver of climate change.[14][15][16] Gas is therefore as emission-intensive as coal, if not more so, and thus as much a contributor to climate change.

18. To ensure appropriate action, significant ambition is needed in the next ten years to sufficiently reduce GHG emissions within the necessary trajectory range and to get South Africa where it needs to be to avoid the worst impacts of the climate crisis. Doing this requires a commitment to phase out existing fossil fuels and halt new fossil fuel investment as soon as possible – and certainly to refrain from locking-in to new fossil fuel infrastructure, which is not needed. The Draft Regulations, in enabling fracking for gas production, stand in contradiction to the just transition and climate response imperative, and we submit that it is both unreasonable and irrational, in addition to posing a substantial threat to the Constitutional rights of the people of South Africa.

Water

19. The biggest threat to water resources is upstream during production and transport. Gas production puts heavy pressure on water resources. Fracking, for example, depends on injecting massive volumes of water into a well in order to open up fissures in the shale rock formation, which then allows gas to flow back up to the wellhead. The water used per fracturing operation continues to increase as companies find that more water equates to more gas returned from each well. In some regions, the average volume of water per hydraulic fracture is 42 500 m3 – about 20 Olympic-sized swimming pools of water.[17] In the United States, an additional 1.5 million m3 of water per day is also required for gas processing and pipeline transport.[18] This intense water consumption presents an unjustifiable risk to environments and therefore to people in water-stressed countries such as South Africa in particular.

20. Generally, between 10 and 30% of water used for fracking returns to the surface as "produced water."15 This produced water contains radioactive material, toxic heavy metals, and salts. While produced water can in some cases be "recycled," or used again to frack another well, that process further concentrates those harmful materials in the flowback and produced water from the well.

21. Gas production presents several pathways to contaminate ground and surface water, stemming from the process's generation of large quantities of water infused with chemicals used to stimulate the well, as well as radioactive materials, heavy metals, and salts from the geologic formation. This water can migrate from the formation into which it is injected for well stimulation into underground aquifers. It also migrates into these aquifers via faulty well casings.[19]

22. Further, wastewater from gas production may be reinjected into wells in order to reduce risks in managing the toxic water at the surface, but this presents many of the same risks as the fracking process itself.[20] Wastewater

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[14] Ibid page 8.

[15] One ton of methane has the same climate-forcing impact as 84 tons of CO2 over a 20-year period and the same impact as 28 tons of CO2 over a 100-year period.
See G. Myhre et al., "Anthropogenic and Natural Radiative Forcing," Table 8.7, in Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, T. F. Stocker et al., eds. (Cambridge, U.K., and New York, N.Y.: Cambridge University Press, 2013), https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf.

[16] U.S. Environmental Protection Agency (hereinafter U.S. EPA), "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2017," April 2019, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2017.

[17] Andrew J. Kondash, Nancy E. Lauer & Avner Vengosh, The intensification of the water footprint of hydraulic fracturing, 4 Science Advances eaar5982 (2018), https://advances.sciencemag.org/content/4/8/eaar5982

[18] Union of Concerned Scientists (2013), How it Works: Water for Natural Gas, available at https://www.ucsusa.org/resources/water-naturalgas

[19] Avner Vengosh et al., A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States, 48 Environ. Sci. Technol. 8334–8348 (2014), https://pubs.acs.org/doi/10.1021/es405118y; A. R. Ingraffea et al., Assessment and risk analysis of casing and cement impairment in oil and gas wells in Pennsylvania, 2000-2012, 111 Proceedings of the National Academy of Sciences 10955–10960 (2014), http://www.pnas.org/cgi/doi/10.1073/pnas.1323422111.

[20] Weiyu Zheng et al., Wastewater leakage in West Texas revealed by satellite radar imagery and numerical modeling, 9 Sci Rep 14601 (2019), http://www.nature.com/articles/s41598-019-51138-4

injection wells also cause earthquakes by putting significant pressure on faults,[21] even in locations many kilometers from the wells.[22] (It is noted that the Draft Regulations prohibit the use of re-injection disposal wells.)

23. Produced water treated at the surface can only be safely managed as a hazardous material, undergoing special salt removal and radioactivity reduction treatments. Without this, high levels of radium are likely to end up in local waterways and bio-accumulate through local food webs.[23] The toxic sludge left behind must be disposed of as hazardous waste.[24]

Waste

Fracking produces large volumes of toxic waste that require special treatment

24. Fracking operations generate large volumes of hazardous waste. The US EPA estimated that in 2016, some 4136 million tonnes of waste were generated by fracking in the United States.[25] The agency acknowledged that this is likely an underestimate given the growing volumes of water used in fracking and length of the wells.[26] This figure includes some 4038 million m3 of wastewater -- or some 1,615,200 Olympic swimming pools filled with wastewater.[27] Treatment of this water then yields some 70 million tonnes of toxic solids.[28] About 25 million additional tonnes of solid waste created by drilling mud and drill cuttings also have to be managed.[29] While South Africa's fracking operations would be unlikely to reach this scale, even a single well using fracking can produce between hundreds and thousands of tonnes of waste that requires special disposal processes, meaning that the waste management challenge created by fracking quickly adds up as even exploration wells multiply.

25. The wastewater from fracking includes water from the formation that returns to the surface in the first few weeks to months after fracking, known as flowback, along with the water that comes back over the life of the well, known as produced water. Drilling also requires liquid "drilling muds" that ease the drill bit through the formations that also return to the surface and require disposal. Fracking's solid wastes are composed primarily by the earth removed by the drill bit, known as drill cuttings, as well as the scale that builds up in tanks and pipes of solids precipitating out of the wastewater.

26. These wastes contain hazardous materials, including toxic chemicals used in the drilling process and hazardous materials brought out of the earth during the fracking process, including endocrine disruptors, carcinogens, and radioactive ions.[30] Chemical combinations and transformations underground also create new waste compounds

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[21] K. M. Keranen et al., Sharp increase in central Oklahoma seismicity since 2008 induced by massive wastewater injection, 345 Science 448– 451 (2014), https://science.sciencemag.org/content/345/6195/448.

[22] Shelby L. Peterie et al., Earthquakes in Kansas Induced by Extremely Far-Field Pressure Diffusion, 45 Geophysical Research Letters 1395–1401 (2018), https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2017GL076334.

[23] Nathaniel R. Warner et al., Impacts of Shale Gas Wastewater Disposal on Water Quality in Western Pennsylvania, 47 Environ. Sci. Technol. 11849–11857 (2013), https://doi.org/10.1021/es402165b.

[24] Alisa L. Rich & Ernest C. Crosby, Analysis of Reserve Pit Sludge from Unconventional Natural Gas Hydraulic Fracturing and Drilling Operations for the Presence of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM), 23 New Solut 117–135 (2013), https://doi.org/10.2190/NS.23.1.h.

[25] U.S. Environmental Protection Agency, Office of Research and Development, *Management of Exploration, Development, and Production Wastes: Factors Informing a Decision on the Need for Regulatory Action* 3–11 (2019), https://www.epa.gov/sites/production/files/2019-04/documents/management_of_exploration_development_and_production_wastes_4-23-19.pdf.

[26] *Id.* at 3–11.

[27] *Id.* at 3–11.

[28] *Id.* at 3–11.

[29] *Id.* at 3–11.

[30] Martin Elsner & Kathrin Hoelzer, *Quantitative survey and structural classification of hydraulic fracturing chemicals reported in unconventional gas production*, 50 Environ. Sci. Technol. 3290–3314 (2016), https://doi.org/10.1021/acs.est.5b02818; Cloelle Danforth et al., *An integrative method for identification and prioritization of constituents of concern in produced water from onshore oil and gas extraction*, 134 Environment International 105280 (2020), http://www.sciencedirect.com/science/article/pii/S0160412019319907; Samuel J. Maguire-Boyle & Andrew R. Barron, *Organic compounds in produced waters from shale gas wells*, 16 Environ. Sci.: Processes Impacts 2237–2248 (2014), http://pubs.rsc.org/en/content/articlelanding/2014/em/c4em00376d; U.S. Environmental Protection Agency, Office of Research and Development,

that are just beginning to be identified.[31] Many of the chemicals identified in these wastes have unknown toxicity profiles.[32]

27. These hazardous wastes can contaminate the air, soil, and water if they are not stored, transported, treated, and disposed of properly, separately from other waste streams. They contain hydrocarbons that emit volatile organic compounds (VOCs), including known carcinogens like benzene and formaldehyde, into the air, along with radioactive elements. Their high salt content, heavy metals, and radioactive materials also contaminate soils and surface water if spilled, and are harmful to humans and wildlife alike. Standard wastewater treatment venters are not able to treat fracking wastewater due to both the high salt content and the concentration of radioactive material. Both must be removed from the water with special filtration processes that result in radioactive solids that must be disposed of in special sites for these products.

Draft Regulations

28. The Draft Regulations contain several strong provisions for managing waste from fracking. Nonetheless, additional detail and improvements on several points are necessary to reduce the risk of harms from these large volumes of toxic materials. In what follows we note the provisions currently in the Draft Regulations that should be maintained, as well as improvements that could be made to reduce risks from fracking waste.

29. *No pit use allowed*

29.1. The Draft Regulations state:

"The following activities when undertaken in terms of an exploration or production right for onshore oil and gas intending to or utilising hydraulic fracturing are prohibited:…(e) The storage of process water for reuse or disposal in pits or pollution control dams; (f) The storage of drill cuttings, sludge and waste other than in above ground tanks or leakproof skips…"

29.2. These are important requirements to maintain, as pits often leak or overflow, contaminating soils and waterways, and pose a danger to wildlife unlucky enough to land or fall into them.[33]

29.3. It is critical, however, that the tanks and skips not leak or overflow themselves, as noted in para 36.

30. *No reinjection permitted*

30.1. Also disallowed under the Draft Regulations is the "Discharge or disposal of hydraulic fracturing fluids, process water or any other component of process water… (iii) to underground, including the use of re-injection disposal wells".[34]

30.2. Reinjecting wastewater underground can seem a convenient way of dealing with large volumes of wastewater, but it poses additional risk of contamination to aquifers, and has been the primary source of induced seismicity, that is, small earthquakes caused by the pressure the injected water places on faults.

Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States 666 ES-42 (2016), https://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=332990.

[31] Kathrin Hoelzer et al., *Indications of transformation products from hydraulic fracturing additives in shale-gas wastewater*, 50 ENVIRON. SCI. TECHNOL. 8036–8048 (2016), https://doi.org/10.1021/acs.est.6b00430 (last visited Jun 12, 2020); Marika Nell & Damian E. Helbling, *Exploring matrix effects and quantifying organic additives in hydraulic fracturing associated fluids using liquid chromatography electrospray ionization mass spectrometry*, 21 ENVIRON. SCI.: PROCESSES IMPACTS 195–205 (2019), http://pubs.rsc.org/en/content/articlelanding/2019/em/c8em00135a.

[32] Cloelle Danforth et al., *An integrative method for identification and prioritization of constituents of concern in produced water from onshore oil and gas extraction*, 134 Environment International 105280 (2020), http://www.sciencedirect.com/science/article/pii/S0160412019319907.

[33] U.S. Fish and Wildlife Service, *Wildlife Mortality Risk in Oil Field Waste Pits*, (December 2000).

[34] Regulation 4.c.iii.

[35] This induced seismicity not only damages local structures, but also increases risk and uncertainty for fracking operations and generates new pathways for groundwater contamination. As such, prohibition of wastewater reinjection as a method for disposal is also an important provision to maintain.

31. *No disposal in government landfills*

31.1. The Draft Regulations further prohibit the "Discharge or disposal of hydraulic fracturing fluids, process water or any other component of process water…(iii) to a government water treatment works".[36]

31.2. As noted, fracking wastewater requires special treatment for its radioactivity, heavy metals, and high total dissolved solids, and government treatment works are typically unable to provide this treatment.[37] This is therefore an important provision to maintain. However, the Draft Regulations would be strengthened by

a) specifically naming the treatments required of wastewater to deal with these toxic materials, including the final disposal plan for the solids; and,
b) requiring the identification within the EIA of the specific treatment facilities that are able to process this hazardous waste, and elaborating a waste transportation plan to the facility named.

32. *No disposal in watercourses – or anywhere without prior treatment*

32.1. In addition, the Draft Regulations prohibit discharge or disposal of wastewater "into a surface watercourse".[38] This should be a rather obvious, though necessary requirement. However, the prohibition should go further to prohibit discharge of all untreated process water anywhere on the ground. Experience with dumping of process water on roads and fields in the US has shown that it contaminates not just the soil, but also local waterways when the dumped material runs off in rainstorms.[39]

33. *Full public disclosure of drilling fluids*

33.1. The Draft Regulations require that "The names of all drilling fluids must be submitted to the designated agency for approval prior to use".[40] Given that these fluids can be toxic and interact in ways harmful to the environment and human health within the formation, it is critical that the specific chemical formulations be provided to the agency. However, the Draft Regulations should also require that these be made available publicly, either on the company or the DFFE website, and on request.

34. *Need for chemical analysis of waste*

34.1. The Draft Regulations, or the Requirements for later stage exploration and production that have not yet been published, presently lack guidance on a system for testing fracking waste. Because fracking waste is more than the sum of the chemicals that enter the formation and those that come out of them – the chemicals injected and already present in the formation can undergo various transformations, producing

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[35] Thomas H. W. Goebel & Emily E. Brodsky, *The spatial footprint of injection wells in a global compilation of induced earthquake sequences*, 361 Science 899–904 (2018), https://science.sciencemag.org/content/361/6405/899; Groundwater Protection Council, *Produced Water Report: Regulations, Current Practices, and Research Needs* 318 (2019).
[36] Regulation 4.c.ii.
[37] Nathaniel R. Warner et al., *Impacts of shale gas wastewater disposal on water quality in Western Pennsylvania*, 47 Environ. Sci. Technol. 11849–11857 (2013), https://doi.org/10.1021/es402165b.
[38] Regulation 4.c.ii.
[39] Nancy E. Lauer, Nathaniel R. Warner & Avner Vengosh, *Sources of Radium Accumulation in Stream Sediments near Disposal Sites in Pennsylvania: Implications for Disposal of Conventional Oil and Gas Wastewater*, 52 Environ. Sci. Technol. 955–962 (2018), https://doi.org/10.1021/acs.est.7b04952 (last visited Mar 6, 2020).
[40] Regulation 14.4.

new substances in the process – it is critical to test the waste to know what it needs to be treated for.[41] This testing must occur on an ongoing basis, and must seek to identify a wide range of substances. It appears that some space may be made for such testing in the Regulations – "(iv) details of hydraulic fracturing and process water management programme, including testing programmes and operations which expands on the plans contemplated in regulation 7."[42] Nevertheless, there is not presently a specific requirement for what that testing program and operations must contain, which is a significant gap.

35. *Need for tracking waste volumes*

35.1. In addition to testing the waste, best practice dictates that the waste volumes be measured regularly and tracked through their transportation to their end disposal. This will help to ensure that nothing is lost along the way in the form of spills, and will help the company and the government better understand and manage waste flows.

36. *Need for clarity about conditions under which waste must be stored and transported*

36.1. Currently, there is no specific freeboard requirement identified in the Draft Regulations for the fracking waste held in tanks and skips, nor for the way this waste will be isolated from, for example, birds and other wildlife to prevent harm to them. Moreover, there are no requirements for transportation of waste to a processing facility described. Given the often poor condition of roads in rural regions where fracking is likely to take place, the waste will need to be carefully secured to prevent spills.

Cumulative Impacts

37. It is critical that any regulatory regime for fracking consider the cumulative impacts of fracking across a landscape in advance of activity beginning and throughout all project activities, from seismic surveys to production. Fragmented consideration of an individual project's impacts can lead to a proliferation of projects that then have much more harmful impacts on a region in their sum, fundamentally changing the character of a region and its ecosystems. Presently, neither the Draft Regulations nor the Requirements contain requirements for predicting and assessing cumulative impacts across all impact types. This significant gap must be remedied in both Requirements and in the Draft Regulations.

38. A robust cumulative impact assessment regime for fracking would include the following elements:

38.1. Regional baseline assessments of water quantity and quality, biodiversity, socioeconomic contexts, air quality, and greenhouse gas emissions. These should be designed by teams of qualified scientists with public input, and should provide at least two years of baseline data, as well as historical context and future projections.

38.2. A Strategic Environmental Assessment that assesses and helps those living in and near to region to understand what a future with this new industry would look like in the region, creating projections for impacts on water quantity and quality, biodiversity, socioeconomic contexts, air quality, and greenhouse gas emissions at different scales of production.

38.3. Inclusive design and execution of a long-term regional monitoring plan that monitors water quantity and quality, biodiversity, socioeconomic contexts, air quality, and greenhouse gas emissions.

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[41] Kathrin Hoelzer et al., *Indications of transformation products from hydraulic fracturing additives in shale-gas wastewater*, 50 Environ. Sci. Technol. 8036–8048 (2016), https://doi.org/10.1021/acs.est.6b00430 (last visited Jun 12, 2020); Marika Nell & Damian E. Helbling, *Exploring matrix effects and quantifying organic additives in hydraulic fracturing associated fluids using liquid chromatography electrospray ionization mass spectrometry*, 21 Environ. Sci.: Processes Impacts 195–205 (2019), http://pubs.rsc.org/en/content/articlelanding/2019/em/c8em00135a (last visited Dec 3, 2020).
[42] Regulation 14.3.b.iv.

38.4. Consideration in an EIA of any given project's contribution to impacts across the region, looking at the cumulative impacts of not only industry projects on water quantity and quality, biodiversity, socioeconomic contexts, air quality, and greenhouse gas emissions, but also considering the rest of the contributors from the region to these key indicators of ecosystem and human health. The scope of this region to be included in the EIA should be clearly defined within the Draft Regulations and both Requirements. The analysis should be done equally for 2D seismic surveys as for fracking.

39. Having a clear framework about the cumulative impacts of fracking and how they will be monitored, publicised, and weighed in advance of any exploration beginning is particularly important because of several qualities unique to fracking. First is that fracking has significant impacts on a landscape, including substantial clearing for roads, access paths, well pads, and pipelines; on air quality; and on water quantity and quality. When compared to conventional oil and gas extraction, each fracked well uses far more water and proppant, [43] generates more traffic on the roads, and creates more waste to be managed as a result of the longer wells. [44] Additionally, where fracking is successful, the U.S. example suggests that wells multiply rapidly because there is an economic incentive for companies to drill as quickly as possible given the capital-intensive nature of the work. [45] There are economies of scale in fracking, so scaling up quickly is economically preferable and companies will push for this, especially if they seek to compete on global markets.[46]

40. Lessons from Mozambique show us that large flows of foreign investments are often not translated into a boom. In 2009 –11 large offshore gas fields were discovered in the Rovuma Basin, north-east of Mozambique. The country has been expected to benefit largely from new natural gas projects as several foreign enterprises have been investing heavily in the sector, with total investments estimated to reach around US$100 billion. However, this has not been the case. There is no evidence of a growth spurt that might have been expected to follow from the very large foreign direct investment inflows. Growth in the period since ~2013 has been weaker than at any time in the past 20 years. The gas finds led to inflated expectations of revenues from extractives, which in turn contributed to premature, undisclosed public sector borrowing, which then triggered a debt crisis in Mozambique. Even when the enlarged revenues from the new gas extraction do eventually materialise, they will most likely need to be committed quite heavily to deal with the still high rates of debt and debt service. It is likely that Mozambique faces at least six more years with fiscal restraints, high debt ratios and low growth, even though the country will still be attracting high rates of private investment, ultimately shrinking the country's fiscal space. [47]

41. Given these pressures, it is vital that our government and communities get out in front of this to prevent corporate desires for profit from defining the future of an entire region and its people. Without robust consideration of cumulative impacts, elusive in narrow project-by-project approvals, the state and local people are likely to become beholden to companies pushing through a proliferation of projects.

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[43] Andrew J. Kondash, Nancy E. Lauer & Avner Vengosh, *The intensification of the water footprint of hydraulic fracturing*, 4 SCIENCE ADVANCES eaar5982 (2018), https://advances.sciencemag.org/content/4/8/eaar5982 (last visited Dec 4, 2019).

[44] Drilling for Miles in the Marcellus: Laterals Reach New Lengths, JOURNAL OF PETROLEUM TECHNOLOGY, 2018, https://pubs.spe.org/en/jpt/jpt-article-detail/?art=4465 (last visited May 18, 2020).

[45] Justin Mikulka, *Fracking in 2018: Another Year of Pretending to Make Money*, DESMOG, 2018, https://www.desmogblog.com/2018/12/18/fracking-finances-record-oil-production-fuzzy-math (last visited Jun 29, 2020); Justin Mikulka, *The North American Natural Gas Industry Is Struggling—Here's Why*, DESMOG, 2020, https://www.desmogblog.com/2020/03/11/us-natural-gas-lng-export-chesapeake-financial-struggle (last visited Jun 12, 2020).

[46] David Fickling, *Analysis | Don't Count the Fracking Industry Out Just Yet*, WASHINGTON POST (2020), https://www.washingtonpost.com/business/energy/dont-count-the-fracking-industryout-just-yet/2020/04/14/7c25f130-7ea4-11ea-84c2-0792d8591911_story.html (last visited Jun 12, 2020).

[47] See https://igmozambique.wider.unu.edu/research-brief/bust-boom

Public Participation

On the Draft Regulations

42. Given the substantial and widespread impacts of gas exploration and production, particularly through fracking, we submit that an appropriately substantial public participation process be conducted by the DFFE on these Draft Regulations. Any legislation enabling reconnaissance, exploration, production, retention, supply, distribution and storage of fossil fuels will have significant environmental impacts on surrounding communities. Any public participation around the Draft Regulations should permit adequate and meaningful engagement with ample time, accessible information and process to engage with interested and affected parties in order for the process to be transparent, just and equitable.

43. While we acknowledge and appreciate the opportunity to comment and engage on the Draft Regulations, we record that further consultation must be conducted to allow communities and all who are interested in and affected by the Draft Regulations to actively participate in their development. We therefore request that you share your consultation road map depicting the DFFE's plans in this regard.

Within the Draft Regulations

44. It is widely accepted that the public and all relevant stakeholders should be involved in the environmental decision-making process. In fact, it is the constitutional imperative of the government to ensure that people in South Africa are afforded administrative action that is lawful, reasonable and procedurally fair – this means that all people are entitled to an opportunity to participate in an informed way in environmental governance. This is especially true in this context where 'fracking operations in oil and gas exploration and production have significant known, well-documented, and generally acknowledged societal and environmental impacts…'

45. With this context in mind, we are concerned that beyond the acknowledgement of the coordinating function of the Draft Regulations regarding public participation (R 2(f)(i)), there is no explicit provision relating to public participation in the Draft Regulations. Indeed, there is a tacit understanding that the authorisations, rights, permissions, licences and approvals necessary for the exploration or production of onshore gas and oil through fracking, as listed are subject to a participatory process (R 6(h)). However, it is necessary that an explicit provision be included within the Draft Regulations, which requires that public participation and consultation processes be conducted <u>prior</u> to any exploration, production or fracking occurs.

46. Further, we submit that the Draft Regulations should clearly state that a public participation and consultation process should be conducted during the baseline monitoring phase. This is because the resultant base monitoring plan, as a determinate of key reference indicators, should include a section on the projected socio-economic and cultural effects of fracking. To fully establish and contextualise these effects, a consultation process with all the relevant affected peoples and communities should be conducted. Considering the wide-reaching environmental socio-economic and cultural consequences of fracking, the consultation process must be meaningful, accessible and inclusive. Moreover, clear parameters on what constitutes meaningful, accessible, inclusive and sufficient participation / engagement should be determined and should include clarity on the role and importance of participation and community engagement and the timely, transparent and audited disclosure of relevant information, especially the measurements of the baseline monitoring process.

47. We note that the Requirements under subheading 2.2 make provision for the minimum requirements for a public participation process. Although the guidelines are reasonably comprehensive, they are not in fact requirements, only guidelines. We submit that a firmer framework should be established which, as mentioned above, promotes accessible, inclusive and systematic participation processes.

Specific Comments

	PROPOSED REGULATIONS	COMMENTS
Definitions		
1	"hydraulic fracturing" and "stimulation"	Is it the intention for the Purpose of these Regulations at Regulation 2 to cover other forms of stimulation? See also "Application of these Regulations"
Regulations		
2	Regulation 5(b)	Why is fracking not prohibited in Mountain Catchment Areas (s.9(e)) of the Protected Areas Act?
3	Regulation 5(d), (e) and (g)	2 kilometres is insufficient to mitigate against the risk of impacting these important resources. We submit that this radius should not be less than 5kms.
4	Regulation 6(f)	The environmental obligation should not be limited to the rehabilitation of the area <u>used</u>, but should include any area <u>affected</u> by the operations.
5	Regulation 7(4)	What is meant by "acknowledgment of an application…"?
6	Regulation 7(5)	Should this not refer to commencement of the "exploration or production operation" rather than the "hydraulic fracturing operation"?
7	Regulation 7(6) and 7(9)	Monitoring reports must be uploaded also to the co.'s website and made available to the public on request
8	Regulation 7(7)(d)	Who is the authority responsible for approving the emergency and spill emergency plan?
9	Regulation 14(4)	and quantities/proportions of drilling fluids
10	Regulation 19	Copies of all the rights, permits, etc referred to in Regulation 6(h) must be uploaded to the website of the holder and (particularly where there is no website) made available to the public on request.
11	Regulation 19(1)	Regulation 7 info must also be uploaded to the website of the holder and (particularly where there is no website) made available to the public on request.
12	Regulation 20	Insert 20(6) – the results referred to in 20(5) must also be uploaded to the website of the holder and (particularly where there is no website) made available to the public on request.
Appendix 3		
13	clause (1)(c)	Appointments must be in writing.
14	clauses (1)(d) and (2)(d)	"provide in writing".
15	clause (1)(e)(x)	Audit report must be uploaded to the website of the holder and (particularly where there is no website) made available to the public on request.
16	clause (1)(e)(xi)	Notice of incident must also be given to IAPs and local communities within 24 hours.
17	clause (2)(e)(iii)	Must be uploaded to the website of the holder and (particularly where there is no website) made available to the public on request.
18	clause (2)(g)(viii)(ii)	Must be uploaded to the website of the holder and (particularly where there is no website) made available to the public on request.
19	clause (2)(g)(viii)(jj)	This information must also be given to IAPs and local communities.
20	clause (2)(h)	Must be uploaded to the website of the holder and (particularly where there is no website) made available to the public on request.

Administrative Penalties

48. Due to the fact that we have very little experience of administrative penalties relating to South Africa's nascent oil and gas industry, we have looked to lessons from the developed United States oil and gas industry where resolution of environmental law violations is by far the most common method of enforcement.[48] Most U.S. environmental laws contain some sort of administrative enforcement mechanism for non-criminal violations.

49. With regard to fracking, the U.S. states of Colorado and Pennsylvania are considered to have the strongest administrative enforcement provisions. It is helpful to review the penalty rules in their entirety (note that Pennsylvania's provisions are in the state's oil and gas law, not in administrative regulations).[49][50] Below are some key suggestions:

50. Regulators Need Clear Guidelines to Ensure Consistent Enforcement of Violations

50.1. One of the primary criticisms of administrative enforcement mechanisms is that regulators often have too much discretion to ignore or minimise violations, or resolve issues informally with little or no penalty. This can lead to inconsistent or biased enforcement.

50.2. The state of Colorado took steps to eliminate this problem when it revised its administrative enforcement provisions for oil and gas development in 2014. An earlier investigative study by Earthworks (a U.S.-based extractives watchdog organisation) revealed that regulators in the state of Colorado issued enforcement notices in only a fraction of the cases in which inspections noted violations - even in instances where there had been a spill or contamination event.[51]

50.3. The former regulations encouraged informal resolution of all violations, no matter how severe, through phone calls, meetings, and other informal settlement procedures in which monetary penalties were not being assessed. Regulators expressed concern that this approach did not go far enough towards holding the oil and gas industry accountable to the highest standards.[52]

50.4. The regulations were substantially revised to limit use of informal settlement procedures. First, there may be no informal resolution of any Class 3 violation (the most serious) or any Class 1 or 2 violation that caused actual adverse impact.[53] Second, informal resolution procedures cannot be used if the violator has received a warning or inspection notices about the same violation.[54] And, in all cases, regulators retain the authority to seek formal resolution and imposition of monetary penalties even if a violation meets all of the criteria for informal resolution.[55]

50.5. Pennsylvania's enforcement policy, adopted in 2015, declares "[a]n appropriate enforcement action should be taken for each identified violation" and that the minimum response to any violation is written

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[48] See Congressional Research Service, "Federal Pollution Control Laws: How Are They Enforced?" (2014)(available at https://www.fas.org/sgp/crs/misc/RL34384.pdf)(observing

[49]Colorado Oil and Gas Conservation Commission, Rules of Practice and Procedure (Series 500) (hereinafter "COGCC Rules")(available at http://cogcc.state.co.us/documents/reg/Rules/LATEST/500Series.pdf) - see specifically Sections 522 & 523.

[50] Title 58 Pennsylvania Consolidated Statutes Annotated - Oil and Gas, Subchapter E, §§ 3251-3262 (available at http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/OilGasReports/2012/act13.pdf)

29. [51] See "Breaking All the Rules: The Crisis In Oil & Gas Regulatory Enforcement" (2012), p. 58 (available at https://www.earthworksaction.org/files/publications/FINAL-US-enforcement-sm.pdf)

[52] See Colorado Oil and Gas Conservation Commission, "Enforcement and Penalty Policy Review Under Executive Order No. D 2013-004" (2013), p. 15 (available at https://cogcc.state.co.us/Announcements/Enforcement_Penalty_Policy_Review_Final.pdf).

[53] See COGCC Rules, Sec. 522(c)(1)(A).

[54] Id., Sec. 522(c)(1)(B).

[55] Id., Sec. 522(c)(2).

notification to the operator informing it of the violation.[56] This ensures that there is at least a paper trail documenting violations, even if an enforcement action is not taken in a particular instance.

51. Operators should be Held to a Strict Liability Standard for Violations Subject to Administrative Penalties

51.1. We submit that the administrative penalty provisions should do not require regulators to prove that a violator acted with intent, knowledge or even negligence. Instead, there should be a strict liability standard.

51.2. Colorado's enforcement regulations simply state: "An operator who violates the Act, or a Commission rule, order, or permit may be subject to a penalty imposed by Commission order."[57] If gross negligence or willful conduct is found, this is considered an "aggravating" factor warranting a higher monetary penalty. Similarly, the Pennsylvania Oil and Gas Act declares: "the department [of environmental protection,] after a hearing, may assess a civil penalty regardless of whether the violation was willful."[58]

52. Monetary Penalties Must Be Severe Enough to Serve as a Deterrent

52.1. If the administrative penalties for violating fracking rules are too lenient, operators will simply view penalties as the cost of doing business and will have no incentive to change their behaviour.

52.2. Colorado amended its penalty regulations to impose a maximum daily fine of US$15,000 per violation per day (an increase from US$1,000 per violation per day) for the most serious violations.[59] Pennsylvania imposes a very high initial penalty, from US$25,000 to US$75,000 for the first day of violation, and US$1,000 per day after that for continuing violations.[60]

52.3. Ohio also imposes very high penalties, up to US$20,000 per day for certain types of violations. However, and in contrast to many states, monetary penalties cannot be assessed administratively, but must be obtained through civil action filed by the state Attorney General.[61] Ohio regulators may assess other administrative penalties, however, such as suspending activities that are related to a material and substantial violation of the law or the conditions of a permit.[62]

53. Repeat Offenders Should Face More Severe Administrative Penalties

53.1. Colorado's fracking regulations ratchet up enforcement procedures against operators that commit repeated violations. In such instances, regulators must initiate a full administrative hearing comparable to those that are held when an operator commits a violation with gross negligence or does so willfully/knowingly.[63] A repeat violator is not only subject to monetary penalties, but the Commission may opt to suspend the operator's certificate of clearance, which precludes the operator from selling oil and gas, and may also withhold new drilling or oil and gas location permits.[64]

53.2. Monetary Penalties Should Include a "Benefit" Component to Recoup the Financial Gain Achieved by Noncompliance

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[56] See "Standards and Guidelines for Identifying, Tracking, and Resolving Oil and Gas Violations," Doc. No. 820-4000-001 (2015), p.7 (available at http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-105828/820-4000-001.pdf).
[57] COGCC Rules, Sec. 523(a).
[58] Title 58 Pa. Consol. Stat. Ann. § 3256.
[59] COGCC Rules, sec. 523(c)(1)
[60] Title 58 Pa. Consol. Stat. Ann. § 3256.
[61] Ohio Rev. Code Ann. § 1509.33(H) (available at http://codes.ohio.gov/orc/1509).
[62] Id., § 1509.04
[63] See COGCC Rules, Sec. 523(d
[64] Id, Sec. 523(d)(2).

53.3. Oil and gas companies gain an economic benefit by violating environmental, safety, and health requirements. They avoid expenditures for costly pollution control equipment, facility repairs and upgrades, and monitoring. Some state and federal environmental laws authorise regulators to impose monetary penalties that reflect, among other things, the amount of money the violator saved through noncompliance.

53.4. For several decades, the U.S. Environmental Protection Agency (EPA) has used a tool called the "BEN model" to calculate the economic benefit to a violator.[65] Many states authorise or encourage regulators to use EPA's model in setting penalty amounts. For example, the New York Department of Environmental Conservation's penalty policy states: "If a penalty is to achieve deterrence, both the violator and the general public must be convinced that the penalty places the violator in a worse position than those who have voluntarily complied in a timely fashion. For this reason, it is DEC policy that, at a minimum, penalties should remove any economic benefit that results from a failure to comply with the law…In appropriate cases, the DEC may use the EPA computer program known as BEN to calculate and estimate the economic benefit in sophisticated and significant violations…Every effort should be made to calculate and recover the economic benefit of non-compliance."[66]

53.5. In Colorado's regulations, one of the aggravating factors that warrants an upward adjustment in penalty amount is if "[t]he violator benefited economically from the violation, in which case the amount of such benefit shall be taken into consideration."[67]

54. A Penalty Schedule Should be contained in legislation

54.1. It would be beneficial if the Draft Regulations provided clear guidance for penalty determinations to limit the discretion used in assessing the amount of a fine. For example, Colorado uses a penalty schedule that establishes a base penalty amount for three categories of violations and three categories of severity, generating nine base penalty amounts ranging from US$200 to US$15,000 per day.[68] The base penalty can be adjusted for various aggravating and mitigating factors that are identified in the regulations.[69]

54.2. Lastly, there is a financial incentive for operators to come forward and voluntarily disclose violations. If a violation is voluntarily disclosed and the operator comes into compliance within a reasonable time, it may receive a 35 percent penalty reduction.[70]

55. Environmental Monitoring and Enforcement Information Must be Publicly Disclosed

55.1. Inspection reports, compliance data, and enforcement decisions must be made publicly available. As of April 2015, Pennsylvania, Colorado, and West Virginia are the only three U.S. oil and gas producing states (out of 36) that publicly disclose information about rule violations.[71] Colorado's database is very limited, so it is not a worthwhile example to view.[72]

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[65] See http://www2.epa.gov/enforcement/penalty-and-financial-models.
[66] DEE-1 Civil Penalty Policy, Part III (available at http://www.dec.ny.gov/regulations/25227.html).
[67] COGCC Rules, Section 523(3)(A)(6).
[68] COGCC Rules, Sec. 523(c)(1)(available at http://cogcc.state.co.us/documents/reg/Rules/LATEST/500Series.pdf).
[69] Id., Sec. 523(c)(3).
[70] Id., Sec. 523(e).
[71] See Mother Jones, "Is Your Local Fracking Company Breaking the Rules? You'll Probably Never Know," (April 2015) (available at http://www.motherjones.com/environment/2015/04/fracking-violations-report).
[72] Following are links to the Pennsylvania and West Virginia databases:
Pennsylvania: Inspection reports, violations, and enforcement actions (including assessed penalty amounts) are available.
http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/OG_Compliance).
Records can be searched by location, operator name, or date (among other criteria).

CONCLUSION

56. As a final comment, we wish to draw your attention to the current global trend which sees the gas industry on the decline. A recent report conducted by the International Institute for Sustainable Development titled "Step off the Gas: International public finance, natural gas, and clean alternatives in the Global South" stated that while some countries plan to increase their domestic gas production either to generate export revenue or to reduce dependence on imports, these are increasingly risky investments with the global energy market changes. While these comments do not consider the extent of all the risks presented by investing in the gas industry, such comments have been made to the DMRE as the designated energy planning government department.

57. We are willing to make more detailed submissions to the DFFE on any of the issues raised above should this be useful. We thank you again for the opportunity to comment on the Draft Regulations and trust that our comments will be addressed.

Yours faithfully
CENTRE FOR ENVIRONMENTAL RIGHTS

per:

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The Pennsylvania Department of Environmental Protection also publishes an annual report in which it summarises inspection and enforcement efforts for conventional and unconventional oil and gas activities. See 2014 Oil and Gas Annual Report (available at http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/Annual_Report/2014/2014_Annual_Report_for_web_July1.pdf).
West Virginia: Inspection and violation data are available, but maintained in separate databases (making it difficult to compare information). See:
http://www.dep.wv.gov/oil-and-gas/databaseinfo/Pages/OGD.aspx

Professional Opinion regarding Proposed Regulations pertaining to the exploration and production of onshore oil and gas requiring hydraulic fracturing in South Africa

Dr. Lawrence D. Meckel, III ("LDM")
Monteverde Energy
Melbourne, Australia

21 August 2022

My Qualifications and Scope of Review

I, Dr. Lawrence Daniel Meckel, III, am a practicing professional petroleum geoscientist and sustainability consultant with more than 30 years of relevant training and experience.[1] In my professional capacity, I have personally reviewed and evaluated the "Regulations", and provide my opinion on the adequacy of the Regulations to minimize risk and harm to people and the environment, relative to international best practice.

Materials Reviewed

- Documents I considered are entitled:
    - "**Consultation on the Intention to Prescribe Minimum Requirements for the Submission of Applications for an Authorisation, Right, Permit, or Licence for the Onshore Exploration of Oil and Gas Intending to Utilise Hydraulic Fracturing, Revision 0, May 2022**" [dated 08 July 2022] ("Requirements")
    - "**Proposed Regulations Pertaining to the Exploration and Production of Onshore Oil and Gas Requiring Hydraulic Fracturing**" [dated 11 July 2022] ("Regulations")
- Other relevant regulatory documents referred to in "Requirements" and "Regulations" were not consulted, but may include more specific provisions regarding fracking activities. These include:
    - **Environmental Impact Assessment Regulations**
    - **Water Use Licence Regulations, 2017**
    - **Regulations for the Use of Water for Exploration and Production of Onshore Naturally Occurring Hydrocarbons that require Stimulation, including Hydraulic Fracturing and Underground Gasification, to Extract, and any Activity Incidental Thereto that may Impact Detrimentally on the Water Resources, 2021** [DRAFT]
    - **Minimum Information Requirement for the Submission of Applications for an Authorisation, Permit or Licence for the Exploration and Production of Oil and Gas Utlising Hydraulic Fracturing** (unreleased at the time of review)

I present my findings below in three parts: (1) Summary for Decision Makers; (2) General Observations; and (2) Opinion re: "Regulations".

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1 Curriculum vitae of Dr. Lawrence Daniel Meckel, III [attached].

SUMMARY FOR DECISION MAKERS

My opinion is that the proposed Regulations do not currently represent best practice globally for minimizing harm and risk from hydraulic fracturing and all associated oil and gas exploration and production activities, including for the following reasons:

1. The "Regulations" do not apply equally to all exploration and production operations of onshore oil and gas intending to or utilizing hydraulic fracturing. Chapters and Appendices should be included that provide specific guidelines, practices and standards for exploration operations and activities which anticipate hydraulic fracturing and production operations and activities which utilize hydraulic fracturing.
2. A document critical to the assessment of the Regulations ("*Minimum Information Requirement for the Submission of Applications for an Authorisation, Permit or Licence for the Exploration and Production of Oil and Gas Utlising Hydraulic Fracturing*") had not been released for review at the time of writing. Therefore, the proposed "Regulations" cannot reasonably be assessed in their entirety
3. There is no indication of a comprehensive Due Diligence process that would benchmark the proposed Regulations relative to other international regulations, best practices, and standards.
4. In the interest of public and operational safety, prohibited areas must include a consideration of dwellings and built-up areas.
5. Regulations should establish substantially equivalent protections between avoidance (i.e., baseline or *status quo* conditions) and monitoring and mitigation, as regards each of the conditions of the baseline monitoring program discussed in the "Requirements".
6. Regulations should quantify a threshold of induced seismicity that, if exceeded, will result in a termination of all operations until a plan to avoid such seismicity in the future is agreed.

GENERAL OBSERVATIONS

It is clear, from my reading of the "Regulations", that the South African Government and the Department of Forestry, Fisheries, and the Environment seek to minimize harm and risk from hydraulic fracturing ("fracking") and associated oil and gas exploration and production activities, while allowing reasonably regulated commercial activities to proceed.

However, there are numerous aspects of the "Regulations" that require additional consideration, as discussed in this Opinion. Not least among these considerations is a broader consideration of whether the fundamental underlying premise is reasonable: that minimizing harm and risk is sufficient justification to allow fracking to proceed.

Fracking is a particularly fraught topic, involving an interplay of issues that include (among others) national, regional, and international energy security; corporate profit and associated governmental tax revenue; job creation; personal and community health and safety concerns; and environmental protection concerns.

On the one hand, fracking is a mature, established technology for horizontal petroleum well completion in many parts of the world, including Argentina, Canada, China, and the United States.

As a result, fracking operations are fairly standard and well-understood, as are the economics of such ventures, which are highly sensitive to fluctuations in oil and gas price[2].

On the other hand, fracking operations in oil and gas exploration and production have significant known, well-documented, and generally acknowledged societal and environmental impacts[3] that cannot be negated entirely nor absolutely mitigated by legislation.

With specific regard to fracking operations (and with reference to South Africa), common issues include, among others:

- **Environmental impact**
    - The operational footprint, including roads, pads, tanks and other infrastructure, is extensive (Fig. 2). In South Africa, much of the area under consideration for petroleum operations is remote and sparsely inhabited, so operations are unlikely in many instances to affect residents negatively as in other jusrisdictions (and may contribute positively to local economies); however, operations also impact local flora and fauna, and local-regional air and water conditions; accordingly, operations must be governed appropriately to protect the environment.
    - Excessive noise, light and noxious vapors are possible, and are the subject of particularly strict regulations in many jurisdictions internationally.
    - Emissions from gas leaks and venting (Fig. 3), diesel generators and truck traffic, and flaring are a known problem, and require careful monitoring, and either correction or mitigation. These emissions include volatile organic compounds, methane, particulate matter (including black carbon), and nitrogen oxides.[4] These have a global impact, because they are primary or secondary greenhouse gases that contribute to climate change, and also a local impact, contributing to poor health outcomes, including respiratory and cardiovascular disease and increased risk for some cancers, [5] as well as adverse birth outcomes for those living near fracking operations.[6] They

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[2] Recent industry profits, associated with historically high oil and gas prices, follow more than a decade of massive industry-wide financial losses, associated with lower prevailing prices (Fig. 1). Had prices not unexpectedly rebounded as a result of COVID-19 and the war between Ukraine and Russia, there was little reason for optimism. The expected long-term oil price in 2020 was ~ USD $40/barrel. Global oil and gas prices are highly sensitive, and there is no reason to believe current prices (and profits) are sustainable – especially in light of global recognition of the negative impacts of oil and gas exploration on impacted communities and the environment.

[3] Physicians for Social Responsibility, *Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking and Associated Gas and Oil Infrastructure*, Eighth Edition (April 2022), https://psr.org/wp-content/uploads/2022/04/compendium-8.pdf.

[4] R. A. Field et al., *Air quality concerns of unconventional oil and natural gas production*, 16 Environ. Sci.: Processes Impacts 954–969 (2014), http://pubs.rsc.org/en/content/articlelanding/2014/em/c4em00081a; Lisa M. McKenzie et al., *Human health risk assessment of air emissions from development of unconventional natural gas resources*, 424 Science of The Total Environment 79–87 (2012), http://www.sciencedirect.com/science/article/pii/S0048969712001933; Paul S. Goodman et al., *Investigating the traffic-related environmental impacts of hydraulic-fracturing (fracking) operations*, 89–90 Environment International 248–260 (2016), http://www.sciencedirect.com/science/article/pii/S0160412016300277

[5] Gregg P. Macey et al., *Air Concentrations of Volatile Compounds Near Oil and Gas Production: A Community Based Exploratory Study*, Environmental Health 13, no. 82 (2014), https://doi.org/10.1186/1476-069X-13-82. Zoe F. Cairncross et al., *Association Between Residential Proximity to Hydraulic Fracturing Sites and Adverse Birth Outcomes*, JAMA Pediatrics, April 4, 2022, https://doi.org/10.1001/jamapediatrics.2022.0306; 6 Hannah N. Blinn et al., *Exposure Assessment of Adults Living near Unconventional Oil and Natural Gas Development and Reported Health Symptoms in Southwest Pennsylvania, USA*, PLoS One 15, no. 8 (2020): e0237325, https://doi.org/10.1371/journal.pone.0237325; Mary Willis et al., *Natural Gas Development, Flaring Practices and Paediatric Asthma Hospitalizations in Texas*, International Journal of Epidemiology 49, no. 6 (2021): 1883–96, https://doi.org/10.1093/ije/dyaa115

[6] Elaine L. Hill and Lala Ma, *Drinking Water, Fracking, and Infant Health*, Journal of Health Economics, 2022, 102595, https://doi.org/10.1016/j.jhealeco.2022.102595; Peter M. Edwards et al., *High Winter Ozone Pollution from Carbonyl Photolysis in an Oil and Gas Basin*, Nature 514 (2014): 351–54, https://doi.org/10.1038/nature13767.

also affect health and ecosystems at a regional level, as a result of their contributions to harmful ground level ozone.[7]

- **Personal safety**. During fracking operations, road use increases significantly, as a result of the transport of water and/or proppant. The increased traffic may result in additional transport-related accidents.[8]
- **Water use**. Fracking requires significant amounts of water, which must be transported to location by truck or pipeline. In arid climates such as South Africa, where drought is especially prevalent[9], it is not immediately clear how or from where the required volumes of water would be sourced or abstracted.
- **Proppant acquisition and use**. Proppant must be mined (if natural sand is used) or manufactured (if a coated or ceramic proppant is used). In the former case, there are associated issues involved in the extraction/mining of suitable quartz sands.[10] The latter case is highly unlikely in the short-term, given the lack of any nearby fracking operations which would imply a ready source of suitable material. In any case, proppant is likely to need to be transported large distances, which is only achievable in remote South Africa by train and/or highway, adding considerably to CO_2 emissions and road safety concerns.
- **Aquifer/groundwater damage**. Groundwater, especially in arid areas like most of South Africa, is critical to protect for farming, irrigation, and municipal usage. Accordingly, all effort should be made to reduce risk of adverse impact on groundwater resources. International best practice suggests that extractive industries like oil and gas may be held to substantially more restrictive standards in terms of groundwater contamination than other users.[11] I recommend adoption of similar standards as a minimum.
    - Aquifers above the petroleum reservoir may be damaged during drilling or well completion. This risk is generally very low for fracking-specific activities, unless the aquifer is in direct proximity to the reservoir to be fracked. Research at the University of Durham (UK) "indicates that there is a <1% chance of a fracture extending vertically more than 350 metres and that 588m was the maximum recorded. Since gas-bearing shales and aquifers are usually separated by more than 1 kilometre of rock, it is very unlikely that fracking itself could create a pathway for contamination of drinking water".[12]
    - Though the chance of contamination may be small for a given fracture, across a basin and many wells, the risk of contamination increases. Recent research shows,

[7] C. Warneke et al., *Volatile Organic Compound Emissions From the Oil and Natural Gas Industry in the Uintah Basin, Utah: Oil and Gas Well Pad Emissions Compared to Ambient Air Composition*, Atmospheric Chemistry and Physics 14 (2014): 10977–88, https://doi.org/10.5194/acp-14-10977-2014; D. Helmig et al., *Highly Elevated Atmospheric Levels of Volatile Organic Compounds in the Uintah Basin, Utah*, Environmental Science & Technology 48, no. 9 (2014): 4707–15, https://doi.org/10.1021/es405046r; Peter M. Edwards et al., *High Winter Ozone Pollution from Carbonyl Photolysis in an Oil and Gas Basin*, Nature 514 (2014): 351–54, https://doi.org/10.1038/nature13767.

[8] Lucija Muehlenbachs, et al., *The Accident Externality from Trucking* (2017), http://www.nber.org/papers/w23791.pdf; Benjamin D. Blair et al., *Truck and multivehicle truck accidents with injuries near Colorado oil and gas operations*, 15 International Journal of Environmental Research and Public Health 1861 (2018), https://www.mdpi.com/1660-4601/15/9/1861; Jove Graham et al., *Increased traffic accident rates associated with shale gas drilling in Pennsylvania*, 74 Accident Analysis & Prevention 203–209 (2015), http://www.sciencedirect.com/science/article/pii/S000145751400325X

[9] M. Dwortzan *Scientists project increased risk to water supplies in South Africa this century,* MIT New, (Nov 5 2021), https://news.mit.edu/2021/scientists-project-increased-risk-water-supplies-south-africa-this-century-1105

[10] E.g., Thomas W. Pearson, *When the hills are gone: Frac sand mining and the struggle for community*, U of Minnesota Press (2017).

[11] Queensland Government – Business Queensland, *Water authorization requirements,* (n.d.), https://www.business.qld.gov.au/industries/mining-energy-water/resources/minerals-coal/authorities-permits/applying/water-authorisations/understanding.

[12] Geological Society of London, *Let's talk about fracking*, (2014), https://blog.geolsoc.org.uk/2014/05/21/lets-talk-about-fracking/.

for instance, that drinking water around fracking sites can be harmful and contribute to worse health outcomes for infants.[13]

 - The protection of valuable groundwater resources is critical, given the prevailing arid conditions. Poor well completions across aquifers or spills that might leak into recharge areas, neither of which is specific to fracking operations but rather are associated with all drilling activities, are the most likely scenarios for aquifer contamination. Well completion issues are addressed explicitly in Chapter 4 and Appendix 1 of the "Regulations. A more thorough review of other regulations and requirements, which may exist in other documents, is outside the scope of this review.

- **Surficial subsidence**. Subsidence is known to occur in certain instances when fluids have been extracted. Again, this is not specific to fracking operations, but is a certainly a potential by-product that must be considered, especially in built up areas or areas of national heritage.
- **Induced seismicity**. Induced seismicity is the occurrence of human induced earthquakes associated with surface and subsurface activities[14]. Fracking, which causes seismicity by definition, appears to significantly increase the risk of earthquakes in areas where fracking is prevalent - earthquake hazard rates in these areas can be 3-4x higher than natural earthquakes.[15] Injection of fracking wastewater into wells for disposal is commonly identified as the most significant source of induced seismicity, and in particular of the larger earthquakes associated with fracking.[16] Such earthquakes are typically low magnitude ($M_W < 5$)[17] but nevertheless capable of causing some damage[18]. Given potential effects on property, surface infrastructure, and subsurface well integrity, as well as significant stakeholder concern about these issues[19], the "Requirements" and "Regulations" should explicitly address what level of induced seismicity (magnitude, rate) would result in curtailment or cessation of fracking operations during exploration or production.
- **Waste.** Waste products such as water, drilling fluids, and disused equipment are a known by-product of exploration and production activities. Some such waste is potentially toxic, and may include heavy metals, hydrocarbons, and radioactive ions.[20] In remote parts of South

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13 Elaine L. Hill and Lala Ma, *Drinking Water, Fracking, and Infant Health*, Journal of Health Economics, (2022), https://doi.org/10.1016/j.jhealeco.2022.102595.

14 Gillian R. Foulger, et al., *Global review of human-induced earthquakes*, Earth-science reviews., 178. pp. 438-514 (2018), https://dro.dur.ac.uk/22613/1/22613.pdf?DDD15.

15 https://www.usgs.gov/programs/earthquake-hazards/science/hazard-estimation-induced-earthquakes

16 Morgan P. Moschetti, et al., *Rupture model of the M5.8 Pawnee, Oklahoma earthquake from regional and teleseismic waveforms*, 46 Geophysical Research Letters , 24942502 (2019), http://pubs.er.usgs.gov/publication/70202304; K. M. Keranen *et al.*, *Sharp increase in central Oklahoma seismicity since 2008 induced by massive wastewater injection*, 345, Science, 448–451 (2014), https://science.sciencemag.org/content/345/6195/448; Robert J. Skoumal et al., *Earthquakes induced by hydraulic fracturing are pervasive in Oklahoma*, 123, Journal of Geophysical Research: Solid Earth, 10,918-10,935 (2018), https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018JB016790.; https://www.usgs.gov/programs/earthquake-hazards/myths-and-misconceptions-about-induced-earthquakes.

17 Michael R. Brudzinski & Maria Kozłowska, *Seismicity induced by hydraulic fracturing and wastewater disposal in the Appalachian Basin, USA: a review*, 67, Acta Geophys., 351–364 (2019), https://doi.org/10.1007/s11600-019-00249-7; Xuewei Bao & David W. Eaton, *Fault activation by hydraulic fracturing in western Canada*, 354, Science, 1406–1409 (2016), http://science.sciencemag.org/content/354/6318/1406; López-Comino, J.A., Cesca, S., Jarosławski, J. et al., *Induced seismicity response of hydraulic fracturing: results of a multidisciplinary monitoring at the Wysin site, Poland*, Sci Rep 8, 8653 (2018), https://www.nature.com/articles/s41598-018-26970-9.pdf.

18 https://web.archive.org/web/20110623113247/http://earthquake.usgs.gov/learn/topics/mag_vs_int.php.

19 RTJ Porter et al.., *Addressing the risks of induced seismicity in subsurface energy operations*, WIREs Energy Environ. 2019;8:e324. https://doi.org/10.1002/wene.324.

20 Martin Elsner & Kathrin Hoelzer, *Quantitative survey and structural classification of hydraulic fracturing chemicals reported in unconventional gas production*, 50 Environ. Sci. Technol. 3290–3314 (2016), https://doi.org/10.1021/acs.est.5b02818 (last visited Oct 30, 2020); Cloelle Danforth et al., *An integrative method for identification and prioritization of constituents of concern in produced water from onshore oil and gas extraction*,

Africa, regulations should ensure that treatment and disposal of such products is properly safeguarded, and that they are not simply dumped where they can contaminate soil and water. Similarly, fluids should not be injected into the subsurface.

Respective of these issues, it is important for South Africa that national prosperity (in a holistic rather than economic sense) should precede profit.[21] From a legislative and regulatory perspective, duty of care (inclusive of the "precautionary principle"[22]) should be paramount, including considerations of national interest; social and economic welfare for local communities and industry workers (including a "just transition"[23]); and environmental interests locally, regionally, nationally, and globally, in accordance with the Paris Agreement[24] and South Africa's recently updated Nationally Determined Contributions.[25]

As stated in the "Requirements", South Africa is in a fortunate position that "baseline monitoring will be able to be undertaken prior to any hydraulic fracturing commencing" and has the additional advantage of being able to adopt Best Practices from other jurisdictions, where the impacts of fracking are better understood.[26]

In this regard, there is divergence in international thinking as to what Best Practices might be, or even whether fracking is beneficial or detrimental to national interest. As of 2022, commercial fracking occurs in Argentina (Neuquén), Canada (British Columbia), China, and USA, whereas the following regions, countries, and states/provinces/territories have banned, opposed, or restricted fracking, or are considering legislation to do so:

- Australia (Tasmania, Victoria, 98% of Western Australia, parts of South Australia);
- Canada (New Brunswick, Newfoundland, Nova Scotia, Quebec);
- EU (Bulgaria, Denmark, France, Germany, Netherlands, Republic of Ireland, parts of Spain; Switzerland);
- Latin America: Argentina (province of Entre Rios); Brasil (states of Santa Catarina & Paraná;) Colombia; México (Veracruz, Puebla); Uruguay;
- New Zealand;
- United Kingdom (England, Northern Ireland, Scotland, Wales);
- USA (California, Florida, Maryland, New York, Oregon, Vermont, Washington);

In South Africa, fracking technology is not prevalent, nor are there likely to be many local specialists and practitioners with relevant training and experience to undertake state-of-the-art fracking

134 Environment International 105280 (2020), http://www.sciencedirect.com/science/article/pii/S0160412019319907; Samuel J. Maguire-Boyle & Andrew R. Barron, *Organic compounds in produced waters from shale gas wells*, 16 Environ. Sci.: Processes Impacts 2237–2248 (2014), http://pubs.rsc.org/en/content/articlelanding/2014/em/c4em00376d.

21 https://hbr.org/2014/09/profits-without-prosperity

22 European Parliament, *The Precautionary Principle*, (2015), https://www.europarl.europa.eu/RegData/etudes/IDAN/2015/573876/EPRS_IDA(2015)573876_EN.pdf; Jose Felix Pinto-Bazurco, *The Precautionary Principle*, IISD (2020), https://www.iisd.org/system/files/2020-10/still-one-earth-precautionary-principle.pdf; D. Kriebel et al., *The Precautionary Principle in Environmental Science*, (2001), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240435/pdf/ehp0109-000871.pdf.

23 S. Smith, *Just Transition*, OECD, (2018), https://www.oecd.org/environment/cc/g20-climate/collapsecontents/Just-Transition-Centre-report-just-transition.pdf

24 UNFCCC, *Paris Agreement,* (2015), https://unfccc.int/sites/default/files/english_paris_agreement.pdf

25 Republic of South Africa, *South Africa: First Nationally Determined Contribution under the Paris Agreement*, (2021), https://unfccc.int/sites/default/files/NDC/2022-06/South%20Africa%20updated%20first%20NDC%20September%202021.pdf

26 See, for example, https://hydraulicfracturing.nt.gov.au/__data/assets/pdf_file/0004/673123/fracking_implementation_plan.pdf.

operations. In all contexts, but particularly in this one of a nascent industry, practice in adopting requirements and regulations for industry and projects would be to err on the side of caution.

I have therefore focused on what it means in practice to take a cautious approach given in my consideration of the "Regulations" as written, rather than opining on the issues of national benefits or detriments.

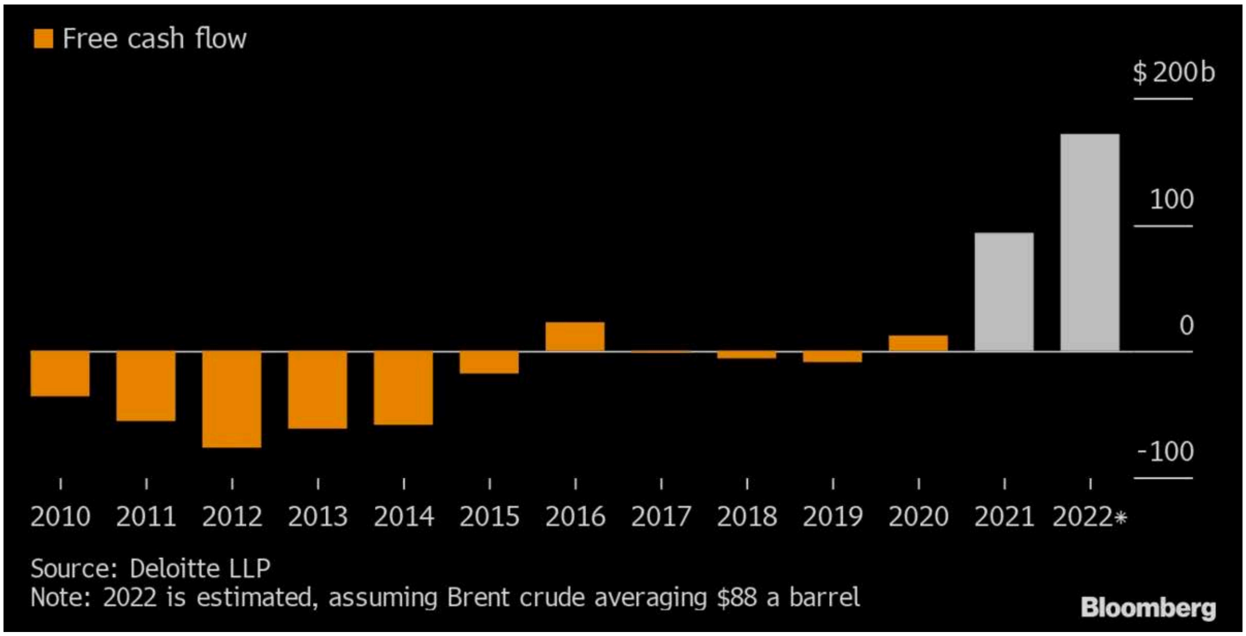

Figure 1. Free cash flow from 28 publicly traded companies. Data exclude cash flow from assets before they were acquired, meaning historic industry-wide losses may have been higher.

***Figure 2**. Aerial view (from Google maps) of a small part of the Permian Basin in the area around Midland, Texas, USA, showing the extensive surficial footprint of oil and gas activities (grids). The Midland Basin is in an environmentally analogous area to the Karoo of South Africa. Area shown is ~125 km x ~70 km (8750 km²). The total area under development in the Permian Basin, the largest oilfield in the world, is in excess of 225,000 km². Not all drilling in the basin is associated with fracking; however, the US Energy Information Administration (https://www.eia.gov/todayinenergy/) estimates that of ~45,000 wells drilled in the past decade, over 38,000 (~85%)are horizontal, fracked wells.*

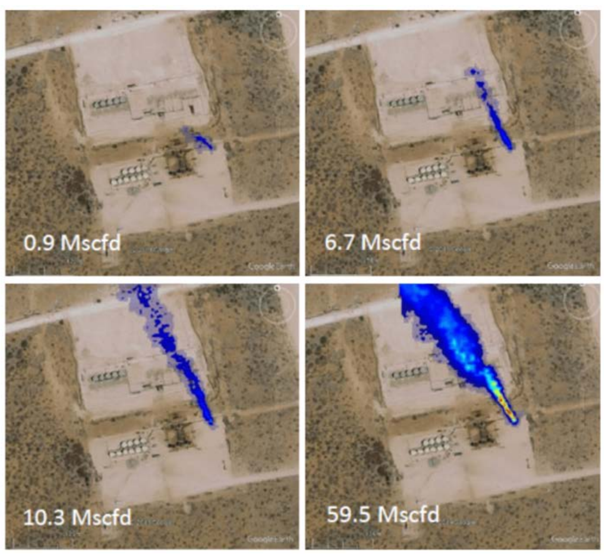

***Figure 3**. Aerial view of methane emissions from a single pad in the Permian Basin in the area near Midland, Texas, USA (Source: https://www.bridgerphotonics.com/blog/key-takeaways-CAMS-permian-basin-study). Number indicates the amount of emitted methane in thousands of standard cubic feet per day (Mscfd). The same report confirms that "most emissions come from tanks, compressors, separators, and flares." A separate report (https://www.bloomberg.com/graphics/2021-methane-permian-basin/) states that methane's "climate-warming power is more than 80 times greater than carbon dioxide's over a 20-year period. Last year, researchers found that oil and gas activity in the basin was responsible for about 2.7 million metric tons of methane a year, or more than those of all but eight countries in the world.*

OPINION RE: "REGULATIONS"

In my opinion, the proposed "Regulations", in combination with the "Requirements", do not currently represent best practice globally for minimizing harm and risk from hydraulic fracturing and all associated oil and gas exploration and production activities.

Three overarching considerations are discussed below, with recommendations underlined, followed by additional comments.

1) According to the documents reviewed, in South Africa:
   a) The "authorisation process for exploration and production of oil and gas" is split "into three distinct phases, which in the context of hydraulic fracturing are: exploration which anticipates hydraulic fracturing, exploration which includes hydraulic fracturing and production of oil and gas which utilises hydraulic fracturing"[27].
   b) The "Regulations" are intended to apply to "all exploration and production operations of onshore oil and gas intending to or utilizing hydraulic fracturing" (p. 51) – in other words, inclusive of all three phases.
   c) One of the purposes of the Regulations is to "set *general and specific guidelines, practices and standards* for the identification, assessment, avoidance and management of environmental impacts associated with *all phases of exploration and production* of onshore oil and gas requiring[28] hydraulic fracturing." (p. 50) [LDM emphasis]

   Chapter 3 (pp 52-55), Chapter 6 (pp. 60-61) and Appendix 3 (pp. 69-72) address general environmental obligations, submission of applications and implementation of monitoring plans, and conditions that apply, where appropriate, to "every applicant or holder of an exploration or production right" (p. 52) and to all exploration and production activities "anticipating or requiring hydraulic fracturing" (p. 52).

   Chapters 4-5 (pp. 55-60) and Appendices 1-2 (pp. 55-68) are specific and quantitative in respect of hydraulic fracturing operations and activities immediately preceding, during, or immediately after drilling. These chapters and appendices discuss responsibility, authorization, well design and construction, operation and management, testing and reporting, decommissioning and monitoring, and reporting.

   However, there are no similarly specific or quantitative chapters or appendices related to exploration operations and activities which anticipate hydraulic fracturing, such as seismic acquisition and non-seismic activities (such as listed in "Opinion re: Requirements", above), and post-drilling production operations and activities which utilize hydraulic fracturing (including pipeline standards and facilities design and construction).

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27 "Requirements", p. 7.

28 The meaning of "requiring hydraulic fracturing" in Clause 2(c) is vague. Compare to Section 6(a), where "anticipating or requiring hydraulic fracturing" is used; "3. Application of these Regulations" (p. 51), where "intending to or utilizing hydraulic fracturing" is used; and the "Requirements" (p. 7), where "anticipates…includes…and utilizes hydraulic fracturing" is used. Does the omission in Clause 2(c) of "anticipating" or similar phrasing imply purposeful exclusion, or is it inadvertent? In context, the latter interpretation seems correct.

Accordingly, the "Regulations" do not meet the criteria fully. Chapters and Appendices should be included that provide specific guidelines, practices and standards for exploration operations and activities which anticipate hydraulic fracturing and production operations and activities which utilize hydraulic fracturing.

2) The "regulations" make extensive reference to a document ("*Minimum Information Requirement for the Submission of Applications for an Authorisation, Permit or Licence for the Exploration and Production of Oil and Gas Utlising Hydraulic Fracturing*") that had not been released for review at the time of writing.

   As a result, the proposed "Regulations" cannot reasonably be assessed in their entirety.

   Provision should be made for additional comment and/or revision to this Opinion when the second set of Requirements is released.

3) The "Regulations" do not contain a statement of the Due Diligence process undertaken to ensure the "Regulations" represent a fair adaptation of global best practice for local South African requirements. This omission should be rectified.

Additional comments on certain parts of the "Regulations" are outlined below.

- 4. Prohibited activities
  - Applies only to certain activities "undertaken in terms of an exploration or production right for onshore oil and gas intending to or utilizing hydraulic fracturing". The clause might be more inclusive of all activities.
  - 4(a) Use of potable water. The "Regulations" state that no potable water may be used for fracking operations, "other than for drinking and domestic purposes" (p. 51). For the avoidance of doubt, it is suggested that the Department defines "potable water" from a geochemical or practical perspective in the Definitions, as it does for "process water" and "produced water".
  - 4(b) Discharge of process water. Approved iterations are subject to the National Water Act, 1998, which was not reviewed as part of this Opinion.
  - 4(c) Discharge or disposal of hydraulic fracturing fluids, process water or any other component of process water. The three locations mentioned are sufficiently restrictive, but should be clarified with respect to disposal methodologies that are allowed, inclusive of standards. Prohibition on the discharge or disposal to underground (4(c)(iii)) is strongly supported, as injection of fracking wastewater into wells for disposal is commonly identified as a source of seismicity, and in particular of higher magnitude earthquakes associated with fracking.[29] In addition to minimizing the risk of induced seismicity, such a prohibition comprehensively protects groundwater resources from potential contamination.

[29] Morgan P. Moschetti, Stephen H. Hartzell & R. B. Herrmann, *Rupture model of the M5.8 Pawnee, Oklahoma earthquake from regional and teleseismic waveforms*, 46 Geophysical Research Letters , 24942502 (2019), http://pubs.er.usgs.gov/publication/70202304; K. M. Keranen *et al.*, *Sharp increase in central Oklahoma seismicity since 2008 induced by massive wastewater injection*, 345, Science, 448–451 (2014), https://science.sciencemag.org/content/345/6195/448; Robert J. Skoumal *et al.*, *Earthquakes induced by hydraulic fracturing are pervasive in Oklahoma*, 123, Journal of Geophysical Research: Solid Earth, 10,918-10,935 (2018), https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018JB016790.

- 5. Prohibited areas
  - Applies to "hydraulic fracturing", but it is not clear whether this Clause applies exclusively to fracturing activities or instead to all exploration and production operations and other activities intending to or utilizing hydraulic fracturing.
  - 5(a) – 5(c) do not define a standoff from the boundaries of the specified prohibited areas. Best practice would be to explicitly establish such prohibitions.
  - 5(d) – 5(g) define a standoff of 2 km from Government waterworks, municipal wellfields, water supply boreholes, groundwater supply infrastructure, strategic water source areas, and thermal or cold springs, but do not rationalize the 2-km distance. The proposed set-back distance meets or exceeds the requirements in every jurisdiction where LDM has worked, and meets minimum requirements suggested by external and independent research. Therefore, a 2-km setback is probably a reasonable distance in the absence of other data; however, the prohibitions do not contemplate the effects of an unforeseen incident in which runoff might occur over larger distances (along waterways or topographic depressions), which might be envisaged under an Environmental Impact Assessment. Furthermore, the 2-km stand-off does not directly address whether oil and gas exploration or production activities or operations (whether related to fracking or not) might be allowed in areas further away that might impact the catchment areas or zones of aquifer/groundwater recharge.
  - There is no prohibition associated with proximity to dwellings or built-up areas such as roadways, municipal buildings, schools, other companies' infrastructure. etc. Best practice would be to explicitly establish such prohibitions. A stand-off of at least 2 km is recommended, consistent with 5(d)-5(g).
  - Section 5 should explicitly address protecting aquifer resources, including a stand-off of 2 km from recharge areas at surface and a vertical distance of at least 600 m from fresh or saline aquifers in the subsurface (per global statistics discussed in the Preamble).
- 6. Environmental obligations
  - 6(a) addresses the identification, assessment, avoidance, mitigation, management, and monitoring of "all possible environmental impacts" to ensure they are "avoided, where possible, or mitigated to ensure sustainability" (p. 52).
    - It should be clarified that "environmental" in this case means all components of the baseline conditions, as outlined in Part 1, Chapter 3 of the "Requirements".
    - "Avoided, where possible, or mitigated to ensure sustainability" is vague and potentially unenforceable. An example of global Best Practice is that adverse conditions are avoided, minimized, and mitigated and that conditions of approval provide "substantially equivalent protections for public health, safety, welfare, the environment, and wildlife resources".[30]
  - 6(e) "International best practices and standards" (p. 54) is a nebulous definition in this instance. How will such practices and standards be recognized in practice? If the "Regulations" maintain this wording, then for the avoidance of doubt, a separate document or Appendix should specify what such standards and practices are.
  - 6(g) obliges applicants or holders to "provide funding for the decommissioning, rehabilitation and closure of the exploration and production operations", but does not explicitly oblige them or their agents to perform the decommissioning, rehabilitation and

[30] Colorado Oil and Gas Conservation Commission (n.d.). *Safety and Facility Operations Regulations: 600 Series*. PDF available online at: https://cogcc.state.co.us/documents/reg/Rules/LATEST/600%20Series%20-%20Safety%20and%20Facility%20Operations%20Regulations.pdf.

closure. In LDM's experience, best practice globally is that the holder(s) are responsible for the performance, unless the obligation is legally transferred.

- 7. Submission of applications and implementation of monitoring plans
  - This Section appears to cover all exploration and production activities.
- 8. Responsibility of the applicant or holder to meet standards.
  - 8(2)(c) The wording (p. 55) is critical to the Responsibility, and should not be altered.
- 17. Drilling fluids
  - 17(1) The wording (p. 59) is critical to the Responsibility, and should not be altered.
  - 17(2) does not describe under what conditions it may be determined that using air, water, or water-based systems is "unfeasible", nor what would constitute justification for an exception, nor under what process approvals for alternatives will or may be granted.
- 18. Powers and duties of the designated agency (p. 59).
  - 18(1). It is not clear why there is a 2-day time frame for the designated agency to deliver approval or request additional information. Timely decisions are good practice, but the Regulation does not describe what happens if an approval or request is not made in the time frame contemplated.
- 19. Disclosure of information (p. 59)
  - 19(1) – 19(3). The information indicated for disclosure "on the website of the holder" do not explicitly state whether the information must be publicly accessible.
  - 19(2). "…except where it may be shown … holder's acreage" is vague and non-definitive. Companies appear to be able to claim non-specific proprietary or confidential rights that justify the avoidance of this regulation. It is general practice for companies to be able to withhold competitively-sensitive information for a period of time, but not in perpetuity.
- 24. Penalties
  - The "Regulations" quantify the penalty associated with offences, but do not address the obligation of remediation in the case of negative impacts associated with offences. Many global jurisdictions include the necessity of remediation.
- APPENDIX 1 - Well construction standards (pp. 62-67)
  - LDM is not a certified well engineer and so is unaware if certain parameters, quantified in Sections 3(1), 3(2), 3(4), 3(6)(a), 3(7)(a), 3(7)(b), 3(11), 4(2), 4(3), 4(6), 4(7), 4(9), 5(1), 5(2), 5(4), 5(5), 5(6), 7(1), 7(2)(b), 7(5), 8(3), 8(5), 8(8), 8(9), and 8(10), are industry-standard, international Best Practice, and/or provide the optimum isolation and protections indicated in Clause (2) and inclusive of the comments specific to Clause (2) below. A certified well engineer should opine on these quantified parameters.
  - Specific review of the international Standards was outside the scope of the present review, but these appear reasonable on preliminary inspection.
  - 1. General
    - 1(2)
      - Multi-well pads are not defined in terms of the minimum number of wells that must occupy a pad.
      - "…maximize the spacing between neighbouring wells and minimize cumulative surface impacts…." Maximize and minimize in this context are qualitative terms, and subject to different interpretations. The intent is good, but perhaps a quantified standard or expectation should be considered.

- 2. Objective of well design
  - (a) "…aquifer and permeable zones…" should read "aquifer and non-petroleum producing permeable zones…".
  - (b) "…migration of polluted water into groundwater…" should read "…migration of polluted water, drilling fluids, and produced hydrocarbons into groundwater…"
  - The stated objectives (a) – (c) of a well design is an incomplete list. Additional objectives include
    - (d) allow the well to reach objective depth safely and securely;
    - (e) ensure mechanical integrity of drilling and completion activities (including hydraulic fracturing, if planned) (cf. Section 8).
- 3. Well construction
  - 3(7)(a)
    - There appears to be a word missing, as indicated by [?] in the following quote: "…must be set at least 30 m below the base of the unexpected deepest [?] to protect unexpected fresh water found below the surface casing shoe."
    - The first use of the word "unexpected" in the preceding quote may be meant to be "expected," depending on the missing word. If [?] is unexpected, how will the holder know it is the "*unexpected* deepest [?]".
  - 3(7)(c). "A minimum of 180, above the shallowest fresh water zone" is not clear in terms of what unit. I assume meters (m).
- Induced seismicity is only peripherally addressed in Appendix 1 and Appendix 2 (and nowhere else in the "Regulations"). In other global jurisdictions, many stakeholders are particularly concerned about induced seismicity. Although the risk of significant damage is likely to be low, due care should be exercised in terms of ensuring that mitigation measures are sufficiently comprehensive, and that all fracking activity should cease if induced seismicity exceeds a specified magnitude or recurrence interval.