Environmental Defense Fund

Please see attached file for EDF comments.

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February 14, 2020

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Water Quality Division
200 West 17th St.
Cheyenne, WY 82002

Submitted online via: http://wq.wyomingdeq.commentinput.com/?id=Q7YBm

RE: Proposed renewal of Aethon Energy Operating, LLC permit WY0002062

Dear Mr. Thomas:

Environmental Defense Fund (EDF) appreciates the opportunity to submit the following comments regarding the updated draft of the above-referenced permit renewal. EDF is an international environmental organization with over two million members and activists worldwide including several thousand in Wyoming, many of whom are deeply concerned about the impacts of oil and gas development on human health and the environment, including water resources.

EDF has a depth of expertise on produced water, including those issues related to the chemical and toxicological characterization and treatment of produced water and respectfully submits these comments for your careful consideration. EDF commends WYDEQ for a number of key changes made in this draft to expand sampling, monitoring, and testing requirements that are on the whole improvements to the original permit. However, we remain concerned regarding what appear to be steps backward in protections as compared to the 2019 draft, the scope of monitoring and effluent limits, and the potential holistic impacts of this permitted discharge given remaining unknowns regarding this waste stream.

The mere fact that the new revision reverts back in many cases to conditions of the original permit (e.g., does not authorize new or expanded discharges and retains the existing salt load limits), while rational given the failure of the reverse osmosis facility, does not equate to definitive reassurance that those conditions – even if historic – are appropriately protective and should be authorized to continue. Furthermore, the fact remains that oil and gas wastewater is under characterized and there are significant associated knowledge gaps and research needs

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regarding its treatability, toxicity, and risks associated with its release or reuse.[1] These unknowns create real challenges with respect to the ability to establish appropriate permitting requirements that can be shown to definitely meet key numerical and narrative standards, including that produced water discharges:

- Shall be of good enough quality to be used for wildlife or livestock watering or other agricultural uses and actually be put to such use during periods of discharge;[2] and
- Must not contain toxic materials in concentrations or combinations which are toxic to human, animal or aquatic life.[3]

With this in mind, EDF submits the following comments for your consideration:

1. **The lack of interim chloride limits, expanded compliance schedule on chlorides, and the Total Dissolved Solid (TDS) limits continue to present questions regarding current and near-term quality of receiving streams.**

The Wyoming Surface Water Quality Standards provisions regarding the protection of aquatic life includes specific numeric standards for toxicants, below which are not protective of aquatic life.[4] The acute and chronic values for chloride are 860 and 230 mg/L, respectively.[5] Although the draft permit allows for a multi-year progression to meet appropriate chloride requirements to protect designated water uses, **there is no interim limit or value assigned to limit discharges until that point**, creating a scenario that has the potential to severely, and irrevocably impact aquatic life, as salt contamination is long-lived.[6] Has the WYDEQ conclusively established that discharges at this level – and in fact, without limit until 2024 – are of "good enough quality" and not toxic for purposes of the water quality standards?

Total dissolved solids can also have significant negative consequences for habitat, wildlife, and livestock. Scientists assessing protective water qualities for Wyoming livestock and wildlife have concluded the following:

> We do not recommend relying upon TDS to evaluate water quality for livestock and wildlife; however, if no other information is available, TDS concentrations less than 500 mg/L should ensure safety from almost all inorganic constituents. Above 500 mg/L, the individual constituents contributing to TDS should be identified, quantified, and evaluated.[7]

With this in mind, EDF has the following questions:

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[1] *See, e.g.* Ground Water Protection Council, Produced Water Report: Regulations, Current Practices and Research Needs (June 2019). Also, Danforth C, Chiu WA, Rusyn I, Schultz K, Bolden A, Kwiatkowski C, Craft E. 2020. An integrative method for identification and prioritization of constituents of concern in produced water from onshore oil and gas extraction. *Environment International*. 134:105280. doi:10.1016/j.envint.2019.105280.

[2] 40 C.F.R. PT.435.

[3] 020-0011-2 WYO. CODE R. app. H.

[4] 020-0011-1 WYO. CODE R. §21 app B.

[5] *Id. at app. B.*

[6] Farag AM, Harper DD. 2014. A review of environmental impacts of salts from produced waters on aquatic resources. *International Journal of Coal Geology*. 126:157–161. doi:10.1016/j.coal.2013.12.006.

[7] Water Quality for Wyoming Livestock & Wildlife: A Review of Literature Pertaining to Health Effects of Inorganic Contaminants at 50, *available at* http://www.wyomingextension.org/agpubs/pubs/B1183.pdf.

How did WYDEQ quantitatively establish that retaining a load limit of 908 tons/month of TDS was "good enough quality"?

EDF recognizes that the reduction in allowed TDS limits from the 2019 draft permit represents an important and necessary decrease given technical failures of the proposed treatment plant. However, we continue to question how the final limits were quantitatively determined to be of "good enough" quality to protect downstream water, ecosystems, wildlife and agricultural or other users given current conditions and knowledge.

As we understand from the Statement of Basis, this permit grants a variance from the produced water discharge requirements in Wyoming Water Quality Rules and Regulations (Ch.2, Appx. H) of 5,000 mg/L because one landowner signed a letter stating they put this water to beneficial use.[8] However, there does not appear to be a science-based determination by the DEQ that this quality is broadly "good enough" for wildlife or livestock watering. The calculation appears to simply be the approximate monthly TDS load from a historically unrestricted discharge. Acknowledgement from one downstream user that their livestock drink a water does not equate to an informed, best professional judgment assessment that the allowed TDS levels are holistically appropriate for discharge or "good enough quality" for wildlife, livestock or other downstream uses. The permit's Statement of Basis appears to present a qualitative, circular argument on determination of safety and appropriateness based on an arbitrary historic TDS load. Furthermore, EDF remains concerned that despite advancements in analytical and environmental knowledge, changes in oil and gas operations, and improvements to Wyoming's own produced water discharge standards, this growing facility continues to fall under exceptions and variances allowances for facilities predating 1978 as referenced to defend this modification.[9]

Given the DEQ's determination of reasonable potential of exceedances[10] of existing chloride standards, why was the 2019 draft interim limit for chloride deleted and the compliance schedule extended in this new draft – leaving no effluent limit for chlorides until 2024?

In light of the recent reality that Aethon has met significant challenges in operating and maintaining treatment facilities for the reduction of chlorides and salts,[11] the WYDEQ's wholesale deletion of interim limits on chlorides and expansion of timeline for compliance with final effluent limits from the 2019 draft does not give confidence that discharges from this facility will be protective of downstream ecosystems and users for *at least* four years (assuming successful treatment units are eventually brought online and maintained operational).

At the moment, there is no restriction or limitation on the discharge of chlorides from this facility despite the expectation that the facility cannot in its current state meet standards, and some concern that chloride water quality criteria may have been impacted by the ongoing permitted discharges in Badwater Creek below its confluence with Alkali Creek, per DEQ's

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[8] Statement of Basis at 4.
[9] *Id.*
[10] Statement of Basis at 2-3.
[11] *Id.* at 1.

review of currently available data.[12] EDF seriously questions whether this creates acceptable conditions for the environment or downstream users.

2. Despite important improvements, effluent monitoring and limitation requirements could be further improved to better address organics and other constituents of concern in oil and gas wastewater.

Addition of routine sampling requirements for BTEX constituents and hydraulic fracturing and maintenance chemicals is an important and necessary step to ensure compliance with Wyoming rules.

EDF commends the DEQ for including key new provisions in order to begin to monitor and enforce Wyoming regulatory and permit requirements that discharges of drilling fluids, acids, stimulation waters or other fluids derived from the drilling or completion of wells are not allowed. There is no clear delineation to signal a transition from flowback fluid to formation or produced waters from well to well, thus necessitating an assessment of the chemical nature of produced waters destined for discharge. Such monitoring and limitation appears particularly important for this facility as it expands, given existing concerns regarding the presence of foams tied to surfactants downstream from the facility as noted in WYDEQ Letter of Violation dated December 17, 2019.[13]

Similarly, the monitoring of BTEX compounds, contaminants often associated with dissolved oil,[14] are known to present risks to the environment when released[15] and their presence would be expected to alter conclusions regarding the discharge's compliance with Wyoming laws and regulations requiring that the effluent be of "good enough quality" and lacking in toxic chemicals in toxic amounts. Consistent monitoring of these compounds is therefore essential. Because WYDEQ has set effluent limits to protect Badwater Creek[16] (a Class 2AB water), water quality based limits for BTEX compounds should be set accordingly; they are as follows: benzene 2.2 µg/L; ethylbenzene 530 µg/L; toluene 1,000 µg/L; xylenes 10,000 µg/L.

The addition of effluent limits for temperature, sulfide, radium, and barium are improvements, but removal of ELG limits for other constituents as compared to 2019 draft present questions regarding quality of discharges.

Table 1 (below) presents a comparison between the 2019 draft ELG limits and monitoring requirements (WY0002062-RENEWAL-5-4-2017) and the revised permit. Of note, thirteen chemicals (including chloride) had ELG limits in the draft permit that are now only subject to

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[12] Letter from Kevin Frederick, Administrator, Water Quality Division to Andrea Taylor, Aethon Energy Operating LLC (December 17, 2019).
[13] *Id.*
[14] Chittick EA, Srebotnjak T. 2017. An analysis of chemicals and other constituents found in produced water from hydraulically fractured wells in California and the challenges for wastewater management. *Journal of Environmental Management*. 204:502–509. doi:10.1016/j.jenvman.2017.09.002.
[15] Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Interaction profile for benzene, toluene, ethylbenzene, and xylenes (BTEX). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.
[16] See p. 4 of the Statement of Basis for WY0002062-RENEWAL-12-17-2019

monitoring requirements, however there is no clear explanation for the removal of many of these compounds. Furthermore, calcium, fluoride, magnesium, manganese, and sodium no longer have ELGS or monitoring requirements. WYDEQ notes that "limits for Manganese, Fluoride, [and] Uranium... were not included in the permit because *based on available data*, the facility has no reasonable potential to exceed the calculated effluent limits for those pollutants."[17] Previous data for manganese (provided in the June 30, 2012 WYPDES permit renewal application and again in the 2019 renewal application) indicate dissolved manganese levels of 70 µg/L and non-detect (less than 50 µg/L). The water quality standard for manganese in Class 2AB streams is 50 µg/L.[18] Given the historical evidence that this standard has not always been met, this compound should at a minimum continue to be monitored.

Importantly, it is EDF's understanding based on available documents that there *are no data* for uranium or fluoride.

Wyoming's inclusion of a fluoride limit in Form C[19] underscores the state's understanding that discharges can cause harm. Fluoride is known to be present in produced water at elevated levels (100 to 1100 mg/L).[20] Fluoride toxicosis has been documented in wildlife (elk, deer, and bison) where corresponding water samples contained 0.5-24 mg/L. It cannot be assumed that fluoride, like any other unmeasured constituent of concern reasonably assumed to be present in produced water, will not exceed dangerous levels for wildlife or livestock in the receiving waters. Without further assessment of chemicals of concern identified in produced water, such as fluoride, it cannot be shown that discharges are of "good enough quality" or that no toxics are being discharged in toxic amounts. Therefore, fluoride (as well as other constituents of concern present in the discharge) should also be limited at the EOP to monitor that discharges are protective of wildlife or livestock.

Table 1: Comparison Effluent Limitation Guidelines and monitoring frequencies of the draft permit (WY0002062-RENEWAL-5-4-2017) to the renewed permit (WY0002062-RENEWAL-12-17-2019)

	WY0002062-RENEWAL-5-4-2017		WY0002062-RENEWAL-12-17-2019	
Parameter	**EOP Mixed Concentration Limit**	**Measurement Frequency**	**Effluent Limit (Outfalls 001-016)**	**Measurement Frequency**
Aluminum (µg/L)	750	Quarterly	N/A	Semi-Annually
Arsenic (µg/L)	90	Quarterly	N/A	Semi-Annually
Beryllium (µg/L)	0.05	Quarterly	N/A	Semi-Annually
Cadmium (µg/L)*	0.05	Quarterly	N/A	Semi-Annually
Chloride (mg/L)	2419	Monthly	N/A	Quarterly
Chromium (µg/L)*	126	Quarterly	N/A	Semi-Annually
Copper (µg/L)*	15	Quarterly	N/A	Semi-Annually
Lead (µg/L)*	0.5	Quarterly	N/A	Semi-Annually
Mercury (µg/L)	0.77	Quarterly	N/A	Semi-Annually

[17] See p. 7 of the Statement of Basis for WY0002062-RENEWAL-5-4-2017

[18] See Appendix B of Chapter 1 of the Wyoming Water Quality Rules and Regulations

[19] Wyoming Pollutant Discharge Elimination System Application – Short Form C

[20] Thacker J, Carlton D, Hildenbrand Z, Kadjo A, Schug K. 2015. Chemical Analysis of Wastewater from Unconventional Drilling Operations. Water. 7(12):1568–1579. doi:10.3390/w7041568; see also McBeth I, Reddy KJ, Skinner QD. 2003. Chemistry of trace elements in coalbed methane product water. Water Research. 37(4):884–890. doi:10.1016/S0043-1354(02)00382-2.

Parameter	WY0002062-RENEWAL-5-4-2017		WY0002062-RENEWAL-12-17-2019	
	EOP Mixed Concentration Limit	Measurement Frequency	Effluent Limit (Outfalls 001-016)	Measurement Frequency
Nickel (µg/L)*	90	Quarterly	N/A	Semi-Annually
Selenium (µg/L)	0.5	Quarterly	N/A	Semi-Annually
Silver (µg/L)*	0.5	Quarterly	N/A	Semi-Annually
Thallium (µg/L)	0.25	Quarterly	N/A	Semi-Annually
Calcium (mg/L)	N/A	Quarterly	N/A	N/A
Fluoride (mg/L)	N/A	Quarterly	N/A	N/A
Magnesium (mg/L)	N/A	Quarterly	N/A	N/A
Manganese (µg/L)*	2083	Quarterly	N/A	N/A
Sodium (mg/L)	N/A	Quarterly	N/A	N/A

EDF questions the justification for these changes in the scope of effluent limitations, particularly given that advanced treatment will no longer be applied to discharges from this facility.

Hardness-based modifications to water quality effluent limits should be included to appropriately protect receiving waters.

EDF recognizes that some water quality effluent limits are hardness-dependent because the toxicity of certain metals constituents is a function of hardness. The receiving stream systems are low-flow and should be assumed to be effluent-dominated for at least some of the year. Therefore, the hardness-dependent metal concentrations must be based off the measured hardness of the effluent (47 mg/L $CaCO_3$). Using the reported hardness of the effluent and according to the conversion factors cited in Appendix F of Chapter 1 of Wyoming Water Quality Rules and Regulations, the following metals should be limited to the following concentrations: cadmium 0.15 µg/L; chromium 40 µg/L; copper 4.7 µg/L; lead 1.1 µg/L; nickel 27.5 µg/L; and zinc 25.7 µg/L.

WYDEQ should give further consideration to at a minimum monitoring requirements for other potential toxic organic constituents that can reasonably be expected to be present in produced waters.

Despite marked improvements in the scope of constituents monitored from the original permit, EDF remains concerned that the full suite of constituents monitored and/or limited in the draft permit are not appropriately representative of the broad range of constituents of concern potentially present in oil and gas wastewater. Without more comprehensive analysis and monitoring, definitive conclusions regarding toxicity or quality are not – and cannot be – complete.

Produced water contains many constituents including organic and inorganic material, dispersed and dissolved oil compounds, production chemicals, and formation minerals, including radioactive material and heavy metals.[21] Organic compounds known to be in produced water, including contaminants associated with dissolved oil (e.g., naphthalene, phenantherene,

[21] Fakhru'l-Razi A, Pendashteh A, Abdullah LC, Biak DRA, Madaeni SS, Abidin ZZ. 2009. Review of technologies for oil and gas produced water treatment. Journal of Hazardous Materials. 170(2–3):530–551. doi:10.1016/j.jhazmat.2009.05.044.

polycyclic aromatic hydrocarbons (PAHs), and phenols) still do not appear to have been analyzed or considered for limitations despite well-documented accounting of their presence in this type of wastewater.[22] Oil and grease was measured at 6 mg/L in the singular analysis submitted for Aethon's original renewal application. This is a surrogate measure of many types of organic material generally associated with petroleum based hydrocarbons.[23] The technology based limit from 40 CFR pt. 435 for oil and grease is 10 mg/L (a limit that Aethon has violated historically)[24]; at these concentrations, it is likely that many dissolved petroleum hydrocarbons are in produced water at concentrations that can be toxic humans and aquatic organisms.

EDF understands that analysis and monitoring is necessary prior to implementing and enforcing limits based a reasonable potential analysis. However, collectively considered, the water quality analysis EDF reviewed as submitted in the original renewal package is not comprehensive enough to identify potential pollutants in the wastewater or establish appropriate limitations. Aethon's response to the permit application requirement (#13) to "Provide a list of **all** potential pollutants expected to be in the discharge and an explanation of their presence in the discharge" of "trace amount of petroleum hydrocarbons due to oil production and total dissolved solids" was not only woefully lacking but also proven factually incorrect by even the limited analysis required in permit application item #14, Table 2. EDF believes that a more thorough assessment continues to be necessary.

A permit writer's basic responsibility is to understand the nature of a proposed discharge and ensure that permit limits appropriately protect receiving waters and their designated uses. The EPA's NPDES Permit Writers' Manual allows for permit writers to require supplemental information in order to process the permit.[25] Importantly, the permit writer can consider "pollutants otherwise expected to be present in the discharge," described as thus:

> "A final category of pollutants of concern includes those pollutants that are not in one of the other categories, but are otherwise expected to be present in the discharge. There

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[22] Kathrin Hoelzer, Andrew J. Sumner, Osman Karatum, Robert K. Nelson, Brian D. Drollette, Megan P. O'Connor, Emma L. D'Ambro, Gordon J. Getzinger, P. Lee Ferguson, Christopher M. Reddy, Martin Elsner, and Desiree L. Plata. "Indications of Transformation Products from Hydraulic Fracturing Additives in Shale-Gas Wastewater." *Environmental Science & Technology* 2016 50 (15), 8036-8048. DOI: 10.1021/acs.est.6b00430.; see also Maguire-Boyle SJ, Barron AR. 2014. Organic compounds in produced waters from shale gas wells. *Environ Sci: Processes* Impacts. 16(10):2237–2248. doi:10.1039/C4EM00376D.; see also Orem W, Tatu C, Varonka M, Lerch H, Bates A, Engle M, Crosby L, McIntosh J. 2014. Organic substances in produced and formation water from unconventional natural gas extraction in coal and shale. *International Journal of Coal Geology*. 126:20–31. doi:10.1016/j.coal.2014.01.003.; see also Wesolowski D, Broughton A, Hansotte CA, Koraido SM, Fillo JP. 1987. Characterization of Produced Waters from Natural Gas Production Operations. Chicago, Illinois: Gas Research Institute Report No.: GRI-87/0335.3.; see also Tellez GT, Nirmalakhandan N, Gardea-Torresdey JL. 2005. Comparison of purge and trap GC/MS and spectrophotometry for monitoring petroleum hydrocarbon degradation in oilfield produced waters. *Microchemical Journal*. 81(1):12–18. doi:10.1016/j.microc.2005.01.019.; see also Luek JL, Gonsior M. 2017. Organic compounds in hydraulic fracturing fluids and wastewaters: A review. *Water Research*. 123:536–548. doi:10.1016/j.watres.2017.07.012.; see also Butkovskyi A, Faber A-H, Wang Y, Grolle K, Hofman-Caris R, Bruning H, Van Wezel AP, Rijnaarts HHM. 2018. Removal of organic compounds from shale gas flowback water. *Water Research*. 138:47–55. doi:10.1016/j.watres.2018.03.041.; see also Parker KM, Zeng T, Harkness J, Vengosh A, Mitch WA. 2014. Enhanced Formation of Disinfection Byproducts in Shale Gas Wastewater-Impacted Drinking Water Supplies. *Environmental Science & Technology*. 48(19):11161–11169. doi:10.1021/es5028184.; see also

[23] USPEA. 2010. Method 1664, Revision B: n-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated n-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry. EPA-821-R-10-001. *available at*https://www.epa.gov/sites/production/files/2015-08/documents/method_1664b_2010.pdf

[24] US EPA. 2019. ECHO. Enforcement and Compliance History Online. [accessed 2020 Feb 12]. https://echo.epa.gov/.

[25] EPA, NPDES PERMIT WRITERS' MANUAL: CHAPTER 4 NPDES Permit Application Process. p.14 (2010), *available at* https://www.epa.gov/sites/production/files/2015-09/documents/pwm_chapt_04.pdf

might be pollutants for which neither the discharger nor the permitting authority have monitoring data but, because of the raw materials stored or used, products or by-products of the facility operation, or available data and information on similar facilities, the permit writer has a strong basis for expecting that the pollutant could be present in the discharge. Because there are no analytical data to verify the concentrations of these pollutants in the effluent, the permit writer must either postpone a quantitative analysis of the need for WQBELs and generate, or require the discharger to generate, effluent monitoring data, or base a determination of the need for WQBELs on other information, such as the effluent characteristics of a similar discharge."[26]

Given the evidence that produced water quality is variable, complex, and has been demonstrated to contain many types of organic and inorganic compounds, both influents and expected discharges from all potential outfalls (both treated and untreated) must be better characterized in order to properly consider the effectiveness of treatment technologies, understand the potential impacts of untreated discharges, and establish appropriately comprehensive discharge limitations and monitoring requirements necessary to meet numeric and narrative standards, as identified in Appendix B of Chapter 1 of Wyoming Water Quality Rules and Regulations.

At a minimum, this expanded analysis should include:

- All Volatile Organic Compounds listed in 40 CFR pt. 122, Appendix D, Table II.
- All Base/Neutral and Acid Organic Compounds listed in 40 CFR pt. 122, Appendix D, Table II
- All metals listed in 40 CFR pt. 122, Appendix D, Table III
- All compounds as listed in 40 CFR pt. 122, Appendix D, Table IV except for fecal coliforms
- Compounds from 40 CFR pt. 122, Appendix D, Table V that have been detected in other produced waters.[27]

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[26] EPA, NPDES PERMIT WRITERS' MANUAL: CHAPTER 6 Water Quality-Based Effluent Limitations. p.13 (2010), *available at* http://www.epa.gov/npdes/pubs/pwm_chapt_06.pdf .

[27] Including, for example Cyclohexane and Dimethylphenol (Carey J, Zaidi A, Ribo J. 1992. Specific Toxic Organics in Produced Waters from In-Situ Heavy Oil Recovery Operations in Western Canada. In: Ray JP, Engelhardt FR, editors. Produced Water. New York, NY: Plenum Press. p. 133–150. [accessed 2019 Jan 4]. http://link.springer.com/10.1007/978-1-4615-2902-6_11.); methyl methacrylate (Sirivedhin T, Dallbauman L. 2004. Organic matrix in produced water from the Osage-Skiatook Petroleum Environmental Research site, Osage county, Oklahoma. Chemosphere. 57(6):463–469. doi:10.1016/j.chemosphere.2004.05.034.); quinoline (Orem W, Tatu C, Varonka M, Lerch H, Bates A, Engle M, Crosby L, McIntosh J. 2014. Organic substances in produced and formation water from unconventional natural gas extraction in coal and shale. International Journal of Coal Geology. 126:20–31. doi:10.1016/j.coal.2014.01.003.); acetaldehyde, butyl acetate, and formaldehyde (Lyman SN, Mansfield ML, Tran HNQ, Evans JD, Jones C, O'Neil T, Bowers R, Smith A, Keslar C. 2018. Emissions of organic compounds from produced water ponds I: Characteristics and speciation. Science of the Total Environment. 619–620:896–905. doi:10.1016/j.scitotenv.2017.11.161.); cresol (DiGiulio DC, Jackson RB. 2016. Impact to Underground Sources of Drinking Water and Domestic Wells from Production Well Stimulation and Completion Practices in the Pavillion, Wyoming, Field. Environmental Science & Technology. 50(8):4524–4536. doi:10.1021/acs.est.5b04970.); uranium (Barbot E, Vidic NS, Gregory KB, Vidic RD. 2013. Spatial and Temporal Correlation of Water Quality Parameters of Produced Waters from Devonian-Age Shale following Hydraulic Fracturing. Environmental Science & Technology. 47(6):2562–2569. doi:10.1021/es304638h.); strontium (Nelson AW, May D, Knight AW, Eitrheim ES, Mehrhoff M, Shannon R, Litman R, Schultz MK. 2014. Matrix Complications in the Determination of Radium Levels in Hydraulic Fracturing Flowback Water from Marcellus Shale. Environmental Science & Technology Letters. 1(3):204–208. doi:10.1021/ez5000379.); styrene (Kassotis CD, Klemp KC, Vu DC, Lin C-H, Meng C-X, Besch-Williford CL, Pinatti L, Zoeller RT, Drobnis EZ, Balise VD, et al. 2015. Endocrine-Disrupting Activity of Hydraulic Fracturing Chemicals and Adverse Health Outcomes After Prenatal Exposure in Male Mice. Endocrinology. 156(12):4458–4473. doi:10.1210/en.2015-1375); carbon disulfide, vanadium and zirconium (Thacker J, Carlton D, Hildenbrand Z, Kadjo A, Schug K. 2015. Chemical Analysis of Wastewater from Unconventional Drilling Operations. Water. 7(12):1568–1579.

3. The addition of any Whole Effluent Toxicity testing is an improvement on historic permitting, but current requirements are insufficient as proposed

As noted in our original comments on the first draft, while EDF strongly supports the WYDEQ including of WET testing in this permit, we believe that the requirements are currently inadequate and are in fact, *even less adequate* than in the 2019 draft. In particular, EDF is disappointed to see the wholesale deletion of chronic WET testing in this draft as compared to the 2019 version with no apparent explanation of this change.

Given the significant unknowns regarding the chemical and toxicological character of produced waters and the limitations in current monitoring requirements as discussed above, EDF strongly supports the inclusion of WET testing as a mechanism for identifying otherwise undetected mixture impacts and commends the WYDEQ for including this important test. The requirement of WET testing in the permit will provide a first line of protection of native fauna exposed to discharged effluent. *However, EDF does not believe that the current WET testing requirements are adequate to serve a truly protective function to ensure no toxic substances are discharged in toxic amounts at any time.*

As mentioned previously, the permit writer can reasonably expect many other organic compounds (in addition to BTEX and oil and grease) such as aromatic compounds, which will contribute to environmental toxicity, and are not removed during oil/water separation processes.[28] Any water that has been untreated (a more likely scenario now than before given that the High Efficiency Reverse Osmosis (HERO) treatment process at the Neptune Facility has been taken offline) will likely contain these and other compounds of concern, noted previously.

Although chemical analysis provides a snap-shot estimate of some of the known constituents of concern, it does not provide adequate information on the potential toxicity of the actual effluent. Similarly, a single annual WET test may provide a snap-shot in time of toxicity, but does not provide adequate information to monitor impacts of year-round discharges. The variability of produced water[29] coupled with seasonal variations in water flow and chemical usage, necessitates a more thorough assessment of potential toxicity that accounts for this heterogeneity in quantity and quality of produced water. Therefore, WET tests should be, *at a minimum*, conducted on samples on a quarterly basis using both the invertebrate and vertebrate test species, for a minimum of two years or eight quarters. This applies to **both** acute and chronic tests. The whole effluent toxicity assessment is an approach defined as one that "involves the use of acute and chronic toxicity text to measure the toxicity of wastewater."[30]

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doi:10.3390/w7041568); and xylenes (Wesolowski D, Broughton A, Hansotte CA, Koraido SM, Fillo JP. 1987. Characterization of Produced Waters from Natural Gas Production Operations. Chicago, Illinois: Gas Research Institute Report No.: GRI Report No. GRI-87/0335.1.).

[28] Fakhru'l-Razi A, Pendashteh A, Abdullah LC, Biak DRA, Madaeni SS, Abidin ZZ. 2009. Review of technologies for oil and gas produced water treatment. *Journal of Hazardous Materials*. 170(2–3):530–551. doi:10.1016/j.jhazmat.2009.05.044.

[29] Orem W, Tatu C, Varonka M, Lerch H, Bates A, Engle M, Crosby L, McIntosh J. 2014. Organic substances in produced and formation water from unconventional natural gas extraction in coal and shale. *International Journal of Coal Geology*. 126:20–31. doi:10.1016/j.coal.2014.01.003.; see also Benko KL, Drewes JE. 2008. Produced Water in the Western United States: Geographical Distribution, Occurrence, and Composition. *Environmental Engineering Science*. 25(2):239–246. doi:10.1089/ees.2007.0026.

[30] P.4 of the Technical Support Document for Water Quality-Based Toxics Control. EPA/505/2-90-001 PB91-127415 March 1991

More specifically, chronic testing is vital in order to support the understanding if this discharge will permit normal propagation of aquatic life in the receiving waters. Class 2AB waters are known to "support game fish populations or spawning and nursery areas." There are many chemicals in produced water (or that can be reasonably assumed to be present)[31] that may be present at concentrations that are not acutely toxic to aquatic organisms but can impair normal growth and/or reproduction, among other adverse effects beyond mortality.

If no failures occur during the two-year period and no changes occur in the outfalls that cause an increase in flow or water quality, then it may be appropriate to adjust WET testing to quarterly acute tests and a yearly chronic test. It is EDF's position that WET testing of any less frequency than this is inadequate.

Should toxicity occur in the WET test, the permit applicant should begin accelerated monthly testing once a month and perform a toxicity identification evaluation/toxicity reduction evaluation to establish the cause of the toxicity, locate the source(s) of the toxicity, and develop control of, or treatment for, the toxicity.

Conclusion

EDF acknowledges the clear challenges underlying the permitting of such discharges in light of serious knowledge gaps and the clear commitment to improved outcomes that WYDEQ has made in its reconsideration of this draft. However, given what we know and continue to learn about produced water, continued vigilance in the manner in which this wastewater is studied and controlled when released is more important than ever. In fact, many other states are currently looking to Wyoming as they consider development of their own discharge programs for this poorly characterized wastewater. Given the state's experience with these discharges, newly renewed permits such as these should represent the best available knowledge, technologies, and analytical monitoring and limitations rather than a maintenance of historic status quos. Wyoming has an opportunity to set the bar for what protective discharge permits could look like based on knowledge and experience, and EDF does not believe this permit does that as currently drafted.

Getting this permit right *now*, rather than some point in the future is vital, particularly in light of uncertainties regarding the scope and scale of operations or hypothetical treatment at this facility in the future. Wyoming laws and regulations demand assurance that unacceptable risk and harm will not come from approved, permitted discharges. EDF believes there remains room for improvement to ensure this permit can meet those requirements.

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[31] Danforth C, Chiu WA, Rusyn I, Schultz K, Bolden A, Kwiatkowski C, Craft E. 2020. An integrative method for identification and prioritization of constituents of concern in produced water from onshore oil and gas extraction. *Environment International*. 134:105280. doi:10.1016/j.envint.2019.105280.

Respectfully Submitted,

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