Appendix D

September 13, 2016

Basil Seggos, Commissioner
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233-6510

Attn: Part 360 Series regulations, Solid Waste Management Facilities

Cc: Catherine A. Dickert, Director, Division of Mineral Resources
David Vitale, Director, Division of Materials Management
Melissa Treers, P.E., Division of Materials Management

Dear Commissioner Seggos:

Earthworks, Environmental Advocates of New York, and Riverkeeper, Inc., appreciate the opportunity to comment on NYSDEC's proposed revisions to the Part 360 series of solid waste regulations and related amendments.

We submit these comments with the support of the Adirondack Mountain Club, Catskill Citizens for Safe Energy, Catskill Mountainkeeper, Center for Environmental Health, Citizens Campaign for the Environment, Compressor Free Franklin, Concerned Citizens of Allegany County, Damascus Citizens for Sustainability, Delaware Riverkeeper Network, Environment New York, Finger Lakes Zero Waste Coalition Inc., Food and Water Watch, Fossil Free Tompkins, Grassroots Environmental Education, Natural Resources Defense Council, Partnership for Policy Integrity, People for a Healthy Environment, Protect the Adirondacks, Residents for the Preservation of Lowman and Chemung, Sierra Club Atlantic Chapter, Stop the Algonquin Pipeline, and Stop Polluting Orleans County. Collectively, we represent hundreds of thousands of New Yorkers.

We appreciate NYSDEC's efforts to strengthen the regulations, most of which have not been revised in decades. While the New York Code, Rules and Regulations (NYCRR) Part 360 series covers many aspects of solid waste management, we focus our comments on those related to oil and gas exploration, development, and production wastes (collectively known as E&P waste). Specific topics

covered include the characterization of oil and gas wastes; management and disposal procedures at landfills, including those related to landfill leachate; radioactivity detection; and the Beneficial Use Determination program for oil and gas brine.

We appreciate and support key improvements that the NYSDEC has proposed in Part 360 and other regulatory amendments, in particular:

- The installation of radiation detectors at landfills to monitor waste loads.
- Standardized parameters for the testing of landfill leachate.
- The storage of leachate in tanks rather than open-air impoundments.
- New tracking requirements for several categories of waste, including drilling waste.

As detailed in the following pages, our organizations firmly believe that much more is needed to address the problems posed by oil and gas waste. Neither NYSDEC nor state policymakers have yet fully weighed and addressed the well-documented risks to the environment and health posed by ever-growing volumes of waste generated by operations within New York and by Marcellus and Utica Shale development in other states.

Further, accurate tracking and accounting of these potentially harmful wastes is lacking. Conventional drillers in New York continue to produce E&P waste, yet it is impossible to say how much or where it ends up because the state does not maintain a centralized database on the oil and gas field waste stream nor provide public information on waste production and disposal. It is therefore impossible to assess the types or volumes of oil and gas waste actually being disposed of at landfills.

However, we do know from records submitted by both conventional and unconventional operators in Pennsylvania to the Department of Environmental Protection (PADEP) that since 2010, at least five New York landfills have accepted oil and gas waste from Pennsylvania, including 597,000 tons of drill cuttings; 23,000 barrels of fracturing and produced fluids; 200 tons of used fracturing sand; 480 tons of used well site pit liners; 550 tons of contaminated soils; and 420 barrels of sediment.[1] In addition, eight road-spreading, well services, and waste treatment companies in New York have

[1] PADEP Oil & Gas Reporting Website, Waste Reports by Waste Facility, https://www.paoilandgasreporting.state.pa.us/publicreports/Modules/Waste/WasteByWasteFacility.aspx (last visited Aug. 17, 2016) (data downloaded and summed for all New York facilities included in the database).

accepted 55,000 barrels of fracturing and produced fluids.[2]

As these data indicate, the oil and gas waste disposed of at New York landfills includes both fracturing and produced fluids, which contain toxic chemicals. At the same time, drill cuttings, muds, contaminated soil, pit liners, and fracturing sand often contain numerous chemicals, radioactive material, high levels of salts, and hydrocarbons.

Accordingly, New York is now disposing significant volumes of E&P waste, but because of weak management protocols and insufficient oversight, these wastes are barely tested prior to disposal. At the same time, special exemptions for the oil and gas industry in federal and state laws allow operators to keep the chemicals they use secret and to skirt the more stringent waste tracking and disposal requirements that other industries must follow.

On the whole, New York currently lacks systems to track and account for the volume, origin, and destination of oil and gas waste; effective waste characterization requirements to determine the actual content of waste and, in turn, proper disposal regimes; comprehensive, consistent oversight of waste management facilities; and regulatory enforcement capacity at NYSDEC. **Given this, we believe that in order to protect the environment and communities, NYSDEC should prohibit:**

1. **Disposal of oil and gas drilling, exploration, and production waste in municipal solid waste (MSW), industrial, and construction & demolition (C&D) landfills.**
2. **Disposal of leachate from landfills accepting oil and gas drilling, exploration, and production waste at Publicly Owned Treatment Works (POTWs).**
3. **Application of liquid waste from oil and gas drilling and production sites on roads as a de-icing and dust suppressant agent.**

We also strongly believe that NYSDEC should close the loophole in state law that exempts oil and gas waste from ever being subjected to classification as hazardous. Doing so would provide the waste characterization and tracking that is sorely needed in New York. As noted by the US Environmental Protection Agency (USEPA), were it not for the exemption for E&P waste in the US Resource Conservation and Recovery Act (RCRA), some oil and gas waste would certainly meet the definition of "hazardous waste."[3] Although New York has replicated this exemption in its own

[2] *Id.*
[3] USEPA,Office of Solid Waste, EXEMPTION OF OIL AND GAS EXPLORATION AND PRODUCTION WASTES FROM FEDERAL HAZARDOUS WASTE REGULATIONS (2002). See also the discussion on RCRA and state waste laws in Nadia

waste laws and regulations, fortunately the state also has the ability to close the loophole and provide commonsense protection for the long-term health and safety of residents statewide.

The following comments detail the reasons and justifications for these positions, as well as recommendations for strengthening specific sections of the proposed Part 360 revisions and related amendments.

In addition, we draw your attention to and incorporate by reference the attached report prepared by Downstream Strategies on behalf of Earthworks.[4] The report includes comments and recommendations on the proposed Part 360 revisions, including with regard to radionuclides and toxic substances in oil and gas waste and landfill monitoring and disposal practices. Downstream Strategies, based in West Virginia, draws on its extensive technical expertise on water and soil quality, including in relation to the management of oil and gas waste.

Lastly, our organizations' overall perspective on the regulatory proposals put forth by NYSDEC is informed by the fact that nearly two years ago, New York made the historic decision to prohibit shale gas production because of concerns for health and the environment—concerns that are increasingly legitimized by scientific research and realities on the ground nationwide. In fact, the Final Supplemental Generic Environmental Impact Statement on hydraulic fracturing in the Marcellus and Utica Shale included waste generation among the reasons not to permit unconventional oil and gas production.[5] NYSDEC can, and should, now apply this same level of concern and caution to the regulation and management of oil and gas field waste generated both within and outside of its borders.

1. Close the hazardous waste loophole

As noted above, we believe that there is credible justification for NYSDEC to close the loophole in state law that exempts oil and gas waste from ever being subjected to classification as hazardous. Along with revisions to the Part 360 regulations, NYSDEC has proposed regulatory amendments to Part 371 on the Identification and Listing of Hazardous Wastes, thereby opening up this section of

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Steinzor's and Bruce Baizel's *Wasting Away: Four states' failure to manage oil and gas waste in the Marcellus and Utica Shale* (Earthworks 2015), available at http://wastingaway.earthworksaction.org.

[4] Marc Glass, Comments on Proposed Changes to New York State Solid Waste Regulations (Downstream Strategies 2016).

[5] NYSDEC, FINAL SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON THE OIL, GAS AND SOLUTION MINING PROGRAM FINDINGS STATEMENT 14 (2015).

regulation to revisions. Part 371.1(e)(2)(v)—Exclusions in effect serves as a loophole for hazardous oil and gas waste.

New York's current hazardous waste regulations grant a special exemption that allows the oil and gas industry to circumvent state requirements for the generation, transportation, treatment, storage, and disposal of waste that would otherwise meet the definition of hazardous waste. NYSDEC should amend Part 371.1(e)(2)(v) by eliminating the words "crude oil, natural gas or" from this section. With that modification, the loophole would only exclude, "drilling fluids, produced waters and other wastes associated with the exploration, development, or production of geothermal energy."

Nearly 30 years ago, the US Congress and USEPA established a categorical exemption for the regulation of E&P wastes under Subtitle C of the US Resource Conservation and Recovery Act (RCRA). As a result, E&P wastes are not defined as hazardous regardless of their actual content and risks posed to the environment.

This federal exemption persists today, and has made it possible for states to define and manage E&P wastes as "solid" or "residual" regardless of whether or not they meet those definitions of waste with regard to their chemical make-up and potentially hazardous (and radioactive) characteristics. In turn, states have avoided the application of additional federal tracking, testing, transport, and disposal requirements established under RCRA.

Unfortunately, instead of using its authority to provide protections against E&P wastes with hazardous characteristics, New York has simply replicated the RCRA exemption. This "path of least resistance" may be convenient for oil and gas operators and reduce oversight and regulatory responsibilities for NYSDEC. However, ignoring the potentially hazardous nature of E&P waste poses risks to the environment and health—particularly because the volumes being transported, processed, and managed in New York (as well as nationwide) have increased over time.

As detailed below (see section on waste characterization), neither NYSDEC nor landfills accepting E&P wastes currently have the regulations and systems in place to test for and determine the chemical constituents of waste. This step is necessary to ensure proper disposal at facilities capable of handling specific types of E&P wastes. Reversing the hazardous waste loophole would solve this problem, since testing and tracking requirements would then be required for E&P wastes.

The current rulemaking offers a critical opportunity for NYSDEC to remove the nonsensical and dated exemption for oil and gas wastes and subject oil and gas wastes actually exhibiting the characteristics of hazardous waste to the same comprehensive transport, treatment, and disposal standards and oversight that all other hazardous waste are subject to. Other industries and generators of potentially hazardous waste in New York are subject to these requirements—there is no reason for the oil and gas industry to enjoy a special preference.

A legal exemption does not make E&P waste benign. In fact, the USEPA study used to determine the RCRA exemption recognized that between 10 and 70 percent of the oil and gas wastes sampled "could potentially exhibit RCRA hazardous waste characteristics," leading the agency to conclude, "It is clear that some portions of both the large-volume and associated waste would have to be treated as hazardous if the Subtitle C exemption were lifted."[6]

In addition, in the 30 years since the USEPA study was conducted, oil and gas development extraction methods have become more aggressive and generate more harmful wastes. New techniques, such as high-volume hydraulic fracturing, use much greater volumes of chemicals and create much greater volumes of waste, which are in turn influenced by many new contaminants acquired from the formations accessed (e.g., deep shale). In the revised draft SGEIS on high-volume hydraulic fracturing, 300 different chemicals—ranging from likely harmless to known toxins and carcinogens—are listed as potential constituents in E&P wastes.

As discussed below in the section on waste characterization, NYSDEC allows waste generators and facilities to self-report what types of waste are being disposed of in landfills. Current testing practices and oversight capacity are insufficient to ensure that E&P wastes ending up in New York's landfills are *not* hazardous, particularly in light of growing evidence that some wastes have characteristics that meet the definition of hazardous. In this context, a categorical exemption for E&P wastes from the state's hazardous waste regulations is both illogical and environmentally risky.

Both the USEPA and New York use four technical criteria to determine if a waste is hazardous: ignitability, toxicity, corrosivity, and reactivity.[7] Waste can be considered hazardous if it exhibits *any* of these characteristics.

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[6] USEPA, Regulatory Determination for Oil and Gas and Geothermal Exploration, Development, and Production Wastes, 53 Federal Register 25447, 25455 (Jul. 6, 1988).
[7] USEPA, RCRA Orientation Manual, Chapter III: RCRA Subtitle C, Managing Hazardous Waste; 40 CFR § 261.20 et seq.; NYSDEC, 6 NYCRR § 371.3.

A growing body of **documentation and scientific evidence confirms that oil and gas waste contains toxic (as well as potentially radioactive) substances that, if comprehensively tested, could meet concentration thresholds for the hazardous characteristic of toxicity**.[8] During the determination on the RCRA exemption, USEPA clearly stated that E&P wastes contain toxic substances that endanger both human health and the environment, including benzene, phenanthrene, lead, arsenic, barium, antimony, fluoride, and uranium at "levels that exceed 100 times USEPA's health based standards."[9] Of these, New York's regulations include arsenic, barium, benzene, and lead among the contaminants that can give a waste the characteristic of toxicity.[10]

Drill cuttings, which can display toxic characteristics, make up a large proportion of the E&P wastes accepted at New York landfills. NYSDEC has stated that drill cuttings are simply "rock and soil residue" and that their disposal in municipal solid waste landfills is "environmentally safe."[11] As discussed in more detail below, NYSDEC appears to base this view on very limited sampling and analysis conducted in 2010, not on more recent scientific studies on the content of cuttings and potential environmental risks. NYSDEC also ignores the fact that because cuttings are essentially ground up bits of shale formations, they can contain heavy metals such as barium and chromium—both of which are included in New York's list of substances with toxicity characteristics.[12]

In addition, NYSDEC's assertion that drill cuttings are "safe" appears to be based on the specious faith that drill site operators are thoroughly separating drill cuttings from other wastes at the well-site and guaranteeing that they are not "oil-based." As discussed below, drill cuttings can be coated with the fluids and muds used to bore oil and gas wells, which are made from chemicals and petroleum products.

In addition, different types of wastes are often stored in reserve pits and tanks at well sites for extended periods of time before they are removed for disposal. As a result, loads of cuttings may end up blended with liquid waste from other parts of an operation, including flowback, produced water, and chemicals used in hydraulic fracturing.

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[8] *See, e.g.*, M. Glass and K. Hatcher, Comments on Proposed Changes to the West Virginia Solid Waste Management Rule, 33CSR1, (Downstream Strategies 2014); and U.S. Occupational Safety and Health Administration, Drilling fluid, https://www.osha.gov/SLTC/etools/oilandgas/drilling/drillingfluid.html (last accessed Sept. 12, 2016).
[9] USEPA, Regulatory Determination for Oil and Gas and Geothermal Exploration, Development, and Production Wastes, 53 Federal Register 25447, 25448 (Jul. 6, 1988).
[10] 6 NYCRR § 371.3(e) tbl.1.
[11] NYSDEC, CHEMUNG COUNTY LANDFILL EXPANSION RESPONSIVENESS SURVEY SUMMARY, at response R2 (2016).
[12] 6 NYCRR § Part 371.3(e) tbl 1; *See* Tracy L. Bank, Lauren A. Fortson, et al., A GEOCHEMICAL AND GEOSPATIAL INVESTIGATION OF HEAVY METALS IN THE MARCELLUS SHALE (University of Buffalo and Chevron USA Inc. 2012).

Drilling muds can also be of great concern. In a 2013 report developed for the West Virginia Department of Environmental Protection, researchers found that samples of drilling muds from vertical wells in the state contained high concentrations of contaminants, including chlorides, benzene, and surfactants.[13] Although little research has been conducted on the chemical content of fracturing sand, it is mixed with chemicals before being used—and thus the waste may contain toxic substances.

The line between "solid" and "liquid" can easily be blurred prior to acceptance and disposal at landfills. Since cuttings are brought to the surface after drilling, they can become coated with both drilling fluids and produced (formation) water. Although produced water, flowback, and fracturing fluids are primarily disposed of at industrial wastewater treatment plants or centralized waste treatment facilities, they can also end up in landfills designed for solid waste. In fact, operators in Pennsylvania have reported sending "drilling fluid waste," "fracing fluid waste," "produced fluid," and "servicing fluid" to landfills; as noted above, New York landfills have accepted nearly 23,000 barrels of liquid waste from Pennsylvania since 2010.[14]

Even if New York landfills only take loads of E&P wastes that they deem to be "solid waste," it is highly possible that some of this waste contains flowback, fracturing fluids, production brine, or muds that have simply been dewatered and bulked either prior to transport to New York landfills or at the landfills themselves.

New York's threshold for wastes being defined as "solid" is only 20 percent solid content,[15] i.e., landfills are allowed to accept wastes which can be as much as 80 percent liquid. In the absence of regulatory requirements and oversight to ensure the proper chemical characterization of wastes (see discussion below), there is simply no way to categorically exclude muds, fluids, and other substances from disposal at landfills. NYSDEC continues to insist that solid waste "will not consist of brine or similar wastes."[16] Yet NYSDEC has never provided a credible basis for this assumption nor documentation that the E&P wastes accepted at landfills consist solely of drill cuttings that have not

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[13] W. VA. WATER RESEARCH INST., ASSESSING ENVIRONMENTAL IMPACTS OF HORIZONTAL GAS WELL DRILLING OPERATIONS (2013).
[14] PADEP Oil & Gas Reporting Website, Waste Reports by Waste Facility, https://www.paoilandgasreporting.state.pa.us/publicreports/Modules/Waste/WasteByWasteFacility.aspx (last visited Aug. 17, 2016) (data downloaded and summed for all New York facilities included in the database).
[15] Richard Clarkson, NYSDEC Div. of Materials Mgmt., Presentation on Current Solid Waste Disposal Regulatory Framework for Gas Development Wastes (2013).
[16] NYSDEC, CHEMUNG COUNTY LANDFILL EXPANSION RESPONSIVENESS SURVEY SUMMARY, at response R12 (2016).

been additionally contaminated by chemicals used in drilling, fracturing, and other processes.

Importantly, samples of flowback from the Marcellus Shale have shown consistently high levels of the toxic substance barium, [17] as well as toxic volatile organic compounds such as benzene and trichloroethylene.[18] As discussed below regarding roadspreading of brine (which by definition may encompass both produced water and flowback), this type of E&P waste can contain a range of chemicals, metals, and radioactive materials.[19]

Many of the chemicals used in drilling and hydraulic fracturing that could end up in E&P wastes are known to be toxic, while the health effects of others are unstudied but potentially harmful. A recent investigation of EPA's regulation of new chemicals proposed for use in drilling and fracturing found that the agency had health concerns about 88 of 105 such chemicals reviewed between 2009 and 2014, ranging from developmental toxicity, liver toxicity and neurotoxicity to irritation to eyes, lungs, mucous membranes, and skin.[20]

Yet EPA had approved all but seven of the chemicals for commercial use, in most cases without receiving or asking for health testing data from the manufacturers. In EPA's draft study of hydraulic fracturing and drinking water published in 2015, the EPA acknowledged that "major knowledge gaps exist regarding the toxicity of most chemicals used in hydraulic fracturing fluids or detected in flowback/produced water…."[21] The agency reported that among the chemicals used in hydraulic fracturing and found in flowback were arsenic, benzene, ethylbenzene, toluene and xylene.[22]

Similarly, a 2011 Congressional review of hydraulic fracturing fluids found that they included more than 650 different products that contained chemicals that were known or possible human carcinogens, regulated under the Safe Drinking Water Act for risks to human health, or listed as

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[17] Paul Ziemkiewicz, John Quaranta, and Michael McCawley, *Practical Measures for Reducing the Risk of Environmental Contamination in Shale Energy Production*, ENVIRONMENTAL Science (2014).
[18] U.S. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, HYDRAULIC FRACTURING AND FLOWBACK HAZARDS OTHER THAN RESPIRABLE SILICA (2014), *available at* https://www.osha.gov/Publications/OSHA3763.pdf.
[19] Robert B. Jackson et al., *The Environmental Costs and Benefits of Fracking*, 39 ENVIRONMENT AND RESOURCES 327 (2014); U.S. GEOLOGICAL SURVEY, RADIUM CONTENT OF OIL AND GAS FIELD PRODUCED WATERS IN THE NORTHERN APPALACHIAN BASIN (USA): SUMMARY AND DISCUSSION OF DATA (2011), *available at* http://pubs.usgs.gov/sir/2011/5135/.
[20] Dusty Horwitt, TOXIC SECRETS: COMPANIES EXPLOIT WEAK US CHEMICAL RULES TO HIDE FRACKING RISKS (Partnership for Policy Integrity 2016).
[21] USEPA, ASSESSMENT OF THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING FOR OIL AND GAS ON DRINKING WATER RESOURCES, at 9-35. 2015.
[22] *Id.* at 9-34.

hazardous air pollutants under the Clean Air Act.[23]

New York's current solid waste regulations provide another reason why E&P waste would likely be defined as hazardous if the exemption were reversed. Part 371.1(d)—Definition of hazardous waste specifies that wastes excluded from the definition of hazardous can be considered hazardous if mixing with other substances gives it hazardous characteristics. This is consistent with USEPA's 2002 warning to oil and gas operators that waste mixtures "might become a non-exempt waste and require management under RCRA Subtitle C regulation."[24]

Currently, however, **NYSDEC does not appear to enforce Part 371.1(d) by requiring landfills to conduct chemical testing of mixtures that contain excluded E&P wastes to determine if they are hazardous.** Instead, E&P wastes solidified or downblended with other products in order to meet "solid" thresholds for disposal at landfills are left untested for toxic or radioactive contaminants. According to Argonne National Laboratory, the effectiveness of solidification is limited and various factors can result in the leaching of contaminants into the environment from mixtures.[25]

Given this, NYSDEC should prevent compounding the risks to soil and water by adopting mechanisms to ensure that landfills in New York that accept E&P wastes do not mix them with materials that also contain toxic or radioactive materials. For example, some landfills mix E&P waste with coal ash, which contains arsenic, mercury, and lead and is defined by the USEPA as Technologically Enhanced Naturally Occurring Radioactive Material (TENORM), or auto shredder residue, which contains high enough levels of heavy metals, petroleum products, and polychlorinated biphenyls to render it "hazardous wastes according to the [USEPA] Toxicity Characteristic Leaching Procedure (TCLP)."[26]

Finally, **realities in oil and gas fields nationwide indicate that E&P wastes can have the hazardous characteristic of ignitability**. For example:

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[23] STAFF OF H. COMM. ON ENERGY AND COMMERCE, 112TH CONG., CHEMICALS USED IN HYDRAULIC FRACTURING COMMERCE (2011) (Committee Minority Staff Report).
[24] USEPA, EXEMPTION OF OIL AND GAS EXPLORATION AND PRODUCTION WASTES FROM FEDERAL HAZARDOUS WASTE REGULATIONS (2002).
[25] Argonne National Laboratory Drilling Waste Information System, Fact Sheet - Solidification and Stabilization, http://web.ead.anl.gov/dwm/techdesc/solid/index.cfm (last visited Sept. 12, 2016).
[26] Michael C. Mensinger, Amir Rehmat, Satish Saxena, and N.S. Rao, Treatment Technology for Auto Fluff, *available at* https://web.anl.gov/PCS/acsfuel/preprint%20archive/Files/38_3_CHICAGO_08-93_0837.pdf.

- In January 2003, a Texas collection pit of oil and gas waste ignited when hydrocarbon vapors interacted with sediments and water in the pit.[27]
- In May 2006, a natural gas condensate tank and pit in Colorado caught fire and burned for five hours.[28]
- In April 2010, a wastewater impoundment in Pennsylvania ignited reportedly shooting flames 100 feet in the air.[29]

2. Strengthen waste characterization

According to researchers with Downstream Strategies, "The composition of the drilling waste stream may present an even greater management challenge to MSW [Municipal Solid Waste] landfills than the sheer volume. Drilling wastes will, at a minimum, consist of drill cuttings…from the vertical portion of the wellbore, organic-rich layers from the shale formation, and components of the muds and chemicals used to lubricate the drilling tools and assist with the return of drill cuttings to the surface. Once oxidized by interactions above the ground surface, both metals and radionuclides may become much more water soluble, especially under acidic conditions."[30]

Yet even in the face of such realities and rapidly growing volumes of E&P wastes entering New York landfills, **NYSDEC has never taken the important step of determining whether landfill disposal is an appropriate management approach for E&P wastes.** Despite their complex chemical and radiological characteristics, NYSDEC continues to categorize E&P wastes as general "solid waste," effectively sanctioning the disposal of substances with unknown content and, in turn, with unknown environmental consequences.

NYSDEC has not been clear about how E&P wastes are categorized and which landfills in New York can permissibly accept this waste stream. According to a letter from NYSDEC, drilling and

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[27] US Dep't of Labor, Occupational Safety and Health Admin., Potential Flammability Hazard Associated with Bulk Transportation of Oilfield Exploration and Production (E&P) Waste Liquids, SHIB 03-24-2008. It is possible also that this incident shows that E&P waste meets the RCRA standard for reactivity.
[28] Earthworks Oil & Gas Accountability Project, Spring/Summer 2006 Report (2006), *available at* https://www.earthworksaction.org/files/publications/OGARspringsummer2006.pdf.
[29] Janice Crompton, *Residents Reported Gas Odors Before Explosion,* PITTSBURG POST-GAZETTE (Apr. 1, 2010), *available at* http://www.post-gazette.com/local/washington/2010/04/01/Residents-reported-gas-odors-before-explosion/stories/201004010317.
[30] M. Glass and K. Hatcher, Comments on Proposed Changes to the West Virginia Solid Waste Management Rule, 33CSR1 (Downstream Strategies 2014).

production waste has sometimes been classified as construction and demolition (C&D) debris.[31] It is clear from PADEP's waste records that both C&D and MSW landfills in New York have been accepting this waste stream.

This lack of clarity is made worse by NYSDEC's broadening of the definition of "industrial waste" in the proposed Part 360 revisions. The definition in the current 6 NYCRR Part 360 regulations clearly states that E&P waste is not industrial waste.[32] However, in the proposed revisions, NYSDEC simply states in the Definitions section that, "*Industrial waste* means waste generated by manufacturing or industrial processes."

MSW, C&D, and Industrial landfills all have different requirements and regulations governing their operations, maintenance, and structure. Due to the potentially hazardous and radioactive characteristics of E&P wastes, we firmly believe that this waste stream is best suited for disposal at hazardous or low-level radioactive waste facilities (as discussed previously). However, NYSDEC must be explicit as to whether or not the agency considers E&P waste to be industrial waste, C&D waste, or its own category of waste for the purposes of regulation and enforcement. If E&P waste is its own category of waste, the proposed regulations should clearly spell out which facilities can accept it and under what conditions.

We recognize that NYSDEC oversees waste treatment and disposal facilities and requires them to submit reports on the volumes and types of waste managed to NYSDEC regional offices. However, it does not appear that NYSDEC has ever assessed information held (presumably in hard copy format) at regional offices to determine whether current practices offer a sufficient level of environmental protection.

In 2014, Citizens Campaign for the Environment submitted a Freedom of Information Law (FOIL) request to NYSDEC on the types of oil and gas waste disposed of in landfills. Unfortunately, NYSDEC's response included spreadsheets with titles of reports that had been submitted to regional NYSDEC offices—but no actual data or information on what those reports contained.

Further, in a comprehensive review of 100 permit applications from drillers, Environmental Advocates of New York (EANY) found that NYSDEC simply asks operators how drilling fluids and waste will be stored, contained, and disposed of—leaving it up to operators to decide how much

[31] Letter from Ruth Earl, NYSDEC Records Access Officer, to Sarah Eckel, Citizens Campaign for the Environment, June 13, 2014.
[32] 6 NYCRR § 360-1.2 (b)(88).

detail to provide.[33] EANY's analysis indicates that responses provided by drillers vary greatly and are often based on generic statements, such as that wastes will be disposed of "at approved facilities" and "in accordance with NYSDEC regulations."[34]

A 2015 review of oil and gas waste management practices found that in the absence of a standardized state form, New York waste disposal facilities often develop their own waste characterization forms—which may not even include solidified/bulked drill cuttings or other E&P wastes.[35] Further, both NYSDEC and landfill forms require only basic descriptions of wastes (such as texture, size, appearance, and degree of odor) and give operators wide latitude in whether or not to submit actual laboratory analysis of the content of the waste.[36]

Oil and gas operators are required only to certify that "representative samples" of waste have been tested, not necessarily the actual waste being disposed of. As a result, they and associated transporters may be approved to dispose of many loads or tons of waste from different locations over the course of several months or more. This is clearly inadequate given that the nature and concentration of constituents can vary depending on geological conditions and potentially even within the same well bore or on the same well site.[37]

In the absence of comprehensive chemical testing and standardized documentation, the actual content of waste entering New York landfills remains largely unknown. **Such lack of scrutiny and oversight is unacceptable when managing E&P wastes, which have complex chemical profiles, contain radioactive material, and (as discussed above) could potentially meet the definition of hazardous if properly characterized.**

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[33] ENVIRONMENTAL ADVOCATES OF NEW YORK, OUT OF SIGHT, OUT OF MIND: NEW YORK'S FAILURE TO TRACK OR TREAT FRACKING WASTE ENDANGERS PUBLIC HEALTH AND THE ENVIRONMENT (2012).
[34] *Id.*
[35] Discussion in N. Steinzor and B. Baizel, WASTING AWAY: FOUR STATES' FAILURE TO MANAGE OIL AND GAS FIELD WASTE FROM THE MARCELLUS AND UTICA SHALE REGION (Earthworks 2015). *See* NYSDEC, Application for Treatment or Disposal of an Industrial Waste Stream, *available at*http://www.NYSDEC.ny.gov/docs/materials_minerals_pdf/indwasteform.pdf; Casella Resource Solutions, Special Waste Characterization Form, *available at* http://www.casella.com/what-we-do/landfills/special-waste/special-waste-new-york; and Chautaugua County Landfill, Generator Waste Charazterization Report Form, *available at* http://www.co.chautauqua.ny.us/DocumentCenter/Home/View/349.
[36] *See* NYSDEC, Application for Treatment or Disposal of an Industrial Waste Stream, *available at*http://www.dec.ny.gov/docs/materials_minerals_pdf/indwasteform.pdf; Casella Resource Solutions, Special Waste Characterization Form, *available at* http://www.casella.com/what-we-do/landfills/special-waste/special-waste-new-york; and Chautaugua County Landfill, Generator Waste Charazterization Report Form, *available at* http://www.co.chautauqua.ny.us/DocumentCenter/Home/View/349.
[37] M. Glass and K. Hatcher, Comments on Proposed Changes to the West Virginia Solid Waste Management Rule, 33CSR1 (Downstream Strategies 2014).

The overall concept of "drilling waste" represents a chemically complex mixture of fluid and solid organics, salts, minerals, metals, and radionuclides. The characteristics of drill cuttings, muds, fracturing sand, and other "solid" wastes, and in turn their interaction with water, soil, and air, are not yet completely documented. Researchers in West Virginia recently summed up the need for both further investigation and caution: "At present little is known about the risks associated with the solid wastes from hydraulic fracturing in the Marcellus: spent drilling mud, drill cuttings and filtrates/precipitates from flowback. Characterization of their inorganic, organic and radioactive contaminants is at present, incomplete. A systematic study including worker, environmental and community risks is needed."[38]

Nonetheless, recent scientific analysis of both vertical and horizontal drill cutting samples in West Virginia showed they contain chloride, arsenic, barium, iron, manganese, strontium, benzene, and fluoride, as well as Radium 226 and 228.[39] NYSDEC does not currently distinguish in regulation between cuttings generated from different types of formations and drilling depths, factors that determine the concentration of metals, radioactivity, and hydrocarbons contained in resulting waste. For example, a recent analysis of radioactivity in E&P wastes by the Pennsylvania Department of Environmental Protection showed that samples of horizontal drill cuttings had Ra-226 levels nearly twice as high as samples of vertical cuttings.[40]

NYSDEC should establish clear definitions of different types of cuttings and establish regulations prohibiting disposal of those containing concentrations of chemicals and radiological substances higher than thresholds in New York's hazardous waste and radioactive waste disposal laws.

Even the way in which cuttings are generated can influence contaminant levels; for example, those generated with mud drilling techniques have been found to contain higher chloride concentrations, presumably due to additives in the mud.[41] A new study indicates that a "green" synthetic drilling mud has the potential to lower toxicity levels in cuttings, compared to other muds that are much

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[38] Paul Ziemkiewicz, John Quaranta, and Michael McCawley, *Practical Measures for Reducing the Risk of Environmental Contamination in Shale Energy Production*, ENVIRONMENTAL Science (2014).
[39] MARSHALL UNIV. CTR FOR ENVTL., GEOTECHNICAL AND APPLIED SCIENCES, *EXAMINATION OF LEACHATE, DRILL CUTTINGS AND RELATED ENVIRONMENTAL, ECONOMIC AND TECHNICAL ASPECTS ASSOCIATED WITH SOLID WASTE FACILITIES IN WEST VIRGINIA;* STUDY AND REPORT FOR WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION (2015).
[40] PERMAFIX ENVIRONMENTAL SERVICES FOR PADEP, TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS (TENORM) STUDY REPORT (2015).
[41] *Id.*

more widely used today.[42]

In recognition of these variations, New York allows "water-based" drill cuttings to be buried onsite unless they contain oil- and polymer-based mud or lubricant, at which point they are considered to be "industrial non-hazardous waste" and must be removed from the site for disposal in a landfill.[43] However, due to limitations in waste characterization discussed above, NYSDEC does not have mechanisms in place to ensure that cuttings managed and disposed of onsite are in fact "uncontaminated." This makes it even more critical for NYSDEC to link the management and disposal of cuttings to established contaminant thresholds.

In light of the chemical and radiological complexities of E&P wastes and the potential for different wastes to be mixed during transport and disposal, the wastes should be properly characterized at the site where they are generated *prior to disposal.* NYSDEC should develop requirements for oil and gas operators to conduct comprehensive waste characterization at the well site; and require landfills accepting E&P waste from both within and outside of New York to obtain documentation from the generators of that waste at the point of origin.

In addition, NYSDEC should require that the full list of chemicals used at the well sites where the wastes being characterized were generated be made publicly available before those wastes can be accepted at landfills in New York. The chemicals should be listed by Chemical Abstracts Service (CAS) registry number and, if the chemical is a new chemical, by the EPA tracking number assigned to chemicals reviewed by EPA's New Chemicals program (e.g. P-09-0205). The CAS number is a unique chemical identifier that enables regulators and others to know precisely what chemical is being used. The EPA tracking number would enable regulators to know, among other things, whether EPA has identified health or environmental concerns about new chemicals and other information. If NYSDEC adopts this disclosure standard, the agency should require drilling operators to waive claims of confidentiality regarding chemical identities that are often asserted by

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[42] MARSHALL UNIV. CTR FOR ENVTL., GEOTECHNICAL AND APPLIED SCIENCES, *EXAMINATION OF LEACHATE, DRILL CUTTINGS AND RELATED ENVIRONMENTAL, ECONOMIC AND TECHNICAL ASPECTS ASSOCIATED WITH SOLID WASTE FACILITIES IN WEST VIRGINIA;* STUDY AND REPORT FOR WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION (2015).

[43] NYSDEC, REVISED DRAFT SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON THE OIL, GAS AND SOLUTION MINING REGULATORY PROGRAM WELL PERMIT ISSUANCE FOR HORIZONTAL DRILLING AND HIGH-VOLUME HYDRAULIC FRACTURING TO DEVELOP THE MARCELLUS SHALE AND OTHER LOW-PERMEABILITY GAS RESERVOIRS § 5.13.1 (2011).

chemical manufacturers and operators.[44]

As stated above, our organizations hold the position that NYSDEC should prohibit E&P waste disposal at MSW, Industrial, and C&D landfills. At the same time, the current rulemaking gives NYSDEC the opportunity to take a significant step forward in strengthening waste characterization procedures at landfills, as follows.

Part 360.16—Permit applications and permit provisions. Part 360.16(4)(h)(2) requires landfills, municipal waste combustors, and transfer facilities to include in their facility operating manuals a detailed plan that, "describes procedures and timeframes for conducting periodic waste characterization surveys." We support this provision because such procedures are essential to tracking what landfills are accepting and the potential environmental risks.

However, the current language is too general to ensure that landfills will survey waste frequently or comprehensively enough to prevent the eventual contamination of soil and groundwater. Because this provision lacks associated standards, it will be difficult to actually enforce.

NYSDEC should amend Part 360.16, Section 4(h)(2) to require characterization procedures and timeframes for E&P wastes specifically. These revisions should include consistent, binding protocols for the testing and characterization of both raw and solidified waste. Protocols should address chemical and radiological parameters for testing; frequency of testing; and the origin and maximum volume of E&P wastes that can be tested as a "representative sample."

As discussed earlier, NYSDEC should amend Part 371.1(e)(2)(v) to close the loophole in state regulations that exclude E&P wastes from characterization as hazardous. We therefore support NYSDEC's specification in Part 363-8.1 (p) that special handling and disposal procedures for drilling and production wastes must be included in landfill waste control plans. However, this section should be expanded and amended to require that all landfill waste control plans include the analytical testing of oil and gas waste for its potentially hazardous characteristics (ignitability, toxicity, corrosivity, and reactivity), and if the waste tests as hazardous, it must be sent to a facility specifically licensed to manage hazardous waste.

[44] Dusty Horwitt, TOXIC SECRETS: COMPANIES EXPLOIT WEAK US CHEMICAL RULES TO HIDE FRACKING RISKS (Partnership for Policy Integrity 2016); *see* Katherine Konschnik and Archana Dayalu, *Hydraulic Fracturing Chemicals Reporting: Analysis of Available Data and Recommendations for Policymakers*, 88 ENERGY POLICY 504-514 (2016); STAFF OF H. COMM. ON ENERGY AND COMMERCE, 112TH CONG., CHEMICALS USED IN HYDRAULIC FRACTURING COMMERCE (2011) (Committee Minority Staff Report) (finding that companies are injecting fluids containing chemicals that they themselves cannot identify).

Currently, waste management facilities in New York do not consistently require documentation of laboratory analysis to determine if wastes have hazardous characteristics. Testing parameters should include, at minimum, all of those on NYSDEC's lists of substances with primary hazardous properties.[45] Until landfills update their waste control plans to ensure comprehensive analytical testing, NYSDEC should prohibit them from accepting oil and gas waste.

It is vital for landfills to take measures to ensure greater protection against the impacts of E&P waste they accept. At the very minimum, NYSDEC should require any landfill it permits to obtain documentation from waste transporters to certify that the specific load of waste in question has been thoroughly analyzed by a laboratory using USEPA Toxicity Characteristic Leaching Procedure (TCLP) analyses for Metals, Volatile Organic Compounds, Semi-volatile Organic Compounds, and Total Petroleum Hydrocarbons. These certifications should be made available to both NYSDEC to ensure regulatory compliance and to the public upon request.

3. Adequately manage and test landfill leachate

We believe that insufficient testing, characterization, and regulation warrant a prohibition on the disposal of leachate from landfills accepting E&P wastes at POTWs. The environmental consulting company Downstream Strategies has analyzed trends for several common drilling waste contaminants detected in leachate from West Virginia landfills, finding that chloride, arsenic, and barium increased in tandem with growing rates of E&P waste disposal, and that the leachate frequently contained concentration of Ra-226 and Ra-228 that exceeded the federal Maximum Contaminant Level (MCL).[46] Another analysis of leachate from six West Virginia landfills by researchers at Marshall University found that barium was present only in the leachate from landfills that accept drill cuttings.[47]

A recent report by PADEP concluded that, "Because landfills accept natural gas industry wastes such as drill cuttings and treatment sludge that may contain TENORM [Technologically Enhanced

[45] 6 NYCRR § 597.3 (listing hazardous substances).
[46] M. Glass and K. Hatcher, Comments on Proposed Changes to the West Virginia Solid Waste Management Rule, 33CSR1 (Downstream Strategies 2014).
[47] MARSHALL UNIV. CTR FOR ENVTL., GEOTECHNICAL AND APPLIED SCIENCES, *EXAMINATION OF LEACHATE, DRILL CUTTINGS AND RELATED ENVIRONMENTAL, ECONOMIC AND TECHNICAL ASPECTS ASSOCIATED WITH SOLID WASTE FACILITIES IN WEST VIRGINIA;* STUDY AND REPORT FOR WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION (2015).

Naturally Occurring Radioactive Material], there is a potential for leachate from those facilities to also contain TENORM." [48]

Such findings indicate that solidification practices at landfills may be insufficient to stabilize contaminants and prevent the possibility of groundwater contamination—a condition that may well exist at landfills in New York that accept E&P wastes. Given the strong potential that both E&P wastes entering landfills and the leachate leaving them will have elevated levels of toxic and radioactive contaminants, we offer the following comments.

Part 363-6.20—Aboveground and on-ground leachate storage tank requirements. We strongly support these provisions to properly contain leachate in closed systems prior to disposal, including subpart (a) requiring a secondary containment system in the event of a leachate spill. Containment is particularly vital because the design provisions in this requirement implicitly allow for the storage of leachate onsite up to three months.

Part 363-6.1—General Requirements. The Publicly Owned Treatment Works (POTWs) to which landfill leachate is sent for disposal are generally designed to remove suspended solids and organic material using biological treatment. They do not monitor for Ra-226 and Ra-228 or other contaminants associated with E&P wastes (such as benzene or barium), largely because Federal National Pollutant Discharge Elimination System (NPDES) permits don't generally require it.[49] Unfortunately, New York's State Pollutant Discharge Elimination System (SPDES) is equally limited in its testing and monitoring requirements.

Two such New York State POTWs serving the towns of Wellsville (SPDES Permit No. NY0020621) and the Village of Bath (SPDES Permit No. NY0021431) have accepted or may accept leachate from landfills that store E&P wastes. Without treatment methods designed for E&P wastes, the POTWs may discharge radionuclides or other E&P pollutants to New York's waterways. Any unregulated discharge of these dangerous pollutants most likely would run afoul of the federal Clean Water Act's anti-degradation provision, as they could impair the receiving water's existing use, whether for drinking, recreation, or fish propagation.[50]

Unless landfills can guarantee that the leachate going to POTWs is free of toxic substances and has a

[48] PERMAFIX ENVIRONMENTAL SERVICES FOR PADEP, TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS (TENORM) STUDY REPORT (2015).
[49] *Id.*
[50] *See* 40 CFR § 131.12(a)(1).

radiological content no greater than drinking water standards (5piC/g), their leachate should not be disposed of at POTWs—since this practice effectively means direct discharge of contaminants into rivers and streams. NYSDEC should amend Part 363-6.1 to include a provision that any landfill accepting E&P wastes is prohibited from sending its leachate to Publicly Owned Treatment Works (POTWs). This is necessary to prevent toxic and radioactive substances associated with oil and gas activities from reaching potentially causing harm to aquatic life, drinking water resources, and public health.

The inability of POTWs to remove substances contained in E&P wastes is reflected in USEPA's 2016 rule prohibiting the disposal of wastewater from unconventional oil and gas operations at POTWs because it can, "…contain high concentrations of dissolved solids (or salts), as well as pollutants such as radioactive elements, metals, chlorides, sulfates, and other dissolved inorganic constituents that POTWs are not designed to remove…constituents can be discharged, untreated, from the POTW to the receiving water; can disrupt the operation of the POTW (e.g., by inhibiting biological treatment); can accumulate in biosolids (sewage sludge), limiting their use; and can facilitate the formation of harmful DBPs [disinfection by-products]"[51]

For the same reasons cited by USEPA with regard to oil and gas wastewater, leachate associated with the disposal of E&P wastes should only be disposed of at specialized treatment plants capable of removing and safely disposing of toxic and radioactive substances. Notably, the National Association of Clean Water Agencies recently called on USEPA to expand its review of effluent discharge guidelines and consider the adoption of federal standards on the treatment and disposal of landfill leachate at POTWs. Although this request did not specify problems associated with E&P wastes, it was based on growing evidence that landfill leachate interferes with POTW treatment systems.[52]

NYSDEC should also incorporate into Part 363-6.1 a provision that any landfills accepting drill cuttings and other E&P wastes must dispose of them in dedicated cells. These cells should be constructed to segregate leachate generated from E&P wastes within the cell from the leachate generated from all other municipal solid wastes at the facility. Since 2013, municipal solid waste

[51] USEPA, Fact Sheet: Pretreatment Standards for the Oil and Gas Extraction Point Source Category (2016), *available at* https://www.epa.gov/sites/production/files/2016-06/documents/uog-final-rule_fact-sheet_06-14-2016.pdf (last visited Aug. 21, 2016).
[52] National Association of Clean Water Agencies, comment letter on USEPA's Preliminary 2016 Effluent Guidelines Program Plan, *available at* https://www.nacwa.org/images/stories/public/2016elgcom.pdf (accessed Aug. 21, 2016).

facilities in West Virginia at risk of exceeding their tonnage limits due to E&P waste streams have been given the option by the state of developing such cells, which are considered necessary to prevent contaminants from drilling waste from reaching larger waste streams.[53]

Part 363-6.1(c) states that leachate collection and removal systems should be designed to "effectively protect surface and groundwater resources from uncontrolled releases of landfill leachate." Studies indicate that over time, most landfills will experience leachate leakage into the environment; known pathways to water resources include the overflow of leachate collection units, cracks in piping systems, as well as landfill liner failures.[54]

Given this, NYSDEC should amend Subpart 363-6.1(c) to include a monitoring and repair requirement for the full leachate collection and removal system, including, at minimum, weekly inspections and full repair within three days of a spill.

Part 363-7.4—Environmental Monitoring Plan. We strongly agree with DEC's requirement that landfills have a detailed plan in place for the frequency and location of monitoring. Part 363-7.4(a)(3) should specify that the "analyses to be performed" must be in accordance with USEPA standard methods for the relevant contaminants, as specified in Part 363-7.6.

In addition, Part 363-7.4(b)(3) should clarify that leachate monitoring for both baseline and expanded parameters in both the primary and secondary collection systems must be conducted on at least a quarterly basis. These improvements are particularly critical at landfills that treat leachate onsite for direct discharge, but also necessary to reduce the possibility that leachate with excessive concentrations of chemicals, metals, and radionuclides will be sent to POTWs.

Part 363-7.6—Water Quality Analysis Tables. We disagree that radionuclide monitoring for groundwater, surface water, and sediment should only occur under a contingency sampling scenario. Table 3A should be made a requirement for facility environmental monitoring plans for groundwater, surface water, and sediment monitoring (not only leachate pools), with radionuclide sampling and analysis performed on at least a routine basis.

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[53] Marc Glass, Comments on Proposed Changes to New York State Solid Waste Regulations (Downstream Strategies 2016).

[54] MARSHALL UNIV. CTR FOR ENVTL. GEOTECHNICAL AND APPLIED SCIENCES, *EXAMINATION OF LEACHATE, DRILL CUTTINGS AND RELATED ENVIRONMENTAL, ECONOMIC AND TECHNICAL ASPECTS ASSOCIATED WITH SOLID WASTE FACILITIES IN WEST VIRGINIA;* STUDY AND REPORT FOR WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION (2015).

4. Adopt appropriate systems for detecting and managing radioactivity

The level of radioactivity that exists in oil and gas waste is vigorously debated, and in turn how the waste should be managed to protect workers and residents from exposure and natural systems from contamination. This longstanding question has become more focused as drilling and generation of associated waste increases. Levels of radioactivity can vary across shale formations depending on depth and concentration. The Marcellus Shale has been found to contain considerably higher levels of radioactivity than many other formations.[55]

Oil and gas development is known to bring radioactivity to the surface through produced water, drill cuttings, and drilling muds, and can also result in radioactive deposits in sludges and scale that accumulate on pipes and equipment. Because of gaps in waste characterization (discussed above), as well as the potential for different types of E&P wastes to mix during storage and transportation, radioactive substances can easily enter landfills.

The current rulemaking indicates that NYSDEC recognizes the risk of radioactivity entering landfills. However, we offer the following comments based on concern over the lack of specific provisions to adequately detect and manage radioactive substances associated with E&P wastes.

Part 363-8.1(a)(4)—Radioactive waste detection procedures and requirements. We strongly support NYSDEC's requirement for the installation of fixed radiation detection units at landfills, including provisions for regular background readings and calibration. However, NYSDEC should amend this provision to specify the required type and capabilities of radioactive waste detection units. Otherwise, it will be left up to landfill operators to determine which technology to use—in turn risking that radioactivity in waste goes undetected.

Fixed radiation detector units, or portal monitors, do not actually quantify specific radionuclide isotopes (such as Radium 226).[56] For drilling wastes, fixed radiation detectors are not an effective method to screen whether waste loads meet municipal landfill activity limitations for Radium 226 and/or Radium 228. This is because fixed radiation detectors are designed to detect energy, primarily gamma or neutron waves—not the activity levels (i.e., as measured in pCi/g) for those

[55] U.S. GEOLOGICAL SURVEY, RADIUM CONTENT OF OIL AND GAS FIELD PRODUCED WATERS IN THE NORTHERN APPALACHIAN BASIN (USA): SUMMARY AND DISCUSSION OF DATA (2011), *available at* http://pubs.usgs.gov/sir/2011/5135/.
[56] Marc Glass, Comments on Proposed Changes to New York State Solid Waste Regulations (Downstream Strategies 2016).

radioactive isotopes.[57]

Importantly, Radium 226 primarily emits alpha particles, which are extremely hazardous to the environment and human health but cannot be detected through a thin barrier (such as the metal or cloth side or top of a waste hauling truck). Radium is particularly dangerous for health and the environment because it bio-concentrates and bio-accumulates, and does not degrade significantly e.g., Ra-226 has a half-life of 1,600 years).[58] Given this, the increasing disposal of radioactive material into landfills poses a strong risk of cumulative effects on surrounding soil and water, and in turn people and wildlife.

The complexities of radioactivity detection in E&P wastes further underscore the importance (discussed above) of conducting laboratory analysis of chemical and radiological characteristics. It also points to the critical need for NYSDEC to take a precautionary approach and prohibit this waste stream from entering landfills and landfill leachate from being sent to POTWs.

For the purposes of the proposed regulations, NYSDEC should at minimum amend Part 363-8.1(a)(4)(ii) by lowering the investigation alarm setpoint to no higher than 5piC/g. This is USEPA's concentration criterion for surface soil under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, commonly known as the Superfund Act).[59] This standard is based on gamma radiation detection, which is relevant to NYSDEC's very limited proposal for radioactivity detection methods. It is also notable that industrial solid waste landfills nationwide generally follow an even lower limit of 3 piC/g of radium for waste disposal.[60]

Part 363-8.1(a)(4)(vi). We support NYSDEC's requirement that "[e]ach instance in which the radiation detector is triggered by a waste load must be documented," including such details as the origin and hauler of the waste. However, as written, there is nothing in the regulation that would prevent a landfill from transferring the waste that triggered an alarm to another location, potentially without its radioactive content being addressed prior to disposal. Nor does this section require further evaluation of the content of a "hot" waste load and potential risks to landfill

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[57] *Id.*
[58] Marc Glass, Comments on Proposed Changes to New York State Solid Waste Regulations (Downstream Strategies 2016).
[59] USEPA, Memorandum: Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA sites (1998).
[60] USEPA, Radionuclides in Drinking Water; Waste Disposal Options, https://cfpub.epa.gov/safewater/radionuclides/radionuclides.cfm?action=Rad_Disposal%20Options (last visited Aug. 21, 2016).

personnel and the environment.

NYSDEC should amend Part 363-8.1(a)(4)(vi) with specific procedures that landfills must follow once a radiation detector is triggered. Landfills should, at minimum, be required to report the detection event to NYSDEC, contact the generator of the waste, and take precautionary measures to segregate the radioactive waste from contact with personnel, other wastes, and soil and water. Landfills should also be required to document measures taken to ensure the proper management, transport, and disposal of the waste (e.g., at a specialized low-level radioactive waste facility).

In West Virginia, for example, any landfill detecting radiation readings above established limits must immediately cease accepting the affected E&P wastes; in addition, the state Department of Environmental Protection must conduct an inspection to determine when radiation levels have returned to below limits.[61] In addition to incorporating these procedures, NYSDEC should establish a requirement that if radioactivity detectors are triggered at landfills, the "hot" load must be sampled and analyzed for Radium 226 and 228.

Part 363-8.1 (o)—Disposal Prohibitions. We support the prohibitions in Part 363-8.1 (o)(7) on the disposal of low-level radioactive waste and processed and concentrated Naturally Occurring Radioactive Material (NORM) waste, as well as in Part 363-8.1 (o)(8) on waste with a concentration of Radium 226 greater than 25 pCi/g (though, as discussed above, we believe this level should be set much lower).

Regarding Technologically Enhanced Radioactive Material (TENORM), we believe that oil and gas-related drill cuttings meet the definition of TENORM and that DEC should clarify that they will be regulated as such. Metals and radionuclides do not degrade significantly in the environment over time, but as part of E&P wastes their environmental mobility may be enhanced over natural conditions.[62] According to the USEPA, Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) includes "materials that have been concentrated or exposed to the accessible environment as a result of human activities;" in contrast, NORM is defined as materials that are left completely "undisturbed."[63]

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[61] H.B. 107 amending Article 15 of W. Va. Code §§ 22-15-8, 22-15-11 (2014).
[62] M. Glass and K. Hatcher, Comments on Proposed Changes to the West Virginia Solid Waste Management Rule, 33CSR1 (Downstream Strategies 2014).
[63] USEPA, TECHNICAL REPORT ON TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS FROM URANIUM MINING, VOLUME 2 (2008).

For the purposes of the current proposed regulations, however, we strongly recommend that DEC amends the list of disposal prohibitions to include drill cuttings, by revising Part 363-8.1(o)(7) to read "low-level radioactive waste, processed and concentrated NORM waste, including drill cuttings from the exploration and production of oil and natural gas…."

NYSDEC frequently insists that drill cuttings are simply "rock and soil residue" and "do not contain liquids with high concentrations of radioactivity."[64] The agency's longstanding position that drill cuttings do not pose a threat to health or the environment does not have a credible scientific basis. Instead, NYSDEC appears to rely on a single 2010 study by a private consulting company (CoPhysics), as well as the views of a waste management company with a financial interest in landfills accepting drill cuttings.[65]

The CoPhysics report included data on only four samples of Marcellus Shale cuttings from unidentified well sites in Pennsylvania, one of which contained the drilling mud additive barite, which can block gamma radiation.[66] The methodology of the CoPhysics study has been questioned by other scientists in the field, and it is unclear whether the samples of cuttings were taken from high-volume hydraulic fracturing sites.[67]

As discussed above, E&P wastes aren't properly characterized prior to disposal at New York landfills, and liquid wastes are clearly entering landfills. Recent analyses of drill cuttings confirm that this E&P waste contains radioactive material, as well as metals, salts, and chemicals.[68] In 2015, Casella Resource Solutions stated that the company's facilities accept drill cuttings that are "mixed with small amounts of drilling fluids."[69]

In addition, NYSDEC's current approach to the regulation of drill cuttings is inherently illogical. New

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[64] NYSDEC, CHEMUNG COUNTY LANDFILL EXPANSION RESPONSIVENESS SURVEY SUMMARY, at response R2 and RMR2, (2016).
[65] NYSDEC, In re Application for Modification of the Part 360 Permit for a Municipal Solid Waste Landfill on County Route 60 in Lowman, Town of Chemung, New York (August 4, 2011) (Commissioner Decision), *available at* http://www.dec.ny.gov/hearings/76112.html.
[66] COPHYSICS, RADIOLOGICAL SURVEY REPORT, MARCELLUS SHALE DRILL CUTTINGS (2010); Society of Petroleum Engineers, PetroWiki: Gamma Ray Logs, http://petrowiki.org/Gamma_ray_logs (last visited Aug. 17, 2016).
[67] NYSDEC, In re Application for Modification of the Part 360 Permit for a Municipal Solid Waste Landfill on County Route 60 in Lowman, Town of Chemung, New York (August 4, 2011) (Commissioner Decision), *available at* http://www.dec.ny.gov/hearings/76112.html.
[68] MARSHALL UNIV. CTR FOR ENVTL., GEOTECHNICAL AND APPLIED SCIENCES, *EXAMINATION OF LEACHATE, DRILL CUTTINGS AND RELATED ENVIRONMENTAL, ECONOMIC AND TECHNICAL ASPECTS ASSOCIATED WITH SOLID WASTE FACILITIES IN WEST VIRGINIA;* STUDY AND REPORT FOR WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION (2015).
[69] Larry Shilling, Vice President of LF Marketing, Casella Resource Solutions, Presentation to the New York State Bar Association on disposal of Oil and Gas Waste, Oct. 3, 2015.

York's regulations at Part 380-1.2 exclude NORM or materials containing NORM from requirements for specialized disposal and discharge of radioactive material, unless the NORM is "processed and concentrated."[70] According to Part 360.2 in the currently proposed regulations, NYSDEC defines "processing" as "the use of a combination of structures, machinery or devices to alter the volume or the chemical or physical characteristics of solid waste."

Once the activity of drilling a well bore begins, the shale is brought to the surface and broken into many smaller pieces—representing an alteration of physical characteristics using machinery and devices. While cuttings initially appear as "rock," they may be mixed with other wastes during storage and transportation, a further physical alteration. The cuttings' original chemical characteristics are also altered through the use of drilling fluids and coating with produced water during drilling. At landfills, loads of drill cuttings may be dewatered in order to meet the "20 percent" solid content limit for disposal—a clear alteration of volume and physical characteristics.

Given the changes that drill cuttings undergo prior to disposal, NYSDEC should state clearly that this E&P waste meets the definition of "processed or concentrated" NORM and therefore cannot be disposed of at municipal landfills.[71]

USEPA currently leaves management of oil and gas waste that may be classified as TENORM up to the states. This gives New York the legal prerogative to define drill cuttings as TENORM and strictly regulate their management and disposal. However, NYSDEC's continued failure to do so appears to have no basis besides a preference to continue allowing the disposal of potentially radioactive and toxic waste at landfills.

For years, New York landfills have been accepting loads of drill cuttings generated in Pennsylvania from Marcellus Shale well sites. Unlike New York, Pennsylvania does not make an arbitrary distinction between NORM and TENORM with regard to drill cuttings or other types of waste, instead stating that, "[s]ince naturally occurring radioactive material is brought to the surface during drilling, the wastes are classified as TENORM."[72] A recent report on radioactivity in drilling wastes from Pennsylvania found that samples of horizontal drill cuttings had Ra-226 levels nearly

[70] 6 NYCRR § 380-1.2(e).
[71] Richard Clarkson, P.E. NYSDEC Div. of Materials Mgmt., Presentation on Current Solid Waste Disposal Regulatory Framework for Gas Development Wastes (2013).
[72] PADEP Bureau of Waste Management, Presentation on Origin of TENORM-Containing Drill Cuttings and Treatment Sludges Generated at Well Sites and Wastewater Treatment Facilities in the 2012 Calendar Year (May 2013).

twice as high as samples of vertical cuttings.[73] This scientific fact is borne out on the ground; for example, in 2013 drill cuttings generated in Pennsylvania were trucked all the way to a specialized facility in Idaho due to their excessive levels of radioactivity.[74]

5. Prohibit the road-spreading of brine

The new proposed section 360.12(f) sets forth regulatory requirements for case specific Beneficial Use Determinations (BUDs) governing the use of gas storage brine and oil and gas production brine on roads for de-icing, dust control, and road stabilization. While the proposed revisions are a step in the right direction—and in many cases would clarify and improve upon the existing guidance for road spreading of oil and gas brine—they fall short of ensuring that the significant risks of applying oil and gas brine on roadways will be avoided or minimized to the maximum extent practicable, as required by the State Environmental Quality Review Act (SEQRA).

Even with these new regulatory requirements, we remain deeply concerned about NYSDEC's ability to enforce control measures once it approves BUDs for the use of oil and gas brine. This lack of enforcement and oversight capability ultimately undermines the proposed regulatory revisions and leaves human health and the environment at significant risk from the use of oil and gas brine on New York State roads. For the reasons set forth below, we strongly urge NYSDEC to simply prohibit road spreading of oil and gas brine.

The process of extracting oil and natural gas produces large amounts of liquid and solid waste. Liquid waste includes flowback fluid, which is fluid that returns to the surface soon after a well is drilled and fractured, and production brine, which is wastewater that flows to the surface during gas production. As discussed above, waste generated through the extraction of oil or natural gas—including production brine—can contain a number of pollutants, such as chemicals, metals, excess salts, and carcinogens like benzene and radioactive materials.[75] Brine from gas storage facilities can have similar contaminants.[76]

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[73] PERMAFIX ENVIRONMENTAL SERVICES FOR PADEP, TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS (TENORM) STUDY REPORT (2015).
[74] Tara Kinsell, *Rejected Waste Taken to Idaho*, WASH. OBSERVER-REP. (July 12, 2013).
[75] Robert B. Jackson et al., *The Environmental Costs and Benefits of Fracking*, 39 ENVIRONMENT AND RESOURCES 327 (2014); U.S. GEOLOGICAL SURVEY, RADIUM CONTENT OF OIL AND GAS FIELD PRODUCED WATERS IN THE NORTHERN APPALACHIAN BASIN (USA): SUMMARY AND DISCUSSION OF DATA (2011), *available at* http://pubs.usgs.gov/sir/2011/5135/.
[76] In 2013 and 2014, Riverkeeper obtained records from NYSDEC regarding BUDs for use of oil and gas brine on roads. These records included associated test results that showed excessive levels of chloride (salts) in

NYSDEC currently allows the use of production brine from low-volume oil and gas production wells and brine from gas storage facilities to be used on roads. According to a list of BUDs compiled by the agency in January 2016, NYSDEC has currently authorized sixty-six BUDs for the use of oil or natural gas waste for road de-icing, dust control, and/or stabilization.[77] The process is governed by provisions applying in general to case-by-case BUD determinations under the current Part 360 regulations and a NYSDEC-issued memorandum that lays out additional requirements for oil and gas brine BUDs.[78]

These existing requirements raise a number of concerns, including the use of representative brine samples rather than samples of the final brine mixture to be spread on roads, the absence of publicly available numerical testing criteria, the lack of provisions for follow-up monitoring and enforcement, and the fact that approvals authorize multiple applications of oil or natural gas brine per roadway yet do not appear to have an expiration date.

While some of these concerns are addressed in the proposed revisions to Part 360, several remain outstanding or inadequately addressed. To the extent that NYSDEC does not prohibit the issuance of BUDs for E&P waste, we offer the following recommendations.

Part 360.12(f)(2)—Case specific brine beneficial use determination petition. The required content of a BUD petition for oil and gas brine under the proposed revisions would include "a description of the system used at the well location(s) to remove and minimize any oil or gas residue from becoming part of the brine." While identification of some oil or gas residue separator is a laudable goal, the requirement to merely include a description of the unspecified system used is vague and potentially confusing. Rather than this general requirement, NYSDEC should specify the system(s) that *must* be used and include provisions for follow-up monitoring and enforcement.

Under the regulations, BUD applicants would also be required to submit testing results as part of a BUD petition. However, NYSDEC is continuing to require only a representative sample of the brine, rather than a sample of the brine mixture that will be applied on roads. In practice, this has resulted

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brine from both natural gas production wells and gas storage facilities. Sample results for brine from gas storage facilities also revealed the presence of benzene and toluene. *See* Riverkeeper, The Concerns in New York, http://www.riverkeeper.org/campaigns/safeguard/fracking-waste-in-new-york/the-concerns-in-new-york (last visited July 6, 2016).

[77] NYSDEC, Granted Beneficial Use Determinations, Sorted by Waste Type (Jan. 2016), *available at* http://www.NYSDEC.ny.gov/docs/materials_minerals_pdf/budwst.pdf.

[78] 6 NYCRR § 360.15; NYSDEC, Notice to Oil and Gas Well and LPG Storage Fluid Haulers (Jan. 2009).

in BUD applicants submitting testing results from a single well field or gas storage sample covering dozens of other wells or facilities.[79]

This level of testing is inadequate to determine the pollutants in a given batch of brine that is spread on roads, as toxicity levels can vary from well to well within the same field and/or storage facility, and over time.[80] Moreover, one recent study has shown that "when produced [brine] fluids are sealed to the release of radon gas, the total radioactivity concentration of produced fluid can increase by a factor greater than five within the first 15 days following extraction due to the ingrowth of [radon] decay products."[81] Without testing the final solution, NYSDEC cannot determine the contaminant level or radioactivity of the brine being used on roads, nor the subsequent risk to public health and the environment. Therefore, NYSDEC should clearly indicate in the regulations that the representative sample will be collected from the final brine sample slated to be spread on roads.

Part 360.12(f)(3)—Conditions for brine use—all uses. We support NYSDEC's proposal to prohibit the use of gas storage brine and production brine derived from the Marcellus Shale. Brine from the Marcellus Shale can contain dangerous concentrations of pollutants including high salt content, organic and inorganic chemicals, metals, and naturally-occurring radioactive materials[82] and is wholly inappropriate for application on roads. We also support the proposed prohibition on the use of drilling fluids, flowback water, and plugging fluids, which—in addition to contaminants found in the underground formation—can contain high concentrations of added chemicals such as ethylene glycol and sulfuric acid.[83]

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[79] *See* Riverkeeper Freedom of Information Law documents received from NYSDEC in 2013 and 2014, *available at* http://www.riverkeeper.org/campaigns/safeguard/fracking-waste-in-new-york/the-concerns-in-new-york.

[80] Peter Mantius, *New York Imports Pennsylvania's Radioactive Fracking Waste Despite Falsified Water Tests* NATURAL RES. NEWS SERV. (Aug. 14, 2013), *available at* https://dcbureau.org/201308148881/natural-resources-news-service/new-york-imports-pennsylvanias-radioactive-fracking-waste-despite-falsified-water-tests.html#more-8881.

[81] Andrew W. Nelson et al., *Understanding the Radioactive Ingrowth and NYSDECay of Naturally Occurring Radioactive Materials in the Environment: An Analysis of Produced Fluids from the Marcellus Shale*, 123 Envtl. Health Perspectives 689, 690 (2016).

[82] U.S. Environmental Protection Agency, Unconventional Oil and Gas Extraction Effluent Guidelines Documents (Mar. 2015), *available at* https://www.epa.gov/eg/unconventional-oil-and-gas-extraction-effluent-guidelines-documents; U.S. GEOLOGICAL SURVEY, RADIUM CONTENT OF OIL AND GAS FIELD PRODUCED WATERS IN THE NORTHERN APPALACHIAN BASIN (USA): SUMMARY AND DISCUSSION OF DATA (2011), *available at* http://pubs.usgs.gov/sir/2011/5135/.

[83] Robert B. Jackson et al., *The Environmental Costs and Benefits of Fracking*, 39 ENVIRONMENT AND RESOURCES 327 (2014); NATURAL RESOURCES DEFENSE COUNCIL, IN FRACKING'S WAKE: NEW RULES ARE NEEDED TO PROTECT OUR

However, NYSDEC has provided no justification for prohibiting the use of certain types of oil and gas wastewater on roads while allowing others that carry similar risks of harm to public health and the environment. Further, and critically, NYSDEC does not have any oversight or enforcement mechanisms in place to actually ensure that brine being used is not generated through Marcellus Shale drilling.

Brine from conventional wells and the Utica formation (i.e., non-Marcellus formations) can also contain many of the same contaminants, including ammonium and iodide.[84] Documents obtained by Riverkeeper though Freedom of Information Law requests in 2013 and 2014 contained testing results for approved oil and gas brine BUDs that revealed high levels of chloride, as well as the presence of benzene and toluene in brine from non-Marcellus formations.[85] In addition, non-Marcellus formations in New York State are also known to contain NORM that can be present in production brine.[86]

Further, the distinction between production brine, drilling fluids, and flowback water is not always clearcut. While a substantial amount of chemical additive laced drilling fluid does return to the surface as flowback fluid, a sizeable quantity also often remains underground and can be mixed with production brine. In which case, the production brine may contain both contaminants from the formation and chemical additives.[87]

The proposed revisions also include several restrictions governing the use of oil and gas brine post-BUD approval. Unfortunately, a number of these restrictions are either inadequate or too vague to offer real protection to the public and environment. For example, the new regulations would include requirements that "methods must be employed at the well site to minimize the amount of

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HEALTH AND ENVIRONMENT FROM CONTAMINATED WASTEWATER (2012), *available at* https://www.nrdc.org/sites/default/files/Fracking-Wastewater-FullReport.pdf.

[84] Aurana Lewis, WASTEWATER GENERATION AND DISPOSAL FROM NATURAL GAS WELLS IN PENNSYLVANIA 18 (2012), *available at* http://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/5320/Lewis_MP2.pdf rent if both wells types [Marcellus and conventional] are hydraulic fractured.)"; *Water Contamination Just as High from Conventional as from Shale Wells – Scientists Find*, Shale Gas Int'l (Jan. 15, 2015), *available at* http://www.shalegas.international/2015/01/15/water-contamination-just-as-high-from-conventional-as-from-shale-wells-scientists-find/; Zoe Schlanger, *Industry's Solution to Toxic Wastewater: Spray It on Roads*, NEWSWEEK (Mar. 2, 2015), *available at* http://www.newsweek.com/oil-and-gas-wastewater-used-de-ice-roads-new-york-and-pennsylvania-little-310684.

[85] *See* Riverkeeper, The Concerns in New York, http://www.riverkeeper.org/campaigns/safeguard/fracking-waste-in-new-york/the-concerns-in-new-york (last visited July 6, 2016).

[86] U.S. GEOLOGICAL SURVEY, RADIUM CONTENT OF OIL AND GAS FIELD PRODUCED WATERS IN THE NORTHERN APPALACHIAN BASIN (USA): SUMMARY AND DISCUSSION OF DATA (2011), *available at* http://pubs.usgs.gov/sir/2011/5135/.

[87] Robert B. Jackson et al., *The Environmental Costs and Benefits of Fracking*, 39 ENVIRONMENT AND RESOURCES 327 (2014).

hydrocarbons present in the brine" and "brine application measurement methods must be used to ensure that brine application rates are within limits." Both requirements are vague to the point of confusion, and provide no assurance that "methods" will be successful. NYSDEC needs to specify which methods may be employed and provide measures for oversight and enforcement in order for these provisions to have any practical effect.

The requirement that brine cannot be applied within 50 feet of a stream, creek, lake, or other body of water is also inadequate to protect water quality. The restriction fails to include wetlands, which are crucial components of watersheds and water quality protection and are just as sensitive as the listed waterbodies to contamination from oil and gas brine. It also neglects to prohibit spreading on wet roads or when rain is imminent. The widely recognized minimum buffer for wetlands and waterbodies is 100 feet,[88] and NYSDEC provides no justification for using a shorter buffer for the application of oil and gas brine. By contrast, Pennsylvania prohibits brine spreading within 150 feet of a stream, creek, lake, or other waterbody.[89]

While requiring follow-up testing is a step in the right direction, three years is an inappropriately long timeframe. As discussed above, the fact that NYSDEC would continue to allow only representative sampling undermines the testing requirements, as contaminant levels can vary from well to well over time. Since pollutant levels may vary over time and by well, requiring testing only every three years falls short of providing the up-to-date information that NYSDEC needs to adequately determine the type and levels of contaminants allowed to be applied to roads. In addition to requiring testing of each batch of brine rather than representative samples, a more appropriate timeframe for follow-up testing would be one year, since private entities and municipalities are likely to be restocking brine for use in the next winter season.

Finally, we support the five-year limit for E&P waste and other BUD approvals, as new information on public health and environmental dangers could require that the agency modify or prohibit the activity. The five-year limit will require that NYSDEC reassess its decisions periodically. We also

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[88] *See* T. Schueler, SITE PLANNING FOR URBAN STREAM PROTECTION, METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS 111 (1995); USEPA, Draft National Management Measures to Control Nonpoint Source Pollution from Urban Areas 3-17 (2002), *available at* https://www.epa.gov/sites/production/files/2015-09/documents/urban_guidance_0.pdf; ENVIRONMENTAL LAW INST., CONSERVATION THRESHOLDS FOR LAND USE PLANNERS 20 (2003), *available at* https://www.eli.org/sites/default/files/eli-pubs/d13-04.pdf; and R. Fischer, and J. Fischenich, Design Recommendations for Riparian Corridors & Vegetated Buffer Strips, U.S. Army Engineer Research and Development Center 4 (2000).

[89] PADEP, Fact Sheet: Roadspreading of Brine for Dust control and Road Stabilization (2015), *available at* http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-106718/8000-FS-DEP1801.pdf.

support the requirement that all BUD grantees submit an annual report to NYSDEC detailing their use of oil and gas brine for road spreading. Moreover, the reports should be made available to the public on NYSDEC's website. Yearly reports would help the public identify and/or prevent contamination buildup and create a record of waste spreading, in turn allowing an assessment of the practice's potential to affect the environment and public health.

Part 360.12(f)(3)—Numerical criteria for the use of oil/gas brine on roadways. Although we would prefer to see a prohibition on BUDs for E&P wastes, the addition of numerical criteria for the use of oil and gas brine on roads is a step in the right direction. This section will provide the public long-overdue insight into NYSDEC's decision-making criteria for approving oil and gas brine BUDs.

NYSDEC regulations should reflect the basic fact that inorganic components of brine do not degrade much and can therefore accumulate and concentrate in environments for a long time. In turn, this increases the chance that they will ultimately migrate into drinking water.

In light of this fact, **we question NYSDEC's allowance of concentrations of contaminants in road brine at levels several orders of magnitude greater than would be permissible for a public drinking water source**. Although brine is obviously not the same as drinking water, the comparison of chemical components to this higher health standard is warranted, for example as Ohio has done in its brine-spreading guidance due to potential impacts on soil and water.[90]

NYSDEC's proposed brine standards would allow concentrations of lead at over 160 times and benzene at 100 times the USEPA's safe drinking water standards. A 2011 study by the US Geological Survey indicated that there is a positive correlation between high levels of salinity (represented by TDS) and the presence of Ra-226 in both conventional and unconventional brines.[91] It is therefore very concerning that NYSDEC would allow concentrations of Total Dissolved Solids (TDS) for a BUD above 17,000 mg/L, which could be expected to include total radium activity frequently exceeding 1,000 pCi/L.[92]

In addition, this section and associated parameter tables should be amended to require analysis of

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[90] OHIO. DEP'T OF NAT. RESOURCES, DIV. OF MINERAL RESOURCES MGMT, SPREADING OIL-FILED BRINE FOR DUST AND ICE CONTROL IN OHIO, A GUIDANCE FOR LOCAL AUTHORITIES (2004), *available at* http://worldcat.org/arcviewer/6/OHI/2012/04/20/H1334937108106/viewer/file2.pdf.

[91] U.S. GEOLOGICAL SURVEY, RADIUM CONTENT OF OIL AND GAS FIELD PRODUCED WATERS IN THE NORTHERN APPALACHIAN BASIN (USA): SUMMARY AND DISCUSSION OF DATA (2011), *available at* http://pubs.usgs.gov/sir/2011/5135/.

[92] Marc Glass, Comments on Proposed Changes to New York State Solid Waste Regulations (Downstream Strategies 2016).

radiological parameters. A 2015 study on TENORM in E&P wastes conducted for the PADEP indicated that oil and gas brines from both conventional and unconventional wells contain radioactive substances that may be transferred to road during application. The authors concluded that, "[w]hile limited potential was found for radiation exposure to recreationists using roads treated with brine from conventional natural gas wells, further study of radiological environmental impacts from the use of brine from the O&G industry for dust suppression and road stabilization should be conducted."[93]

NYSDEC should amend this provision to require users of oil and gas brine to analyze the waste using EPA Method 900.1 for gross alpha activity and EPA Method 901.1M by gamma spectrometry for Radium 226. These methods are necessary to avoid potential interferences and underreporting of concentrations in samples with elevated total dissolved solids—a common occurrence in brines.[94]

6. Develop a comprehensive environmental review of alternatives for BUD requirements, including a prohibition on the road-spreading of brine

NYSDEC has prepared and made available for public review a Draft Generic Environmental Impact Statement (DGEIS) that covers the proposed revisions set forth in the Part 360 regulatory package. Unfortunately, the DGEIS is little more than a summary list of the regulatory changes, with scant information and almost no substantive evaluation of the impacts that each proposed revision is likely to have on the environment.

The section on revisions to the BUD requirements for oil and gas brine is no different, with approximately half a page dedicated to an issue that is likely to have significant impacts on human health and the environment. Both the discussion and environmental impact sections consist of one sentence each, and the evaluation of alternatives is merely a paragraph that only briefly raises and then dismisses the No Action alternative.[95]

This scant analysis utterly fails to comply with SEQRA, pursuant to which NYSDEC is required to take a "hard look" at the "relevant areas of environmental concern." *Jackson v. New York State Urban*

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[93] PERMAFIX ENVIRONMENTAL SERVICES FOR PADEP, TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS (TENORM) STUDY REPORT (2015).
[94] Marc Glass, Comments on Proposed Changes to New York State Solid Waste Regulations (Downstream Strategies 2016.
[95] NYSDEC, DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT (GEIS) ON THE PROPOSED AMENDMENTS TO 6 NYCRR PART 360, ET AL. 15 (2016).

Dev. Corp., 494 N.E.2d 429, 436 (N.Y. 1986). An Environmental Impact Statement (EIS) must include information sufficient to understand a proposed action's likely environmental impacts and alternatives that might be undertaken to reduce or avoid those impacts. N.Y. E.C.L. § 8-0109(2); 6 NYCRR § 617.9(b). It must include a "description and evaluation of the range of reasonable alternatives" to the proposed action, which "should be at a level of detail sufficient to permit a comparative assessment of the alternatives discussed." N.Y. E.C.L. §§ 8-0109(2)(d),(4); 6 NYCRR § 617.9(b)(5)(v).

The purpose of the alternatives analysis is to afford the lead agency and the public the opportunity to compare different potential actions and identify the one that best avoids or minimizes adverse environmental impacts.[96] While a Generic EIS may be broader or more general than a site specific EIS, it must still contain the same basic elements as an EIS and conform to the same requirements. 6 NYCRR § 617.10.[97]

As such, NYSDEC has a responsibility under SEQRA to take a hard look at the proposed revisions and reasonable alternatives, and choose the alternative that best minimizes environmental impacts. N.Y. E.C.L. § 8-0109(1); 6 NYCRR § 617.11(d). *See also Jackson v. New York State Urban Dev. Corp*., 494 N.E.2d 429, 436 (N.Y. 1986) ("An agency may not approve an action unless it makes 'an explicit finding that … consistent with social, economic and other essential considerations, to the maximum extent practicable, adverse environmental effects revealed in the environmental impact statement process will be minimized or avoided.'") (internal citations omitted).

To that end, NYSDEC must provide the public with a comprehensive evaluation of the likely significant adverse environmental impacts of the use of oil and gas brine for road spreading, and the effect that the proposed revisions to the BUD program will likely have on those impacts. As part of the required SEQRA analysis, NYSDEC must also evaluate a range of reasonable alternatives—including any viable alternatives in addition to the No Action alternative. The Part 360 DGEIS must be amended to include an analysis of an alternative that would prohibit the use of oil and gas brine on roads, and provide sufficiently detailed information about the likely environmental impacts so that the agency and the public are able to take the required hard look and make an informed decision regarding the alternative that best minimizes environmental impacts.

[96] NYSDEC, THE SEQR HANDBOOK: 3RD EDITION AT 101 (2010).
[97] *See also id*. at 146-147.

7. Other sections of the Part 360 revisions

Part 364-1.2(e)(6)—Oil and gas drilling and production waste tracking. This section would require tracking for several new categories of waste, including drilling and production waste. We fully support these new provisions, which are necessary to ensure that E&P wastes (including from high-volume hydraulic fracturing operations in other states) are not illegally dumped—a common problem in and other states. In a recent example, tests of water flowing from the abandoned Clyde Mine in Washington County, Pennsylvania—which discharges to the Ten Mile River and the Monongahela River, a major drinking water source—show high levels of radioactivity suspected to be caused by illegal dumping of hydraulic fracturing wastewater.[98]

In particular, we support the clarification in Part 364-2(b)(5) that small shipments (under 2,000 pounds) of drilling and production wastes would *not* be exempt from tracking provisions. This is critical given the use of single trucks to transport such wastes from well sites.

Given the toxic and potentially hazardous and radioactive nature of drilling and production wastes, NYSDEC should include them in the waste tracking documentation requirements of Part 364-3.3(d), and in turn develop a standardized form for all transporters of E&P wastes disposed of in New York State.

Part 364-3.4(a) should be amended to ensure public access to waste tracking records, to read: "These records must be provided to the department within five business days and will be made available to the public upon request to the department."

Part 363-8.1 (p)—Industrial waste or drilling and production wastes. We strongly support the requirement that any landfill accepting E&P wastes must include them in the facility's waste control plan. However, NYSDEC should amend this provision to describe in detail the "special handling or disposal procedures" implied in general terms by this provision. As discussed above, this should include, at minimum, thorough chemical and radiological waste characterization, the development of designated cells for E&P wastes, and testing for Radium 226 and 228 using appropriate technologies.

Part 363-9.2(a)—Reporting. In light of the limited tracking and reporting mechanisms in place

[98] Dan Hopey, *Tests Find Radiation in Clyde Mine Water in Washington County*, PITTSBURGH POST-GAZETTE (July 28, 2015), *available at* http://www.post-gazette.com/news/environment/2015/07/28/Tests-find-radiation-in-Clyde-Mine-water/stories/201507280086.

with regard to E&P wastes, NYSDEC should amend this section to require landfill operators to submit reports twice a year, rather than annually. NYSDEC should also specify in this section that the data provided will be posted online and made easily accessible to the public. NYSDEC should also make all drilling and production waste tracking forms available to the public in an online database.

Part 360.12(b)—Uses of solid waste that are unacceptable beneficial uses. In light of the discussion above regarding the potential hazardous characteristics of E&P wastes, NYSDEC should specifically include such wastes in Part 360.12(b) as an unacceptable use of solid waste as a beneficial use. This could be achieved by adding the following language: "Any wastes generated through the exploration, drilling, and production of oil and natural gas that are classified and managed as solid waste, including but not limited to drill cuttings, muds, sludges, and fluids."

8. Conclusions

The preceding pages detail many of the inherent challenges posed by waste generated through the exploration and production of oil and gas, based on current science and our organizations' policy and regulatory expertise. We have also provided extensive information on the status of E&P waste management in New York State.

In conclusion, we believe that it is imperative for NYSDEC to swiftly adopt the changes to the Part 360 series and other regulatory amendments recommended in this comment letter. Such measures are necessary given the numerous and significant gaps in how E&P wastes are managed in New York.

Strengthening the Part 360 series is a critical first step toward ensuring protection of the environment against the risks posed by an ever-growing volume of waste from oil and gas operations both within and outside of New York State. However, we hope that NYSDEC will use the current regulatory revision process as a starting point to contemplate comprehensive change in E&P waste management policies and regulations.

Unless and until NYSDEC can ensure that water, soil, land, and natural and human communities will be protected against the risks posed by toxic and potentially hazardous and radioactive E&P wastes, we believe that the department has an obligation to prohibit the disposal of oil and gas waste in landfill, disposal of landfill leachate at POTWs, and the application of liquid waste on roads.

Going forward, NYSDEC should use its regulatory authority to remove any exemptions that prevent oil and gas waste from being subjected to classification as hazardous.

This past spring, seven environmental organizations filed suit against the USEPA to fulfill its legal obligation to revise federal regulations and guidelines for the disposal, storage, transportation, and handling of oil and gas wastes.[99] Despite agency requirements under Subtitle D of RCRA, which applies to solid waste regulation at landfills, USEPA has neglected to review and update rules pertaining to the management of E&P wastes. Specifically, the plaintiffs assert that, "In their current forms, the Subtitle regulations and state plan guidelines are outdated, contain generic provisions that do not specifically address the modern oil and gas industry, and fail to adequately protect against potential harm to human health and the environment resulting from oil and gas wastes."[100]

Depending on the outcome of this lawsuit and any related actions taken by USEPA, state regulatory agencies may eventually be compelled to take action. It would be advantageous for NYSDEC to look ahead and work to resolve New York's own outdated, limited, and inadequately protective regulations pertaining to the management of E&P wastes.

In closing, we fully recognize that NYSDEC's resources and staff are limited and that the expansion of the oil and gas industry in surrounding states poses a new challenge for the Department. However, a lack of capacity should never be an excuse for allowing environmentally risky practices to occur without strong oversight and regulatory enforcement. The generators of contaminated and potentially hazardous and radioactive waste—as well as the waste facilities that accept it—must be held accountable for proper disposal and any resulting environmental harm. This is a task that NYSDEC is clearly mandated to do.

[99] Petitioner Complaint, Environmental Integrity Project et al. v. McCarthy (No. 1:16-cv-842) (D.C. Cir. May 4, 2016), a*vailable at* http://environmentalintegrity.org/wp-content/uploads/2016-05-04-RCRA-OG-Wastes-Deadline-Suit-Complaint-FILED.pdf.
[100] *Id.*

Thank you for your time and attention. We look forward to continuing to work with NYSDEC to achieve strong, binding requirements for the management of oil and gas wastes—and in so doing, to better protect the environment and health for the benefit of all New Yorkers.

Sincerely,

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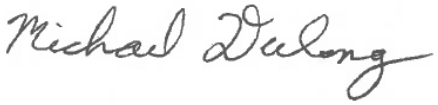

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Comments on Proposed Changes to New York State Solid Waste Regulations

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ABBREVIATIONS

ALARA	As low as reasonably achievable
HVHF	High volume hydraulic fracturing
MCL	Maximum contaminant level
MSW	Municipal solid waste
NORM	Naturally Occurring Radioactive Material
NPDES	National Pollutant Discharge Elimination System
NYCCR	New York Code of Rules and Regulations
ORSANCO	Ohio River Valley Sanitation Commission
PADEP	Pennsylvania Department of Environmental Protection
POTW	Publicly owned treatment works
RCRA	Resource Conservation and Recovery Act
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
USGS	United States Geological Survey
WCSL	Wetzel County Sanitary Landfill
WVDEP	West Virginia Department of Environmental Protection
WVDHHR	West Virginia Department of Health and Human Resources

1. INTRODUCTION

This report has been prepared at the request of the Earthworks™ to assist in its preparation of public comments regarding comprehensive revisions to Title 6 of the New York Code of Rules and Regulations (NYCRR) Part 360, Solid Waste Management Facilities Regulations. The proposed revisions involve a significant reorganization of the existing rule structure, including re-formatting of existing Part 360 into Parts 360-369. As such, references to proposed changes in this report will indicate "Proposed Part" prior to section numerical identifiers.

The comments provided herein pertain to specific sections of proposed Parts 360, 362, and 363 and are narrowed to address certain management approaches for oil and gas exploration and production waste, drill cuttings, associated drilling wastes, Naturally Occurring Radiological Material (NORM), and Technologically Enhance Naturally Occurring Radiological Material (TENORM) at landfill facilities and transfer stations. Since definitions of waste streams that may contain any combination of these components vary between states, the terms may, at times, be used interchangeably, or collectively referenced as drilling waste.

The current NYCCR Part 360 Regulations will remain in effect until such time as the rulemaking process is complete.

2. REGULATORY SETTING

States active with oil and gas development from shale and other tight geologic formations are actively evolving strategies to manage an increasing volume of drilling wastes. The 2015 updates to the West Virginia Solid Waste Management Rule[1], largely aimed at facilitating disposal of drilling wastes at municipal solid waste landfills (MSWs), allow MSWs to accept drilling wastes from a variety of sources, including a number of shale formations currently being exploited for oil and gas development in West Virginia and other states. This is significant, because West Virginia and several surrounding states are in the early stages of development of not only the Marcellus Shale, but also other formations such as the Utica Shale. As of June 2016, 3,100 Marcellus wells have been permitted in West Virginia alone[2]. The number of horizontal wells anticipated for development the Marcellus shale has been estimated by various sources ranging from 26,000[3] to 30,000[4] wells. For perspective, earlier this year, Corky Demarco, former executive director of the West Virginia Oil and Natural Gas Association, was quoted as saying, "[t]he thing is, we've probably only permitted about 5 percent of the potential Marcellus wells in West Virginia"[5].

Based on common lateral well lengths reported for horizontal Marcellus wells under current industry practices, this conservatively equates to approximately 1,000 tons of drilling waste generated per well. Since 2011, the states of West Virginia and Pennsylvania have disposed well over 1,000,000 tons of drilling waste at municipal solid waste landfills (MSWs) and at some facilities, the monthly tonnage of oil and gas drill wastes has exceeded all other waste streams combined. The volumes of waste generated by the expanding oil and gas industry, even during the current economic climate, are unprecedented and management strategies continue to evolve. Despite New York's decision not to allow oil and gas development using unconventional methods, the state has still allowed disposal of hundreds of thousands of tons of solid oil and gas wastes generated from nearby states[6].

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[1] 33 CSR 1, West Virginia Code of State Rules, Title 33, Series 1, Department of Environmental Protection, Waste Management, Solid Waste Management Rule, effective June 1, 2015.
[2] WV Geological & Economic Survey: WV Marcellus Shale Wells, report run on Wednesday, June 29, 2016.
[3] Hohn, Michael and Jessica Moore, 2015. "Methodology For Estimation Of Total Build-Out Scenario For The Marcellus Shale Active Fairway," WVGES
[4] NETL, 2010. "Projecting the Economic Impact of Marcellus Shale Gas Development in West Virginia: A Preliminary Analysis Using Publicly Available Data."
[5] Wheeling Intelligencer/Wheeling News-Register "W. Va. Production Numbers Shocking", Casey Junkins, January 17, 2016
[6] PA Unconventional Drilling Waste Disposal in NYS, 2011-2015. F.T. Karen https://www.arcgis.com/home/item.html?id=8bd41c4a84e446269b8e4b136aa5b633, updated June 15, 2016. Accessed August 1, 2016.

During a June 14, 2016 West Virginia Environmental Regulatory Workshop, West Virginia Department of Environmental Protection (WVDEP) Deputy Cabinet Secretary and Director of the Division of Water and Waste Management Scott Mandirola offered that "landfills are where drilling wastes belong so that if problems present, they are centralized and can be addressed". Mr. Mandirola also indicated that regulators from key states in the active Marcellus shale region of Ohio, Pennsylvania, and West Virginia have met annually for the past several years to exchange ideas and continue with efforts to improve management approaches for drilling waste, noting that consistency of regulatory approaches across states helps discourage the "shopping" of waste from state to state. This insight suggests that there may be benefits to a more consistent regulatory approach applied from the federal level.

While it is generally agreed that consolidation of drilling wastes into existing landfills, where there is a management structure in place, is favorable to the alternative of burial at the drilling site, there still has been no comprehensive analysis of the environmental fate and transport or potential risks associated with municipal landfill disposal of drilling waste and leachate handling, which often includes low-level radioactive materials.

It is fair to say that state and federal regulators are still very much in the experimental phase with management of drilling wastes and as such, a precautionary approach and use of best professional judgement is warranted. This is also a critical time for both state and federal regulators to use their existing authority to require monitoring and tracking of drilling waste streams, both solid and liquid, through their entire life cycle so that the effectiveness of current or new management strategies can be clearly evaluated.

3. CONTAMINANTS CONTAINED IN OIL AND GAS WASTE

Drilling wastes generated from unconventional oil and gas development (UOG) in shale and other tight plays will, at a minimum, consist of drill cuttings from the overburden geology from the vertical portion of the wellbore, organic-rich layers from the shale formation, and components of the muds and chemicals used to lubricate the drilling tools and assist with the return of drill cuttings to the surface.

The broken bits of the geological formations in the drill cuttings include naturally occurring salts, metals, reduced minerals, and organic-rich geology. The exact nature and concentration of constituents will depend on local geological conditions and may vary considerably over distance, and potentially even within the same well bore. The reduced minerals from the cuttings may oxidize when exposed to air and water near the surface to produce acidic, metals-rich leachate[7]. Once oxidized by interactions above the ground surface, both metals and radionuclides may become much more water soluble, especially under acidic conditions. Radium 226, a product of the Uranium 238 decay series, is soluble in water and chemically behaves similarly to calcium, strontium, and barium[7]. As such, it can be found in the formation water that returns to the surface during the drilling process, drill cuttings, drilling mud, scale and sludge build-ups, fluids from spills, treatment residuals, and other waste products at concentrations exceeding the background environmental levels.

Drilling waste is a chemically complex mixture of fluid and solid organics, salts, minerals, metals, and radionuclides. Metals (inorganics) and radionuclides do not degrade significantly in the environment or with time. As components of drilling waste mixtures, their environmental mobility may be enhanced over natural conditions.

With regard to the shale itself, which will be a substantial portion of the drill cuttings generated for any horizontal boring, Middle Devonian Marcellus Shale is recognized from other geologic formations in gamma

[7] William M. Kappel, John H. Williams, Soltan Szabo, U.S. Department of the Interior, U.S. Geological Survey. *Water Resources and Shale Gas/Oil Production in the Appalachian Basin—Critical Issues and Evolving Developments.* 2013. Open-File Report 2013–1137.

ray wireline logs by its high radioactivity[8]. This radioactivity is a result of the NORMs uranium and thorium and their decay products, including Radium 226 and Radium 228[9]. These radioactive elements are brought to the surface with the return of drilling mud, and are then generally considered to be TENORM[10]. However, absent a consistent federal program for management of these wastes, it is currently being managed on a state-by-state basis[10] with different implications for management of drilling waste. For example, several states have developed fairly comprehensive approaches to management of wastes classified as TENORM, but then provide a sweeping exemption for drill cuttings from the TENORM definition altogether. Both New York and Ohio,[11] for example, have specifically excluded drill cuttings from their definition of TENORM in waste management regulations. The result is that large quantities of drill cuttings that would otherwise be classified as TENORM are disposed in municipal landfills, while foregoing detailed analysis and screening requirements states impose for other radium bearing wastes.

Drill cuttings and produced water are currently exempt from the Resource Conservation and Recovery Act (RCRA) Subtitle C hazardous waste regulations, although they are still subject to regulation under Subtitle D, which applies to solid waste regulation at landfills.[10]

Several studies have analyzed samples of drilling wastes in the field and provide a sufficient body of evidence to suggest some of the environmental implications for municipal solid waste landfills (MSWs). In 2013, the West Virginia Water Research Institute conducted a WVDEP-sanctioned water and waste stream study. Both liquid and solid samples of drill cuttings and muds were collected and analyzed from the ***vertical*** portion of the well bore.[12] The authors noted the following results:

> "With the exception of arsenic, mercury, nitrate and selenium, the average concentrations of the primary and secondary drinking water parameters in drilling muds were in excess of all of the inorganic drinking water standards. They also exceeded the drinking water standards for benzene and surfactants (MBAS). Drilling muds contained very high concentrations of sodium, potassium and chloride. TPH (diesel range) was present in all drilling muds. Concentrations ranged from 23 to 315 mg/L." [12]

With regard to radiation levels, the authors further noted:

> "Background levels of radiation ranged from 0.005 millirems per hour (mrem/hr) to 0.013 mrem/hr. Sample levels of radiation ranged from 0.009 mrem/hr to 0.016 mrem/hr. The standard for contamination is typically twice background. A review of the individual background levels of radiation indicated that this criterion was not exceeded."[12]

It is again significant to note that at the time, ***none*** of the drill cutting samples were collected from the lateral or horizontal portion of the well bore. In a later article, the lead author of the 2013 WVDEP-sanctioned study presented an expanded conclusion based on the same data:

> "At present little is known about the risks associated with the solid wastes from hydraulic fracturing in the Marcellus: spent drilling mud, drill cuttings and filtrates/precipitates from flowback.

[8] Enomoto, Catherine B, Loea, Ricardo A and Coleman, Jr, James I. *Characterization of the Marcellus Shale Based on Computer-Assisted Correlation of Wireline Logs in Virginia and West Virginia: US Geological Survey Scientific Investigations Report 2013-5131.* US Geological Survey. Reston, VA : s.n., 2014
[9] Resnikoff, Marvin, Alexandrova, Ekaterina and Travers, Jackie. *Radioactivity in Marcellus Shale.* 2010
[10] US Environmental Protection Agency. *Oil and Gas Production Waste*. [Online] August 30, 2012. [Cited: July 18, 2014.] http://www.epa.gov/rpdweb00/tenorm/oilandgas.html#whatbeingdone
[11] Ohio Administrative Code, Chapter 3701:1-43-01 (H), effective October 1, 2014.
[12] West Virginia Water Research Institute. Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations. s.l. : West Virginia Department of Environmental Protection, 2013. AGM 064.

Characterization of their inorganic, organic and radioactive contaminants is at present, incomplete. A systematic study including worker, environmental and community risks is needed." [13]

More comprehensive assessments of the composition of drill cuttings are currently underway by Dr. Paul Ziemkiewicz under a research collaboration between West Virginia University, Ohio University, Northeast Natural Energy, and the US Department of Energy National Energy Technology Laboratory (NETL) as the Marcellus Shale Energy and Environmental Laboratory (MSEEL). During the recent (2015-2016) drilling of two Marcellus shale well bores near Morgantown, West Virginia, nine drill cutting samples were obtained from the presumed horizontal portions of the well bores (within the Marcellus shale formation). From these samples, the combined concentrations of Radium 226 and Radium 228 were reported ranging between 18.54 pCi/g to 60.33 pCi/g[14], with a median concentration of 30.13 pCi/g. These combined radium concentrations are many times the natural background of most surface soil concentrations reported within the Appalachian basin[15] and in several states would exceed disposal limits for TENORM.

Other implications of the on-going MSEEL studies indicate that a significant source for both organic and inorganic contaminants may be added ingredients of conventional drilling mud mixtures. A comparison between conventional drilling mud sampling results and those where a specifically formulated "green" drilling mud were utilized indicates significant reductions in the amounts of both organic and inorganic contaminants can be achieved by use of the latter. However, this study is incomplete and full analysis has yet to be made available.

4. KEY MANAGEMENT ISSUES

This section discusses several key management issues pertaining to solid wastes generated during UOG. Due to the significant and fairly recent expansion of UOG (horizontal drilling with high-volume hydraulic fracturing), new stresses have been placed on MSWs as the primary repository for these wastes.

Key issues discussed will include the following, and focus on MSWs that accept drill cuttings and other drilling waste that may contain NORM and/or TENORM:

1. Waste characterization
2. Groundwater monitoring
3. Leachate monitoring
4. Radioactivity detection
5. Brine spreading

In consideration of the evolving strategies for management of oil and gas exploration and production wastes coupled with significant public concern pertaining to associated contaminants, discussions may include reference to the ALARA principle. As defined in Title 10, Section 20.1003, of the Code of Federal Regulations (10 CFR 20.1003), ALARA is an acronym for "as low as reasonably achievable". The United States Nuclear Regulatory Commission interprets ALARA to mean "making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health

[13] Practical measures for reducing the risk of environmental contamination in shale energy production. Ziemkiewicz, Paul, Quaranta, John D and McCawley, Michael. 7, 2014, Environmental Science: Process & Impacts, Vol. 16, pp. 1692-1699.
[14] Ziemkiewicz, Paul, 2016, Marcellus Shale Energy and Environmental Laboratory (MSEEL) Update: Water and Waste, RFSEA Onshore Workshop, Appalachian Basin Technology, Cannonsburg, PA, July 20, 2016.
[15] Agency for Toxic Substance and Disease Registry (ATSDR), 1990. Public Health Statement for Radium, Agency for Toxic Substances and Disease Registry, 4770 Buford Hwy NE, Atlanta, GA 30341, updated January 21, 2015

and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest." [16]

4.1 Waste characterization.

As with most states, New York requires waste generators or the receiving facilities to characterize waste streams prior to disposal. Self-reporting regimes such as this provide numerous advantages, but drawbacks include the potential that some wastes may be improperly or inadequately characterized to determine suitability for disposal under varying state regulatory structures. Again, consistency in how waste stream components are defined and common specification for waste characterization methods by various states could assist both generators and waste disposal facilities greatly, particularly as state borders are crossed between generation and disposal.

The following subsections present certain waste characterization approaches for various states that manage significant volumes of drilling wastes.

4.1.1 *Lessons from West Virginia*

West Virginia's Solid Waste Management Rule ("Rule") allows the disposal of drill cuttings and associated drilling wastes in MSWs and defines them as "…the broken bits of solid material and drilling mud removed from a borehole drilled by rotary, percussion, or auger methods…"but does not include wastes generated during the completion process or derived from the hydraulic fracturing process, including but not limited to, flowback solids and liquids, brine, tank bottoms, pit cleanout material and sludges, filters and filter media, pipe scale, used frack sand and proppants, etc."[17] The Rule does not specifically reference NORM or TENORM.

The Rule requires that to dispose of drilling waste, the permitee (landfill operator) must apply for and obtain a special waste minor permit modification. For each minor permit modification at least one sample from the horizontal portion of the well bore must be collected and analyzed for the parameters listed in Table 1.

Table 1: West Virginia drilling waste analytical requirements

Analytical Parameter	Analytical Method
Toxicity Characterization Leaching Procedure (TCLP) Metals	EPA Method 1311
TCLP Volatile Organic Compounds	EPA Method 8260B
TCLP Semi volatile Organic Compounds	EPA Method 8270C
Total Petroleum Hydrocarbons (TPH)	EPA Method 8015C

Notes: Source 33 CSR 1 §5.6.c.1.C.1. Sampling results for these parameters must not exceed the limits of 40 CFR § 261.24.

West Virginia does not have any requirement that this or any sample of drilling waste is analyzed by a laboratory under a prescribed methodology for any radiological parameters before a generator can receive a special waste permit. There is no specific regulatory requirement for laboratory analysis of chloride or bromide, two of the most prevalent and environmentally mobile contaminants in drilling waste. For drilling wastes in West Virginia, the only required screening for radiation occurs via fixed radiation detectors installed at the landfill gates. The limitation of this approach is in detecting the alpha emissions that are the primary form of decay for Radium 226 as discussed in later sections.

[16] United States Nuclear Regulatory Commission (NRC) 2016, ALARA, NRC Library, http://www.nrc.gov/reading-rm/basic-ref/glossary/alara.html, updated June 21, 2016, accessed July 28, 2016.
[17] 33CSR1 33-1-5.6.a.1

4.1.2 *TCLP and development of leachate limitations for Radium 226*

The West Virginia Rule approach provides a valuable insight to the benefits of using the Toxicity Characteristic Leaching Procedure (TCLP) to evaluate the characteristics of waste in a landfill setting. EPA Methods 1311 (TCLP) and 1312, the Synthetic Precipitation Leaching Procedure (SPLP) are designed to assess the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes. Both methods use physical agitation, filtration, and chemical extraction steps to generate a leachate from the sampled material that can then be analyzed for the contaminants of interest. These methods are used to simulate the mobility or leaching of contaminants from a material in a landfill setting (1311) or other environmental setting where normal weathering conditions may exist (1312).

Requiring generators to analyze their waste would assist states with developing their own criteria for leachability of Radium 226. While there is no existing federal TCLP limitation for Radium 226 in 40 CFR Part 261.24, this does not mean that states could not develop their own standard. In fact, while TCLP testing is normally performed to determine if a waste may meet RCRA (40 CFR Part 261) hazardous waste codes, waste generator responsibilities and state regulatory agencies already compel waste generators to utilize the TCLP to evaluate their wastes. Proposed Part 360.12 (e)(5)(i) already indicates that TCLP or SPLP procedures may be required for New York beneficial use determinations.

Despite the exemption of oil and gas production wastes from federal hazardous waste regulations (RCRA Subtitle C), we recommend that the TCLP (1311) method should be used to evaluate Radium 226 concentrations from drilling waste streams prior to disposal in a landfill. To be discussed in later sections, it is well documented that over just the past several years, leachate from MSWs that accept drilling wastes is becoming increasingly contaminated by Radium 226.

This approach could immediately inform drilling waste management options for states such as developing better solidification/stabilization procedures, conducting reasonable potential analyses for landfill National Pollution Discharge Elimination System (NPDES) permits or leachate treatment facilities, and helping to evaluate potential beneficial uses for wastes and limit disposal volumes placed in MSWs.

4.1.3 *Lessons from Ohio*

Ohio exempts drill cuttings from their definition of TENORM although they provide very clear guidance for the sampling and analysis of other waste streams to determine if they comply with MSW TENORM limitations prior to disposal. Two very informative and clear guidance documents produced by the Ohio Department of Health, Bureau of Radiation Protection, “Guidance for Sampling Waste Containing Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)” and “Acceptable TENORM Analytical Methods for Radium-226 and Radium-228” clearly outline acceptable sampling and analytical methods.

Due to the potential for mixed or combined waste streams, such as tanks containing a mixture of liquid and solid fractions, obtaining a sample that is representative of the waste to be disposed can present challenges. This is further complicated by the potential for heterogeneity within individual waste containers or loads.

If there were requirements that individual waste loads of drill cuttings and exploration and production waste loads were representatively sampled for NORM or TENORM, as required for other waste streams containing above-background Radium concentrations, public confidence would be substantially improved. Accurate characterization of drilling waste by representative sample collection and laboratory analysis is highly recommended to facilitate other waste management strategies such as waste minimization, for beneficial use determinations, and to accurately determine if waste acceptance criteria are met for the disposal facility.

4.1.4 *Consideration of evolving analytical methodologies*

A commonly cited challenge to conducting routine analysis for Radium 226 in drilling waste streams has been the relatively long analysis time required, such as for gamma spectrometry methods (EPA Method 901.1M). Gamma spectrometry methods are typically favored for their accuracy over other analytical methods that can be limited by matrix interferences, but have faster analytical turn-around time. Analytical methods with long analysis times can frustrate the operational pace of oil and gas development and may cause waste generators to resist regulatory requirements requiring their use.

A promising development is that recent research has demonstrated a sample preparation/separation protocol for Radium 226 analysis in fluid samples by Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) that has shown very good agreement with gamma spectrometry methods[18]. It is presumed that this protocol could be further modified to accommodate solid samples, or be used in conjunction with other analytical methods, and would provide a method for rapid assessment of Radium 226.

State laboratory certification programs should consider an expedited review process for evaluating new laboratory analytical techniques that could assist waste generators with more rapid, acceptable analytical methods to characterization waste streams containing Radium 226 above background concentrations.

4.2 Dedicated Cells

West Virginia requires that in order for drill cuttings and associated drilling wastes to be accepted at MSWs and not count toward a facility's monthly tonnage limitations, they must be disposed in specially constructed, dedicated cells. The Solid Waste Management Rule requires that these dedicated cells must have discrete leachate collection systems that segregates any leachate generated from within the cell from the leachate in any and all other municipal solid wastes at the facility.

This approach is recommended for consideration by other states due to the obvious advantages of potentially limiting the intensity and volume for leachate treatment prior to discharge from the facility, protection against distributing contaminants from drilling waste into larger waste volumes, potential long-term cost savings to facility environmental monitoring programs, decreased stress on various facility discharge permits, etc.

4.3 Leachate monitoring

The New York proposed approach to landfill leachate monitoring is presented and discussed in the following Section 4.4. This section presents justifications for more intensive leachate monitoring strategies for facilities that accept drilling wastes or oil and gas exploration wastes. A recent analysis of leachate monitoring at a West Virginia MSW facility that accepts large quantities of these wastes is also presented.

In 2015, the Michigan TENORM Disposal Advisory Panel issued a white paper summarizing their assessment as to whether Michigan's disposal guidelines "sufficiently protect public health and the environment." One of the six specific recommendations provided from the white paper was to add Radium 226 to existing facility leachate and groundwater monitoring programs as a measure of additional assurance.

> *"Consider requiring all landfills that accept TENORM waste to monitor leachate and ground water monitoring wells for Radium 226. Landfills currently have leachate collection systems and ground water monitoring wells which are routinely tested. Adding a Radium 226 test to the testing protocol*

[18] Zhang, T., Bain, D., Hammack, R. W., & Vidic, R. D. (2015). Analysis of Radium-226 in high salinity wastewater from unconventional gas extraction by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). Environmental Science & Technology, 49(5), pp. 2969-2976.

provides additional assurance that no excess Radium 226 is being released to the environment or public water treatment system."[25]

It is noted that the leachate treatment systems at many MSW landfills are similar to that used at many publicly owned treatment works (POTWs). It has been demonstrated that leachate from landfills that accept drilling waste contains many of the same contaminants as the wastewater generated from UOG development, although typically at lower concentrations. In a July 2009 response to the Clarksburg Sanitary Board's request to directly accept wastewater from oil and gas operations, the WVDEP responded:

> *"…WVDEP discourages POTWs from accepting wastewater from oil and gas operations such a marcellus shale wastewaters because these wastewaters essentially pass through sewage treatment plants and can cause inhibition and interference with treatment plant operations. The wastewaters from these types of operations contain high levels of chloride, dissolved solid, sulfate, and other pollutants. POTWs provide little to no treatment of these pollutants and could potentially lead to water quality issues in the receiving stream."*[19]

This is noteworthy since, on June 13, 2016, the United States Environmental Protection Agency (USEPA) finalized a rule[20] establishing a pretreatment standard of zero discharge of wastewater from onshore UOG extraction facilities to POTWs. This standard was developed since the treatment technologies used at most POTWs are designed to treat pollutants found in municipally-generated, not industrial, wastewater and typically are only designed to remove suspended solids and organic material using biological treatment. Wastewater from UOG extraction can contain high concentrations of dissolved solids, as well as pollutants such as radioactive elements, metals, chlorides, sulfates, and other dissolved inorganic constituents that POTWs are not designed to effectively remove. The result is that if disposed at POTWs, some UOG extraction wastewater constituents can be discharged untreated, or bypass, from the POTW to the receiving stream. Constituents may disrupt the operation of the POTW (e.g., by inhibiting biological treatment), can accumulate in biosolids (sludge), and can facilitate the formation of harmful disinfection by-products (DBPs). This evaluation by USEPA emphasizes the importance for monitoring of drilling waste contaminants not only for leachate, but for the effluent from leachate treatment systems.

It is therefore advised that monitoring (by laboratory analysis) of Radium 226 is carried through to the discharge from POTWs that receive leachate from MSWs that accept drilling wastes. This should apply to any scenario by which leachate leaves the landfill facility, either through on-site treatment and direct discharge, treatment and transfer off-site for additional treatment, or by trucking.

4.3.1 *Leachate monitoring at West Virginia drilling waste landfills*

The West Virginia Solid Waste Management Rule (33CSR1), Appendix V provides a listing of contaminants the WVDEP considers of concern for drill cuttings and associated drilling wastes. MSW facilities that accept drilling wastes must sample their leachate monthly for these parameters, listed in Table 2, and submit results.

[19] S. Mandirola, 2009, WVDEP Division of Water and Waste Management, Correspondence Re: WV/NPDES no. WVOO23302, July 23, 2009.
[20] United States Environmental Protection Agency, Pretreatment Standards for the Oil and Gas Extraction Point Source Category, Office of Water, EPA 821-F-16-001, June, 2016.

Table 2: West Virginia leachate monitoring parameters for facilities that accept drilling wastes

Drilling waste contaminants		
Total suspended solids	Ammonia nitrogen	Radium 228
Chloride	Nitrogen nitrate	Strontium
Aluminum	Nitrogen nitrite	Strontium 90
Arsenic	Fluoride	Lithium
Cadmium	Benzene	Total nitrated hydrocarbons
Copper	Phthalate esters	Fluoranthene
Cyanide	Barium	Bis(2-ethylhexyl) phthalate
Hexavalent chromium	Antimony	Chromium
Lead	Dibromochloromethane	Vanadium
Mercury	Boron	1,2-dichlorobenzene
Nickel	Chlorobenzene	1,3-dichlorobenzene
Selenium	Beryllium	1,4-dichlorobenzene
Silver	Gross alpha	Toluene
Zinc	Gross beta	Xylene
Sulfate	Radium 226	

Source: 33 CSR1. Appendix V Leachate Sampling Parameters for Facilities Accepting Drill Cuttings and Associated Drilling Waste. June 1, 2015

While this list may not include all contaminants likely present in drilling waste streams, requiring this monitoring for the leachate generated by landfills that accept drilling waste has provided West Virginia regulators with a substantial data set to inform future management and regulatory strategies, such as modifying facility NPDES permits, at landfills that accept drilling wastes.

4.3.2 *Drilling waste contaminant trends in leachate*

As one example of drilling waste contaminant transfer to landfill leachate, we present a summary of leachate monitoring data collected from 2011 through 2015 at a West Virginia MSW facility that has accepted large volumes of unconventional oil and gas well drilling wastes.

The Wetzel County Sanitary Landfill (WCSL) is a permitted Class B commercial solid waste landfill facility located along County Route 28/1 (Cider Run Road) in Wetzel County, West Virginia[21]. The facility is governed by a West Virginia Solid Waste Facility Permit Number SWF-1021/WV0109185. In 2009, the facility consisted of 238-acres of permitted area with 39-acres dedicated for waste disposal. In the 2015 permit, the disposal area was increased to 127-acres, primarily to accommodate the construction of two additional disposal cells to be dedicated for drilling waste, identified as Cell 7 and Cell 8. Historically, drilling wastes have been intermixed with other municipal solid waste streams.

WCSL is the only West Virginia landfill that routinely accepts large volume of drilling waste and does not send leachate for secondary treatment, such as a municipal sewage treatment plant or POTW. All leachate is treated on-site before discharge directly into the waters of the State under a NPDES permit.

Since 2011, WVDEP has required that MSW landfill permittees that accept drill cuttings must analyze their leachate for specific parameters they consider of concern in drilling waste (Table 2). This was a valuable and prudent first step in helping to track the movement of drilling waste contaminants through the landfill system and to help evaluate the environmental performance of MSWs in retaining, or releasing, contaminants to the environment.

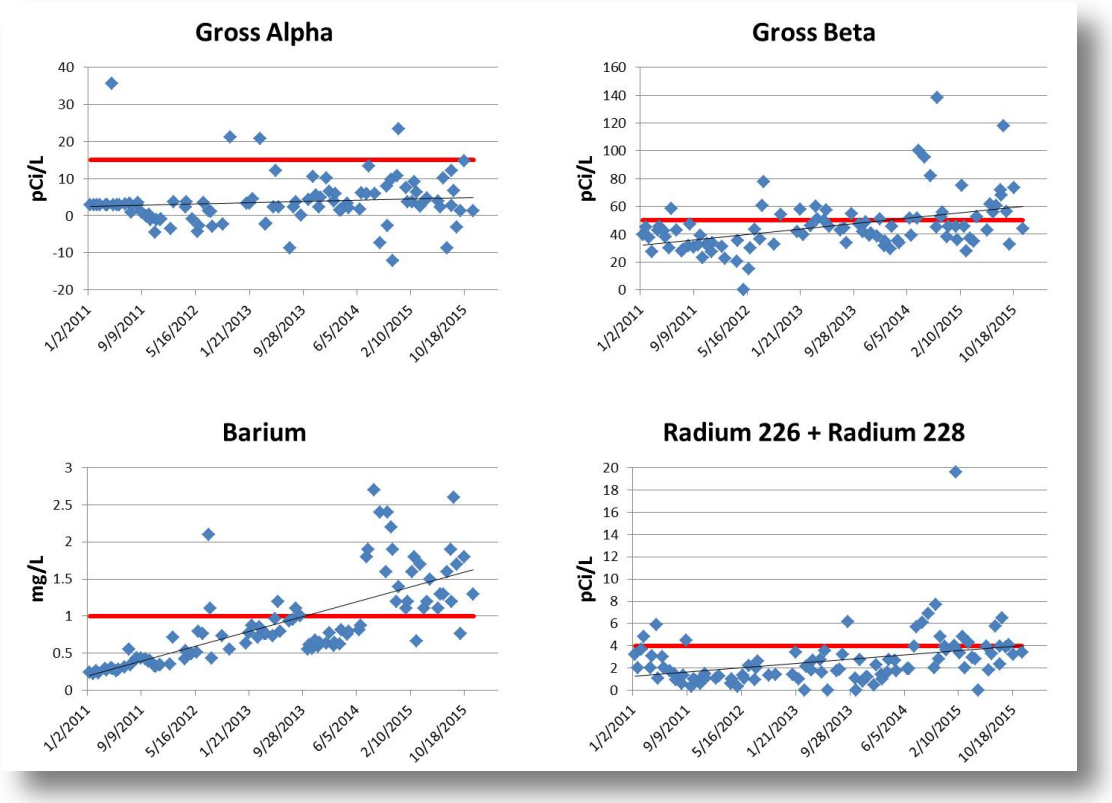
In a 2014 analysis[22] prepared for the Wetzel County Solid Waste Authority (WCSWA), contaminant trends in leachate, prior to on-site treatment, for several common drilling waste contaminants at the WCSL were graphed. From 2011 through 2013, chloride, arsenic, and barium showed increasing trends in leachate.

[21] SWF-1021/WVO109185 Public Notice, June 17, 2015
[22] M. Glass and K. Hatcher, 2014. Comments on Proposed Changes to the West Virginia Solid Waste Management Rule, 33CSR1

Chloride values tripled during the 2011 through 2013 monitoring period, a trend which followed increasing rates of drilling waste disposal at WCSL. The radiological parameters gross alpha, gross beta, and Radium 226 also showed increases. There were no individual Radium 226 or Radium 228 values reported above 5 pCi/L during this period, but there was one exceedance of the federal drinking water maximum contaminant levels (MCLs) and West Virginia surface water quality standards for Radium 226 and Radium 228 combined (5 pCi/L). The Ohio River Valley Sanitation Commission (ORSANCO) standards governing NPDES discharges to the Ohio River set a more stringent limit of 4 pCi/L for combined Radium 226 and Radium 228.

Figure **1** and Figure 2 below present a continuation of the leachate monitoring data extending from 2011 through 2015. Comparison of the corresponding WCSL monthly tonnage reports indicates that acceptance of drilling waste peaked during October 2013 and continued to decline through 2015 (Figure 3).

Figure 1**: Results for select parameters from leachate analysis at WCSL (2011-2015)**



Note: Red lines indicate water quality standards from the Ohio River Valley Water Sanitation Commission Pollution Control Standards for Discharges to the Ohio River, 2015 Revision. Black lines indicate data trend.

In a 2015 study prepared for WVDEP[23], Marshall University's College of Information Technology and Engineering (CITE) analyzed monthly leachate sampling results for several West Virginia landfills to determine if any statistical trends could be determined. Based on the quality of the data and their analysis, they concluded that no radioactive constituent showed evidence of accelerated increase over time. It is unclear what the Marshall researchers

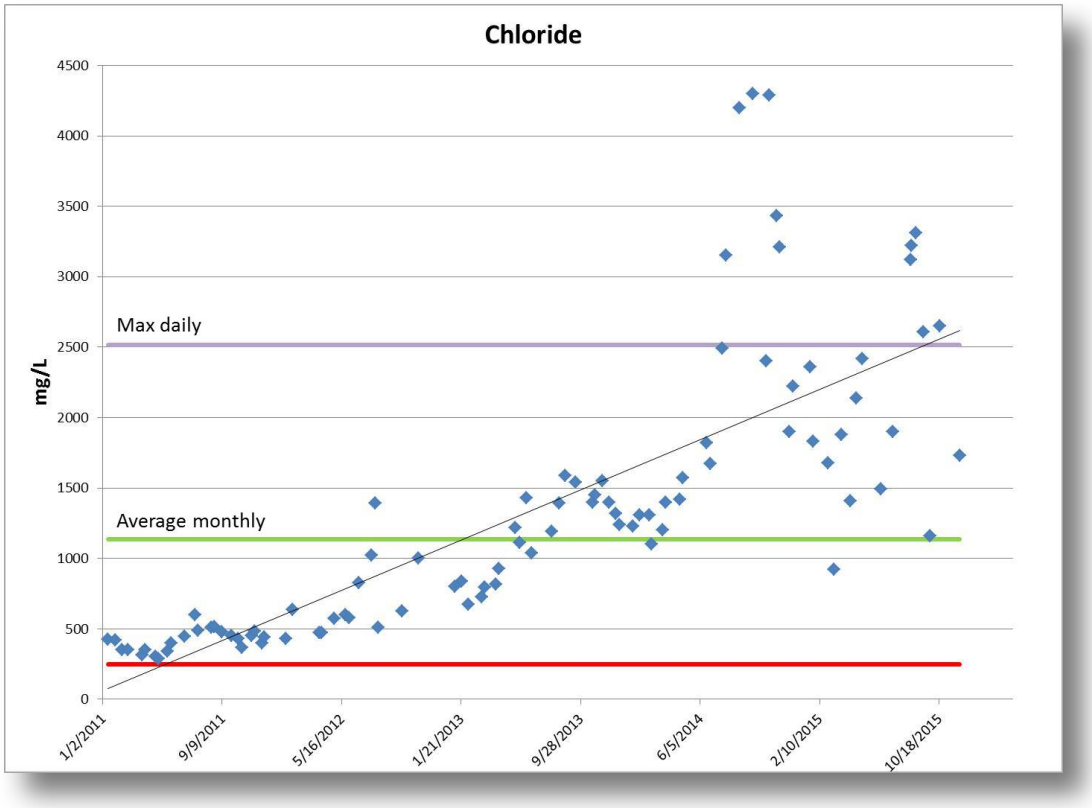
[23] Examination of Leachate, Drill Cuttings and Related Environmental, Economic and Technical Aspects Associated with Solid Waste Facilities in West Virginia, Marshall University Center for Environmental, Geotechnical and Applied Sciences, June 30, 2015.

intended by use of the term “accelerated”, however their own statistical analysis and conclusion confirmed that Radium 226 showed slight positive trends in leachate at WCSL. The Marshall analysis is therefore consistent with the increasing trends presented above in Figure **1**.

The red lines presented on Figure **1** indicate surface or drinking water quality standards for comparison. With the exception of gross alpha radiation, all graphed constituents frequently exceed the water quality standards in leachate prior to treatment.

Figure 2 presents the leachate chloride concentration trends from 2011 through 2015. As above, the red line indicates the applicable surface water quality standard for chloride of 250 mg/L. The purple and green lines indicate the 2015 NPDES permit effluent limitations, which will not become effective until 2017. Based on current chloride trends in leachate and limited removal capability by the on-site leachate treatment system, it appears that new a management approach for chloride is critically needed.

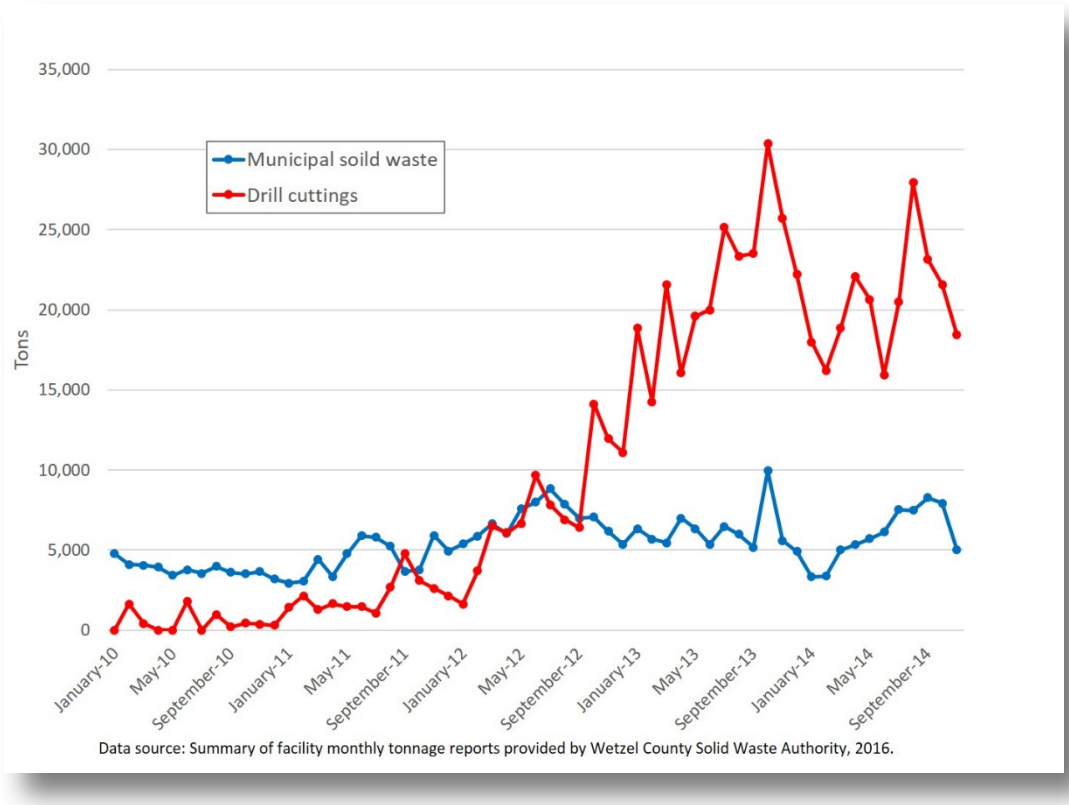
Figure 2: Results for chloride concentration in leachate analysis at WCSL (2011-2015)



Notes: Red line indicates water quality criterion of 250 mg/L for chloride from the Ohio River Valley Water Sanitation Commission Pollution Control Standards for Discharges to the Ohio River, 2015 Revision. Purple line and green line indicate the maximum daily (2,517 mg/L) and average monthly (1,135 mg/L) limit, respectively, as defined by the 2015 NPDES Permit discharge limitations and monitoring requirements beginning in September 10, 2017. The maximum daily and average monthly limits must be met at the outlet so the water quality criterion (red line) is met by edge of mixing zone. Black line indicates data trend line.

Contaminant trends in the WCSL leachate monitoring data presented above suggest that the management approach of solidification of drilling waste before arriving, or once received at the landfill facility, is alone not completely effective at controlling the migration of drilling waste contaminants in the landfill. Further, this analysis demonstrates the need to closely monitor both the landfill leachate and NPDES outlets for leachate treatment systems for drilling waste contaminants, whether treatment systems are located on or off-site.

Figure 3: Municipal solid waste vs. drilling waste tonnage at WCSL



As shown above, increasing trends are noted for several drilling waste contaminants at WCSL through 2015, even though facility monthly drilling waste tonnage reports indicate a peak for drilling waste disposal during October 2013 (Figure 3). This indicates that, despite the predictions of some research, there are scenarios where drilling waste contaminants have not stabilized in the landfill and the rate of contaminant release in leachate continues to increase. Increasing trends for these contaminants in leachate suggests that additional on or off-site treatment prior to discharge to surface waters (under NPDES permits) may be necessary in the near future.

Consistent with this conclusion, the 2016 PADEP TENORM study issued two recommendations pertaining to landfill facilities where TENORM wastes are accepted[24]:

1. Conduct additional radiological sampling and analyses and radiological surveys at all facilities that treat leachate from landfills that accept waste from O&G operations to determine if:
    a. there are areas of contamination that require remediation;
    b. if it is necessary to establish radiological effluent discharge limitations;
    c. and if the development and implementation of a spill policy is necessary.

2. Add total Radium (Radium 226 and Radium 228) to the annual suite of contaminants of concern in leachate sample analyses.

Several radiation exposure modeling exercises[24,25,26] for TENORM exposures at landfill facilities were reviewed. Potential radiation exposure for workers at landfill facilities were anticipated to be generally safe as long as certain work practices were maintained. Scenarios for residents living directly on or nearby and consuming locally grown food, were found to present very low levels of human exposure. These modeling exercises have found exposures from TENORM waste deposited inside the landfill to be very low or negligible for nearby resident scenarios. However, as with any exposure modeling exercise, results are dependent on the inputs and exposure scenarios contemplated. Of the studies reviewed, none had contemplated the human and ecological exposures from release of radioactive substances ***outside*** the landfill facility through leachate in pipes, but only the anticipated leachate concentrations expected to occur inside, or in the groundwater beneath, the facility or to workers handling leachate.

Other research[27] also indicates that sediments downstream of Radium-bearing liquid waste discharges may be adversely impacted by Radium 226. A relevant example of this occurred in Pennsylvania, where a study[28] of river sediments downstream of an industrial brine treatment facility that accepted drilling wastes found Radium 226 concentrations at levels nearly 200 times above upstream and background samples. This was true even though the treatment process was reported to have reduced Radium 226 levels by more than 90% from the original waste stream. This clearly demonstrates the need to monitoring both fluid effluents and sediments in water bodies that receive contributions from drilling waste streams.

4.4 Environmental Monitoring Plans at New York landfills

Proposed Part 363-7.4 provides requirements for facility environmental monitoring plans. The plans must include proposed monitoring points for leachate, underdrains, groundwater, surface water, and sediments. Analytical parameters and sampling frequency for each type of sampling are specified.

Proposed Part 363-7.6 provides several tables listing required analytical parameters for all environmental monitoring samples collected by the landfill facility for groundwater (monitoring wells, springs or seeps), surface water, leachate, and sediments based on either routine, baseline, or contingency sampling schedules (Table 3).

Required analyses include field measured parameters, leachate indicator parameters, inorganics, and for baseline and contingency sampling events, organics. As proposed, monitoring for radionuclides in groundwater, surface water, and sediments would only normally be required in the event of contingency sampling.

[24] Pennsylvania Department of Environmental Protection. Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) Study Report, Revision 1. By Perma-Fix Environmental Services, Inc., May 2016

[25] Michigan TENORM Disposal Advisory Panel, 2014-2015, White Paper

[26] Smith K., Blunt, D., Williams, G, Arnish, J., Pfingston, M, Herbert, J. Haffenden, R., 1999. An Assessment of the Disposal of Petroleum Industry NORM in Non-Hazardous Landfills. Argonne National Laboratory, Environmental Assessment Division. Prepared for U.S. Department of Energy, National Petroleum Technology Office and American Petroleum Institute, September 1999.

[27] Maloney, K. O.; Yoxtheimer, D. A. Production and disposal of waste materials from gas and oil extraction from the Marcellus Shale play in Pennsylvania. Environmental Practice, 2012, 14 (4), 278-287.

[28] *Impacts of Shale Gas Wastewater Disposal in Water Qualtiy in Western Pennsylvania.* **Warner, Nathaniel R, et al., et al.** 20, 2013, Environmental Science and Technology, Vol. 47, pp. 11849-11857.

Table 3: NYS landfill operational water quality monitoring requirements

Monitoring Program	Frequency	Parameters
Routine	Annual, same time each year	Table 1 – Routine field, leachate indicators, and inorganics
Baseline	Quarterly (all quarters except baseline)	Table 2A – Baseline field, leachate indicators, and inorganics Table 2B – Baseline organic parameters
Contingency	Within 90 days of triggering a contingency, quarterly thereafter	Table 3A – Expanded field, leachate indicators, inorganics, and radionuclides Table 3B – Expanded organics

Source: NYCRR Proposed Part 363-7.6, Solid Waste Management Facilities Regulations

4.4.1 *Groundwater, surface water, and sediment monitoring*

Proposed Part 363-7.4 (b)(2) requires monitoring points for all surface water bodies that may be significantly affected by a contaminant release from the facility and notes that additional sediment monitoring may be required by the department if necessary. Sediment samples must be collected from each location where surface water samples are collected and should consist of the upper five centimeters of sediment. Sampling frequency and analytical parameter requirements will follow the routine, baseline, and contingency programs summarized in Table 3. It is again noted that sampling and analysis for radionuclides would occur only under a contingency sampling program, if triggered by analysis of other facility water, sediment, or leachate sampling results.

Based on the recommendations provided from other recent research presented in this report and consistent with the ALARA principle, it is recommended that a requirement for radionuclide analysis, as specified in Proposed Part 363-7.6, Table 3A, should be made a requirement for facility environmental monitoring plans. It is recommended that radionuclide sampling and analysis is performed on at least a routine frequency (annual) for groundwater, surface water, and sediment monitoring.

4.4.2 *Leachate monitoring*

The Michigan TENORM Disposal Advisory Panel White Paper (2014-2015) recommended that landfills accepting TENORM to monitor leachate and groundwater monitoring wells for Radium 226[25]. This recommendation has also been supported by the more recent 2016 PADEP TENORM Study.

Proposed Part 363-7.4 (b)(3) specifies that the environmental monitoring plan must include leachate sampling points for each discrete leachate collection area or facility cell. As presented below in Table 4, primary leachate collection systems will be required to be analyzed for expanded parameters on a semi-annual basis. Secondary leachate collection systems must be monitored quarterly for baseline parameters, which would not include radionuclides. While it is commendable that New York has proposed to require at least semi-annual monitoring for radionuclides, a greater frequency would be highly useful to evaluating influent conditions for leachate treatment systems. It is strongly recommended that the leachate monitoring for radionuclides is conducted on at least a quarterly basis.

Table 4: NYS landfill leachate monitoring requirements

Leachate collection system	Frequency	Parameters
Primary	Semi-annually	Table 3A – Expanded field, leachate indicators, inorganics, and radionuclides Table 3B – Expanded organics
Secondary	Quarterly	Table 2A – Baseline field, leachate indicators, and inorganics Table 2B – Baseline organic parameters

Source: NYCRR Proposed Part 363-7.6, Solid Waste Management Facilities Regulations

It is further recommended to closely evaluate NPDES permits for facilities that treat or transfer leachate off-site for additional treatment, such as POTWs. Evaluation of leachate monitoring data should provide the information necessary to determine if modification to NPDES discharge limitations or additional treatment is warranted.

4.5 Radioactivity screening

Proposed Part 362.35 (d) (1) pertaining to transfer facilities, would require that a fixed radiation detection unit must be installed and operated at a location appropriate for the monitoring of all incoming waste and continues that the concentration of Radium 226 in any waste may not exceed 25 pCi/g. It is noted that fixed radiation detector units, or portal monitors, do not quantify specific radionuclide isotopes, such as Radium 226.

Proposed Part 363-8.1 (o)(8), operating requirements pertaining to landfills, prohibits the disposal of waste which exhibits a concentration greater than 25 pCi/g Radium 226. Proposed Part 363-8.1 (p) states that industrial waste or drilling and production wastes, if accepted, must be included in the landfill's waste control plan, which must describe any special handling or disposal procedures.

For drilling wastes, fixed radiation detectors are not an effective method to screen if waste loads meet municipal landfill activity limitations for Radium 226 and/or Radium 228, which range from 5 pCi/g and 50 pCi/g depending on respective state regulatory requirements. Portal detectors installed at landfill entrances detect the energy, primarily gamma or neutron waves, and do not measure the activity levels (pCi/g) for specific radioactive isotopes., such as Radium 226 and Radium 228.

4.5.1 *Radium 226 characteristics*

Of three primary types of ionizing radiation given off as a substance undergoes radioactive decay: alpha particles, beta particles, and gamma rays, alpha particles are the most difficult to detect. Alpha and beta particles can generally be stopped or shielded with thin layers of material. For example, alpha particles do not travel far in air and are easily stopped by a few sheets of paper, a thin layer of water, or the outer layers of skin. Gamma rays, which are pure energy, can penetrate deeply into substances. Several inches of lead are often required to stop gamma rays.

Radium 226, the primary radionuclide identified in unconventional shale drilling waste, undergoes radioactive decay during its 1,600-year half-life primarily by emitting alpha particles, with only a very weak gamma emission. Radiation detectors installed at landfill gates have limited effectiveness at accurately quantifying the alpha radiation activity from Radium 226 contained in drilling wastes since, due to the low penetrability of alpha particles, the waste itself and the waste container tend to block the alpha particles

from ever reaching the detector[29]. Radiation detected by landfill gate monitors, such as the Ludlum 4525 Series Radiation Portal Monitors, utilize gamma detectors and on rely on gamma emissions[30] from a source material to trigger alarm events.

Even though alpha particles and most beta particles can be stopped by skin, exposure through ingestion or inhalation is hazardous. If alpha emitting radionuclides enter the body by these pathways, they are the most destructive form of ionizing radiation. It is estimated that chromosome damage from alpha particles is anywhere from 15 to 20 times greater than that caused by an equivalent amount of gamma or beta radiation[31]. These characteristics are what make Radium 226 concentrations in leachate, groundwater, sediments, and other environmental media of particular concern. Radium may be bio-concentrated and bio-accumulated by plants and animals, and it is transferred in food chains from lower trophic levels to humans[32]. Radium does not degrade, other than by radioactive decay, significantly in the environment.

4.5.2 *Example of portal radiation monitor limitations for waste screening*

As an example of this conundrum, West Virginia's Solid Waste Management Rule[33] requires that radiation detectors are installed at landfill gates for facilities that accept drilling wastes. If the radiation alarm is triggered, then the load must be sampled and analyzed for the total concentration of Radium 226 and Radium 228 combined. The Rule states that results must be less than 5 pCi/g above local background to be accepted. While West Virginia requires that facilities establish their own local background concentration, they do not specify a default value to use as an alternative. In Ohio, background is presumed to be 2 pCi/g unless an individual location submits and alternative background concentration request and it is approved by the Ohio Department of Health[34].

In this example, it is easy to see that if West Virginia's 5 pCi/g above local background standard for combined Radium 226/228 were followed and supported by laboratory analysis, the drill cuttings from the MSEEL study discussed previously in Section 3, demonstrating a median concentration of 30.13 pCi/g for Radium 226/228 combined, would not be permitted in West Virginia MSWs. This presents a significant gap where only the waste loads that trigger radiation portal alarms are required to be analyzed by laboratory methods to determine if the Radium 226 and Radium 228 activity in the waste meets acceptance criteria.

In order to accurately evaluate Radium activity that is comparable to state TENORM or drilling waste limits, a representative composite sample from each waste container must be submitted for laboratory analysis or directly analyzed in a special vessel and detection equipment. The Ohio Department of Health, Bureau of Radiation Protection (BRP) approves of EPA Method 901.1M by gamma spectrometry for the analysis of Radium 226 or Radium 228[35]. Ohio also allows In-situ gamma spectroscopy using Canberra's ISOCS system, or other alternatives if specific conditions are met.

In-situ measurement using the Canberra (or similar) system requires that a representative waste sample from each waste container is placed into a special vessel of known geometry that is placed in immediate proximity to the sensor equipment for prescribed time measurement periods, a highly specific process as compared to drive-through gate detector rapidly analyzing a truck load of waste. There are further complications for in-

[29] Office of the Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs/Nuclear Matters, Radiation Detection and Measurement, NARP Internet Supplement, Revision 1.122211, DoD 3150.8_M. effective August 22, 2013
[30] Ludlum Measurements, Inc. Ludlum Model 4525 Radiation Portal Monitor Operations Manual. Version 3.1.3/39651N31. November 2015
[31] Brooks, A. L. Chromosome damage in liver cells from low dose rate alpha, beta, and gamma irradiation: Derivation of RBE. Science, 1975.
[32] Agency for Toxic Substances and Disease Registry, Toxicological Profile for Radium
[33] W. Va. Code of State Rules (CSR) §33-1, Solid Waste Management Rule, effective June 1, 2015.
[34] Ohio Department of Health, 2014. Ohio Department of Health, Bureau of Radiation Protection, Acceptable TENOR Analytical Methods for Radium-226 and Radium-228, February 20, 2014, http://www.odh.ohio.gov/~/media/ODH/ASSETS/Files/rp/radiation%20protection/2013/2014/Acceptable%20Radium%20Analysis%20Methods%20Document%2022014.ashx
[35] Ohio Department of Health, Bureau of Radiation Protection. Acceptable TENORM Analytical Methods for Readium-226 and Readium-228. February 20, 2014

situ measurement methods. In a fact sheet explaining USDOT shipping regulations for TENORM[36], the Pennsylvania Department of Environmental Protection (PADEP) specifically warns the oil and gas industry that indirectly measuring external gamma radiation fields from a material over a period shorter than 25 days does not result in an accurate assessment, due to the material not having achieved equilibrium with respective decay products. PADEP further warns that assessment "may require a series of sampling radiochemistry laboratory tests and routine exposure rate measurements from the shipping package to determine if the upper limits of activity and concentration are exceeded."[36]

4.5.3 *Radiation monitor alarm event procedures*

Proposed Part 362.35 (e) (6) would require that each instance in which the radiation detector is triggered by a waste load must be documented. Information that must be recorded includes the date the waste was received, hauler name, origin of waste, truck number or identifying mark, detector reading, disposition of the waste, and the date of disposition. However, there is no requirement listed that this information should be reported to any authority and what appropriate response actions are available if an alarm is triggered. Under the current proposal, an alarm would simply have to be documented, but there is nothing that would prevent the facility from continuing with transfer of the waste or any procedure required for further evaluation of the waste load.

It would provide clarity to landfill facility operators if a specific procedure was outlined in New York regulations for notifying agencies and what options are available for further evaluation or load rejection. An evaluation procedure with clearly defined decision points could be developed and incorporated into Part 362.

As an example, in West Virginia, facility gate radiation monitoring must be able to alarm at 10 µR/hr above local background levels. For any alarm event, the facility is required to provide an incident report to both the WVDEP and the West Virginia Department of Health and Human Resources (WVDHHR) Radiological Health Program, using a specified form, within 24 hours of the initial alarm[37]. In addition to the notification procedure, waste loads triggering an alarm must be sampled and analyzed for the combined concentration of Radium 226 and Radium 228. If the combined Radium concentration exceeds 5 pCi/g above local background, the load must be rejected for disposal at the facility.

4.6 Brine spreading

States have differing policies regarding the use of oil and gas brines and produced fluids for road maintenance operations, such as de-icing and dust control. Each state offers its own definitions for oil and gas produced fluids that may be considered for these uses. There are also differing pre-requisite conditions to evaluate suitability, including what parameters must be verified through laboratory analysis prior to use.

Produced fluid includes all fluids that return through a well bore. However, based on the stage of well development, some states use additional terms such as "return fluids" or "flowback" to differentiate the return of fluids injected during hydraulic fracturing treatments versus those produced from the formation. For hydraulically fractured wells, produced fluid composition is initially similar to the injected fluids. Over time, the composition is affected by the characteristics of the formation fluids and possible interactions with injected fluids. It is estimated that for Marcellus wells in West Virginia and Pennsylvania, less than 10% of the injected fluids return with the produced fluids[38].

[36] PADEP, 2016, Shipping of Technologically Enhanced Naturally Occurring Radioactive Material Under The U.S. DOT Hazardous Material Transportation Regulations, 2900-FS-4374, Rev. 12/2014
[37] 33 CSR 1-5.6.d.5
[38] Hansen E, Mulvaney D, Betcher M. 2013. Water resource reporting and water footprint from Marcellus Shale development in West Virginia and Pennsylvania. Prepared for Earthworks. Downstream Strategies and San Jose State University.

West Virginia does not allow the use of hydraulic fracturing return fluids from vertical or horizontal gas wells for road deicing[39], but does allow use of natural gas well brines that are analyzed and meet specified limits for the parameters listed below in Table 5 and other qualifying conditions to be applied to roads. West Virginia requires that laboratory analysis is performed for each new source of natural gas well brine, but there is no requirement to repeat this testing over time.

Pennsylvania allows brine application on un-paved secondary roads for dust control and road stabilization, although use of brines generated from any shale formation is specifically prohibited. For other brines that may be considered, analysis is required (Table 5) on an annual basis, and a new plan for application of brines must be submitted to the Pennsylvania Department of Environmental Protection (PADEP) for approval each year[40].

Table 5: Comparison of brine analysis parameters for West Virginia, Pennsylvania, and proposed New York

West Virginia	Pennsylvania	New York
Total Dissolved Solids (TDS)	TDS	TDS
Chloride	Chloride	Chloride
Sodium	Sodium	Sodium
Calcium	Calcium	Calcium
pH		
Iron		Iron
Barium		Barium
Lead		Lead
	Magnesium	
		Sulfate
Oil & Grease		Oil & Grease
Benzene		Benzene
Toluene		Toluene
Ethylbenzene		Ethylbenzene
Xylene		Xylene

NYS Proposed Part 360.12(f)(3)(i) will not allow the use of gas storage brine or production brine generated from the Marcellus Shale for road spreading (ice/dust control). Marcellus Shale produced brine has been demonstrated to contain high concentrations of radiological components[41]. Based on results of recent studies discussed below however, exclusion of Marcellus brine alone does not appear effective at eliminating public exposure to ionizing radiation from the practice of brine spreading on roads.

It is noted that none of the above-referenced states (New York, Pennsylvania, West Virginia) require analysis for radiological parameters to evaluate brines considered for road maintenance uses. It appears that this omission may be ill advised and is already allowing increased human exposures to ionizing radiation. Elevated concentrations of Radium in produced brines from many geologic formations other than the Marcellus have been well documented[42]. A 2015 Study prepared for the Pennsylvania Department of Environmental

[39] West Virginia Department of Environmental Protection (WVDEP), 2011. Memorandum of Agreement, West Virginia Division of Highways (WVDOH)/WVDEP Salt Brine from Gas Wells Agreement, December 22, 2011.

[40] Pennsylvania Department of Environmental Protection (PADEP), 2016, Roadspreading of Brine For Dust Control and Road Stabilization, PADEP Roadspreading of Brine Fact Sheet , http://files.dep.state.pa.us/AboutDEP/AboutDEPPortalFiles/RemarksAndTestimonies/Road%20Spreading%20Fact%20Sheet.pdf

[41] New York State Department of Environmental Conservation (NYSDEC), 2009. Draft Supplemental Generic Environmental Impact Statement (SGEIS) on the oil, gas, and solution mining regulatory program: Well permit issuance for horizontal drilling and high-volume hydraulic fracturing to develop the Marcellus Shale and other low-permeability gas reservoirs: New York State Department of Environmental Conservation, Division of Mineral Resources, Bureau of Oil and Gas Regulation, Appendix 13, NYS Marcellus radiological data from production brine, accessed July 24, 2016, Full document: http://www.dec.ny.gov/docs/materials_minerals_pdf/fsgeis2015app114.pdf

[42] Rowan, E.L., Engle, M.A., Kirby, C.S., and Kraemer, T.F., 2011, Radium content of oil- and gas-field produced waters in the northern Appalachian Basin (USA)—Summary and discussion of data: U.S. Geological Survey Scientific Investigations Report 2011–5135, 31 p. (Available online at http://pubs.usgs.gov/sir/2011/5135/), accessed July 24, 2016.

Protection (PADEP) entitled *Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) Study Report*[43] concluded: "While limited potential was found for radiation exposure to recreationists using roads treated with brine from conventional natural gas wells, further study of radiological environmental impacts from the use of brine from the O&G industry for dust suppression and road stabilization should be conducted." In 2016, PADEP issued Revision 1[44] of the same report and this conclusion was modified slightly to read: "While limited potential was found for radiation exposure to recreationists using roads treated with brine from conventional natural gas wells, further study of radiological environmental impacts from the use of brine from the O&G industry for dust suppression and road stabilization should be conducted."

Both the original PADEP TENORM study and its revision provide clear evidence that oil and gas brines, even those generated from conventional, vertical oil and gas wells, contain radioactive components that are transferred to roads during brine application. It appears critical that any regulatory body considering authorization of brine application to roads or other areas that provide human or ecological environmental exposures test and analyze brines for radiological components. Further, even if analysis for the radium activity concentrations of brines is conducted, ongoing monitoring for potential human and environmental exposures should be conducted at the application sites.

Using the ALARA principle, it appears that application of brines for road treatment or maintenance activities is ill-advised as it is already documented as increasing human and ecological exposure to ionizing radiation through road application of brines. It is suggested that this practice should be discontinued altogether until further study and possibly additional public protections are put into place.

At a minimum, it is recommended that NYS require testing and analysis for gross alpha activity and Radium 226 by including the requirement in Part 360. EPA Method 900.1 is recommended for analysis of gross alpha activity and EPA Method 901.1M by gamma spectrometry is recommended for analysis of Radium 226 to avoid potential interferences and underreporting of total alpha activity and radium 226 concentrations for samples with elevated (>500 ppm) total dissolved solids (TDS) concentrations that are common to brines.

Another key consideration is that even if testing indicates that brines were to attain the federal drinking water standard of 5pCi/L for combined Radium 226 and Radium 228[45] (with a non-enforceable health-based goal of zero), that the exposure scenarios and long-term environmental fate and transport mechanisms for road application of brines are very different than those considered when developing a health-based drinking water standard. A separate analysis to determine public exposure from application of brines to roads is needed.

A 2011 U.S. Geological Survey (USGS) Scientific Investigation Report[46] investigated the Radium content of oil and gas produced waters (brines) of the Northern Appalachian Basin - New York and Pennsylvania. Salinities from reservoir rocks in the Appalachian Basin, reported as TDS, commonly exceed 100,000 mg/L, which is far above the salinities of many other oil and gas producing regions of the United States. The analysis indicated a linear relationship for Cambrian-Devonian brines between TDS and radium content. A positive correlation between salinity and both total radium and Ra-226 activities was also reported for non-Marcellus Shale brines, despite originating from reservoirs of varying age and lithology.

Table 6 presents a comparison of proposed brine criteria for beneficial use determinations (BUD) to USEPA primary and secondary drinking water standards. Of note is that New York is proposing TDS concentrations

[43] Pennsylvania Department of Environmental Protection. Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) Study Report. By Perma-Fix Environmental Services, Inc., January 2015.
[44] Pennsylvania Department of Environmental Protection. Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) Study Report, Revision 1. By Perma-Fix Environmental Services, Inc., May 2016.
[45] United States Environmental Protection Agency. 2012 Edition of the Drinking Water Standards and Health Advisories. Office of Water. 2012. EPA 822-S-12-001
[46] Rowan, E.L., Engle, M.A., Kirby, C.S., and Kraemer, T.F., 2011, Radium content of oil- and gas-field produced waters in the northern Appalachian Basin (USA)—Summary and discussion of data: U.S. Geological Survey Scientific Investigations Report 2011–5135, 31 p. (http://pubs.usgs.gov/sir/2011/5135/)

above 170,000 mg/L to meet beneficial use of brine criteria, which should be anticipated to include total radium activity frequently exceeding 1,000 pCi/L for both Marcellus and non-Marcellus brines.

Table 6: Comparison of New York brine criteria to USEPA drinking water standards

Parameter	New York Criteria (mg/L)	USEPA mcl/smcl* (mg/L)
TDS	>170,000	500*
Chloride	>80,000	250*
Sodium	>40,000	--
Calcium	>20,000	--
Iron	<30	0.3*
Barium	<1.0	2
Lead	<2.5	0.015
Sulfate	<250	250*
Oil & Grease	<15	--
Benzene	<0.5	0.005
Toluene	<0.5	1
Ethylbenzene	<0.5	0.7
Xylene	<0.5	10

Notes: mg/L=milligrams per liter, µg/L=micrograms per liter, mcl=maximum containment level, smcl=secondary maximum containment level "--" indicates there is no drinking USEPA water quality standard. Sources: Title 6 of the New York Code of Rules and Regulations (NYCRR) Proposed Part 360, Solid Waste Management Facilities Regulations, United States Environmental Protection Agency. 2012 Edition of the Drinking Water Standards and Health Advisories. Office of Water. 2012. EPA 822-S-12-001.

Brine is not being proposed as source for drinking water, but the comparison to USEPA drinking water standards is provided below in Table 6 for illustrative purposes, as it has also been in Ohio Department of Natural Resources[47] and other guidance documents issued by various states. New York is also proposing specific practices to limit potential direct interactions with surface water or groundwater resources such as:

- prohibiting application within 50 feet of a stream, creek, lake, or other body of water
- no application on road grades exceeding 10%
- no application on unpaved roads
- no application directly to vegetation near the surface being treated
- no application within 12 feet of structures crossing water bodies or crossing drainage ditches
- no application on wet or frozen roads, during rain, or when rain is imminent

Despite these precautionary limitations, inorganic components of brines in particular will tend to accumulate and concentrate in the road substrates they are applied to. Since many inorganic substances do not degrade significantly in the environment, they can be a source of contaminants long into the future. There is a substantial body of literature dedicated to this topic. In 2006, the USGS compiled a bibliography[48] of literature centered on the degradation of soils, ground water, surface water, and ecosystems they support by releases of suspended and dissolved hydrocarbons and co-produced saline water released by oil and gas production.

[47] Ohio Department of Natural Resources, Division of Mineral Resources Management, Spreading Oil-Filed Brine For Dust and Ice Control In Ohio, A Guid for Local Authorities, Created October 1992, Revised September 2004.

[48] Otton, J.K,, 2006, Environmental aspects of produced-water salt releases in onshore and estuarine petroleum-producing areas of the United States- a bibliography: U.S. Geological Survey Open-File report 2006-1154, 223p. https://pubs.usgs.gov/of/2006/1154/pdf/of06-1154_508.pdf

5. CONCLUSIONS AND RECOMMENDATIONS

We appreciate this opportunity to provide comments to Earthworks regarding the proposed comprehensive revisions to Title 6 of the New York Code of Rules and Regulations (NYCRR) Part 360, Solid Waste Management Facilities Regulations.

While we encourage review of this report in its entirety, we have organized key points, recommendations, and comments from our review below in numerical order, with headings for related topics to facilitate the public comment process:

Waste Characterization

1. Considering the ALARA principle, remove exemptions of drill cutting and other associated oil and gas drilling wastes from TENORM definitions. Consider classifying these and any other wastes containing above-background Radium concentrations as TENORM and specifically do not define drill cuttings or drilling wastes to exclude them from the definition of TENORM.

2. Waste characterization by representative sampling and appropriate laboratory analytical methods is currently the most accurate way to determine the quantities and activity of radioactive substances prior to landfill disposal. Waste characterization should be proscribed through regulation or guidance to consist of representative composite sample of drilling waste or TENORM in order to determine if the material is eligible for New York's landfill disposal limitation of 25 pCi/g Radium 226.

3. Consider requiring that drilling wastes are analyzed by TCLP to determine their leaching behavior in a landfill setting prior to disposal. States should consider using their existing authority to develop leachability criteria for drilling waste contaminants that do not already have limits under 40CFR Part 261. TCLP analysis is not recommended as a measure to restrict waste disposal or evaluate toxicity per se, but rather to better understand leaching behavior in a landfill setting to evaluate improvements to management strategies at landfills.

4. State laboratory certification program(s) should closely evaluate new and emerging laboratory analytical techniques for Radium 226 that may provide waste generators or solid waste facilities with more rapid analytical methods to characterize wastes.

Radiation Monitoring

5. Radiation monitoring using portal detection equipment is not an effective approach for quantifying the radioactive substances in drilling wastes and not a substitute for waste characterization as described above. Portal radiation detection monitors do not detect the alpha emissions from Radium 226 and primarily measures gamma and neutron emissions which are not strong from Radium 226 decay.

6. For radiation alarm events, consider specifying in the regulation specific agencies that must be contacted, a consistent and trackable notification procedure/format, and possible follow up actions, such as waste sampling or rejection protocol.

Dedicated waste disposal cells

7. Consider requiring that drilling wastes and any wastes that contain above background Radium concentrations are placed exclusively in dedicated cells constructed with discrete leachate collection systems. It is noted that the greatest benefits provided by this approach will rely on reliable waste characterization prior to disposal.

Environmental Monitoring Plans

8. As proposed, monitoring for radionuclides in groundwater, surface water, and sediments would only normally be required in the event of contingency sampling. It is recommended that a requirement for radionuclide analysis specified in Proposed Part 363-7.6 should be included in at least routine (annual) groundwater, surface water and sediment in facility environmental monitoring plans.

9. Sediment sampling is required by proposed Part 363 at any landfill surface water sampling location. Sediment analysis in landfill environmental monitoring plans should also be required to include the radionuclide parameters listed in Proposed Part 363-7.6, Table 3A.

10. While it is commendable that New York has proposed to require at least semi-annual monitoring for radionuclides in primary leachate collection systems, a greater frequency would be highly useful to evaluating influent conditions for leachate treatment systems. It is strongly recommended that the leachate monitoring for radionuclides is conducted on at least a quarterly basis.

11. It is recommended that environmental monitoring plans are required to include monitoring of sediments for Radium 226 near the discharge points for leachate treatment systems if treated effluents are discharged on-site. If leachate is transferred off-site for treatment, such as a POTW, it is recommended that sediment monitoring for radionuclides on a routine basis is added as an NPDES permit condition.

12. It is further recommended to closely evaluate NPDES permits for facilities that treat or transfer leachate off-site for additional treatment, such as POTWs. Evaluation of leachate monitoring data should provide the information necessary to determine if modification to NPDES discharge limitations or additional treatment is warranted.

Brine spreading

13. Oil and gas produced brines, even from sources other than the Marcellus shale, often contain highly elevated concentrations of Radium 226 and other radiological components. At a minimum, it is recommended that NYS require testing and analysis of brines for radiological components and set protective limits for beneficial use determinations. Monitoring for gross alpha activity and Radium 226 by the methods specified in Proposed Part 360 is recommended. EPA Method 900.1 is recommended for analysis of gross alpha activity and EPA Method 901.1M by gamma spectrometry is recommended for analysis of Radium 226 to avoid potential interferences and underreporting of total alpha activity and radium 226 concentrations for samples with elevated (>500 ppm) total dissolved solids (TDS) concentrations that are common in brine.