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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 435

[EPA-HQ-OW-2014-0598; FRL-9917-78-OW]

RIN 2040-AF35

Effluent Limitations Guidelines and Standards for the Oil and Gas Extraction Point Source Category

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

SUMMARY: EPA proposes a Clean Water Act (CWA) regulation that would better protect human health and the environment and protect the operational integrity of publicly owned treatment works (POTWs) by establishing pretreatment standards that would prevent the discharge of pollutants in wastewater from onshore unconventional oil and gas extraction facilities to POTWs. Unconventional oil and gas (UOG) extraction wastewater can be generated in large quantities and contains constituents that are potentially harmful to human health and the environment. Because they are not typical of POTW influent wastewater, some UOG extraction wastewater constituents can be discharged, untreated, from the POTW to the receiving stream; 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 disinfection by-products (DBPs). Based on the information collected by EPA, the

requirements in this proposal reflect current industry practices for unconventional oil and gas extraction facilities, therefore, EPA does not project the proposed rule will impose any costs or lead to pollutant removals, but will ensure that such current industry best practice is maintained over time.

DATES: Comments on this proposed rule must be received on or before [**insert date 60 days after publication in the Federal Register**]. EPA will conduct a public hearing on the proposed pretreatment standards on May 29, 2015 at 1:00 PM in the EPA East Building, Room 1153, 1201 Constitution Avenue, NW, Washington, DC.

ADDRESSES: Submit your comments on the proposed rule, identified by Docket No. EPA-HQ-OW-2014-0598 by one of the following methods:

- *http:www.regulations.gov*: Follow the on-line instructions for submitting comments.
- *Email*: OW-Docket@epa.gov, Attention Docket ID No. EPA-HQ-OW-2014-0598.
- *Mail*: Water Docket, U.S. Environmental Protection Agency, Mail code: 4203M, 1200 Pennsylvania Ave. NW., Washington, DC 20460. Attention Docket ID No. EPA-HQ-OW-2014-0598. Please include three copies.
- *Hand Delivery*: Water Docket, EPA Docket Center, EPA West Building Room 3334, 1301 Constitution Ave. NW., Washington, DC, Attention Docket ID No. EPA-HQ-OW-2014-0598. Such deliveries are only accepted during the Docket's normal hours of operation, and you should make special arrangements for deliveries of boxed information by calling 202-566-2426.

Instructions: Direct your comments to Docket No. EPA-HQ-OW-2014-0598. EPA's policy is that all comments received will be included in the public docket without change and can be made available online at http://www.regulations.gov, including any personal information provided, unless the comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through http://www.regulations.gov or email. The http://www.regulations.gov website is an "anonymous access" system, which means EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an email comment directly to EPA without going through http://www.regulations.gov your email address will be automatically captured and included as part of the comment that is placed in the public docket and made available on the Internet. If you submit an electronic comment, EPA recommends that you include your name and other contact information in the body of your comment and with any disk or CD-ROM you submit. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA will not be able to consider your comment. Electronic files should avoid the use of special characters, any form of encryption, and be free of any defects or viruses.

Docket: All documents in the docket are listed in the http://www.regulations.gov index. A detailed record index, organized by subject, is available on EPA's website at http://water.epa.gov/scitech/wastetech/guide/oilandgas/unconv.cfm. Although listed in the index, some information is not publicly available, *e.g.*, CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, will be publicly available only in hard copy. Publicly available docket materials are available either electronically in http://www.regulations.gov or in hard copy at the Water Docket in EPA Docket Center, EPA/DC, EPA West, Room 3334, 1301 Constitution Ave., NW, Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is 202-566-1744, and the telephone number for the Water Docket is 202-566-2426.

Pretreatment Hearing Information: EPA will conduct a public hearing on the proposed pretreatment standards on May 29, 2015 at 1:00 PM in the East Building, Room 1153, 1201 Constitution Avenue, NW, Washington, DC. Registration is not required for this public hearing, however pre-registration will be possible via a link on EPA's website: at http://water.epa.gov/scitech/wastetech/guide/oilandgas/unconv.cfm. During the hearing, the public will have an opportunity to provide oral comment to EPA on the proposed pretreatment standards. EPA will not address any issues raised during the hearing at that time but these comments will be included in the public record for the rule. For security reasons, we request that you bring photo identification with you to the meeting. Also, if you let us know in advance of your plans to attend, it will expedite the process of signing in. Seating will be provided on a first-come, first-served basis. Please note that parking is very limited in downtown Washington, and use of public transit is recommended. EPA Headquarters complex is located near the Federal Triangle Metro station. Upon exiting the Metro station, walk east to 12th Street. On 12th Street, walk south to Constitution Avenue. At the corner, turn right onto Constitution Avenue and proceed to EPA East Building entrance.

FOR FURTHER INFORMATION CONTACT: For technical information, contact Lisa Biddle, Engineering and Analysis Division, Telephone: 202-566-0350; email: biddle.lisa@epa.gov. For economic information, contact Karen Milam, Engineering and Analysis Division, Telephone: 202-566-1915; email: milam.karen@epa.gov.

SUPPLEMENTARY INFORMATION:

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I. Regulated Entities

Entities potentially regulated by this proposed action include:

Category	Examples of Regulated Entities	North American Industry Classification System (NAICS) Code
Industry	Crude Petroleum and Natural Gas Extraction	211111
	Natural Gas Liquid Extraction	211112

This section is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this proposed action. Other types of entities that do not meet the above criteria could also be regulated. To determine whether your facility would be regulated by this proposed action, you should carefully examine the applicability criteria listed in 40 CFR 435.30 and the definitions in 40 CFR 435.33(b) of the proposed rule and detailed further in Section XI – Scope, of this preamble. If you still have questions regarding the proposed applicability of this action to a particular entity, consult the person listed for technical information in the preceding FOR FURTHER INFORMATION CONTACT section.

II. How to Submit Comments

The public can submit comments in written or electronic form. (See the ADDRESSES section above.) Electronic comments must be identified by the Docket No. EPA-HQ-OW-2014-0598 and must be submitted as a MS Word, WordPerfect, or ASCII text file, avoiding the use of special characters and any form of encryption. EPA requests that any graphics included in electronic comments also be provided in hard-copy form. EPA also will accept comments and data on disks in the aforementioned file formats. Electronic comments received on this notice can be filed online at many Federal Depository Libraries. No confidential business information (CBI) should be sent by email.

III. Supporting Documentation

The proposed rule is supported by a number of documents including the Technical Development Document for Proposed Effluent Limitations Guidelines and Standards for Oil and Gas Extraction (TDD), Document No. EPA-821-R-15-003 (DCN SGE00704). This and other supporting documents are available in the public record for this proposed rule and on EPA's website at http://water.epa.gov/scitech/wastetech/guide/oilandgas/unconv.cfm.

IV. Overview

This preamble describes the reasons for the proposed rule; the legal authority for the proposed rule; a summary of the options considered for the proposal; background information, including terms, acronyms, and abbreviations used in this document; and the technical and economic methodologies used by the Agency to develop the proposed rule. In addition, this preamble also solicits comment and data from the public.

V. Legal Authority

EPA proposes this regulation under the authorities of sections 101, 301, 304, 306, 307, 308, and 501 of the CWA, 33 U.S.C. 1251, 1311, 1314, 1316, 1317, 1318, 1324, and 1361.

VI. Purpose and Summary of Proposed Rule

A. Purpose of the Regulatory Action

Responsible development of America's oil and gas resources offers important economic, energy security, and environmental benefits. EPA is working with states and other stakeholders to understand and address potential impacts of hydraulic fracturing, an important process involved in producing unconventional oil and natural gas, so the public has confidence that oil and natural gas production will proceed in a safe and responsible manner.[1] EPA is moving forward with several initiatives to provide regulatory clarity with respect to existing laws and using existing authorities where appropriate to enhance human health and environmental safeguards. This proposed rule would fill a gap in existing federal wastewater regulations to ensure that the current practice of not sending wastewater discharges from this sector to POTWs continues into the future. This proposed rule does not, however, address the practice of underground injection of wastewater discharges from this sector since such activity is not subject to the CWA but rather the Safe Drinking Water Act (SDWA) (see TDD Chapter A.3).

Recent advances in the well completion process, combining hydraulic fracturing and horizontal drilling, have made extraction of oil and natural gas from *low permeability*, *low porosity* geologic formations (referred to hereafter as unconventional oil and gas (UOG) resources) more technologically and economically feasible than it had been. As a result, according to the U.S. Department of Energy (DOE), in 2012, U.S. crude oil and natural gas production reached their highest levels in more than 15 and 30 years, respectively (DCN SGE00989). DOE projects natural gas production in the U.S. will likely increase by 56 percent by 2040, compared to 2012 production levels (DCN SGE00989). Similarly, DOE projects that by 2019, crude oil production in the United States (U.S.) will increase by 48 percent compared to 2012 production levels (DCN SGE00989).

[1] For more information on EPA's continued engagement with states and other stakeholders, see: http://www2.epa.gov/hydraulicfracturing.

Hydraulic fracturing is used to extract oil and natural gas from highly impermeable rock formations, such as shale rock, by injecting fracturing fluids at high pressures to create a network of fissures in the rock formations and give the oil and/or natural gas a pathway to travel to the well for extraction. Pressure within the low permeability, low porosity geologic formations forces wastewaters, as well as oil and/or gas, to the surface. In this proposed rulemaking, oil and gas extraction includes production, field exploration, drilling, well completion, and/or well treatment; wastewater sources associated with these activities in low permeability, low porosity formations are collectively referred to as UOG extraction wastewater.

Direct discharges of oil and gas extraction wastewater pollutants from onshore oil and gas resources, including UOG resources, to waters of the U.S. have been regulated since 1979 under the existing Oil and Gas Effluent Limitations Guidelines and Standards (ELGs) (40 CFR part 435), the majority of which fall under subpart C, the Onshore Subcategory. The limitations for direct dischargers in the Onshore Subcategory represent Best Practicable Control Technology Currently Available (BPT). Based on the availability and economic practicability of underground injection technologies, the BPT-based limitations for direct dischargers require zero discharge of pollutants to waters of the U.S. However, there are currently no requirements in subpart C that apply to onshore oil and gas extraction facilities that are "indirect dischargers," *i.e.*, those that send their discharges to POTWs (municipal wastewater treatment facilities) which treat the water before discharging it to waters of the U.S.

UOG extraction wastewater can be generated in large quantities and contains constituents that are potentially harmful to human health and the environment.

Wastewater from UOG wells often contains high concentrations of total dissolved solids (TDS) (salt content). The wastewater can also contain various organic chemicals, inorganic chemicals, metals, and naturally-occurring radioactive materials (referred to as technologically enhanced naturally occurring radioactive material or TENORM)[2]. This potentially harmful wastewater creates a need for appropriate wastewater management infrastructure and management practices. Historically, operators primarily managed their wastewater via underground injection (where available). Where UOG wells were drilled in areas with limited underground injection wells, and/or there was a lack of wastewater management alternatives, it became more common for operators to look to public and private wastewater treatment facilities to manage their wastewater.

POTWs collect wastewater from homes, commercial buildings, and industrial facilities and pipe it to their sewage treatment plant. In some cases, industrial dischargers can haul wastewater to the treatment plant by tanker truck. The industrial wastewater, commingled with domestic wastewater, is treated by the POTW and discharged to a receiving waterbody. However, most POTWs are designed primarily to treat municipally generated, not industrial, wastewater. They typically provide at least secondary level treatment and, thus, are designed to remove suspended solids and organic material using biological treatment. As mentioned previously, wastewater from UOG extraction can contain high concentrations of TDS, radioactive elements, metals, chlorides, sulfates, and

[2] Naturally occurring radioactive materials that have been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction, or water processing is referred to as technologically enhanced naturally occurring radioactive material (TENORM). "Technologically enhanced" means that the radiological, physical, and chemical properties of the radioactive material have been altered by having been processed, or beneficiated, or disturbed in a way that increases the potential for human and/or environmental exposures. (See EPA 402-r-08-005-v2)

other dissolved inorganic constituents that POTWs are not designed to remove. Because they are not typical of POTW influent wastewater, some UOG extraction wastewater constituents can be discharged, untreated, from the POTW to the receiving stream; 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.

Under section 307(b) of the CWA, there are general and specific prohibitions on the discharge to POTWs of pollutants in specified circumstances in order to prevent "pass through" or "interference." Pass through is defined as whenever the introduction of pollutants from a user will result in a discharge that causes or contributes to a violation of any requirement of the POTW permit. See 40 CFR 403.3(p). Interference means a discharge that, among other things, inhibits or disrupts the POTW or prevents biosolids use consistent with the POTW's chosen method of disposal. See 40 CFR 403.3(k). These general and specific prohibitions must be implemented through local limits established by POTWs in certain cases. See 40 CFR 403.5(c). POTWs with approved pretreatment programs must develop and enforce local limits to implement the general prohibitions on user discharges that pass through or interfere with the POTW or discharges to the POTW prohibited under the specific prohibitions in 40 CFR 403.5(b). In the case of POTWs not required to develop a pretreatment program, the POTWs must develop local limits where there is interference or pass through and the limits are necessary to ensure compliance with the POTW's National Pollutant Discharge Elimination System (NPDES) permit or biosolids use.

Under section 307(b) of the CWA, EPA is authorized to establish nationally applicable pretreatment standards for industrial categories that discharge indirectly (*i.e.*, requirements for an industrial discharge category that sends its wastewater to any POTW) for key pollutants, such as TDS and its constituents, not susceptible to treatment by POTWs or for pollutants that would interfere with the operation of POTWs. Generally, EPA designs nationally applicable pretreatment standards for categories of industry (also referred to as categorical pretreatment standards) to ensure that wastewaters from direct and indirect industrial dischargers are subject to similar levels of treatment. EPA, in its discretion under section 304(g) of the Act, periodically evaluates indirect dischargers not subject to categorical pretreatment standards to identify potential candidates for new pretreatment standards. To date, EPA has not established nationally applicable pretreatment standards for the onshore oil and gas extraction point source subcategory.

To legally discharge wastewater, the POTW must have an NPDES permit that limits the type and quantity of pollutants that it can discharge. Discharges from POTWs are subject to the secondary treatment effluent limitations at 40 CFR part 133, which address certain conventional pollutants but do not address the main parameters of concern in UOG extraction wastewater (*e.g.*, TDS, chloride, radionuclides, etc.). POTWs are also subject to water quality-based effluent limitations (WQBELs) where necessary to protect state water quality standards, as required under CWA section 301(b)(1)(C).

It is currently uncommon for POTWs to establish local limits for some of the parameters of concern identified for this proposed rulemaking. This is due to a number of factors, including lack of sufficient information regarding pollutants in the wastewater being sent to POTWs; lack of national water quality recommendations for key pollutants, such as TDS; and lack of state water quality criteria for such key pollutants in some states, all of which can create significant informational hurdles to including appropriate WQBELs in POTW permits. Where a POTW's permit does not contain a WQBEL for all of the constituents of concern in the wastewater being sent to POTWs, it is difficult to demonstrate pass through of industrial pollutants (because "pass through" here means making the POTW exceed its permit limits), and thus difficult for POTWs to establish local limits to implement the general prohibition in the pretreatment regulations. See Section XV. for additional information.

As a result of the gap in federal CWA regulations, increases in onshore oil and gas extraction from UOG resources and the related generation of wastewater requiring management, concerns over the level of treatment provided by public wastewater treatment facilities, as well as potential interference with treatment processes, and concerns over water quality and aquatic life impacts that can result from inadequate treatment, EPA proposes technology-based categorical pretreatment standards under the CWA for discharges of pollutants into POTWs from existing and new onshore UOG extraction facilities in subpart C of 40 CFR part 435. Consistent with existing BPT-based requirements for direct dischargers in this subcategory, EPA proposes pretreatment standards for existing and new sources (PSES and PSNS, respectively) that would prohibit the indirect discharge of wastewater pollutants associated with onshore UOG extraction facilities.

Based on the information reviewed as part of this proposed rulemaking, this proposed prohibition reflects current industry practice. EPA has not identified any existing onshore UOG extraction facilities that currently discharge UOG extraction wastewater to POTWs. However, because onshore unconventional oil and gas extraction facilities have discharged to POTWs in the past, and because the potential remains that some facilities can consider discharging to POTWs in the future, EPA proposes this rule.

B. Summary of the Proposed Rule

EPA proposes pretreatment standards for existing and new sources (PSES and PSNS, respectively) that would prohibit the indirect discharge of wastewater pollutants associated with onshore UOG extraction facilities. EPA is defining UOG extraction wastewater as sources of wastewater pollutants associated with production, field exploration, drilling, well completion, or well treatment for unconventional oil and gas extraction (*e.g.*, produced water (which includes formation water, injection water, and any chemicals added downhole or during the oil/water separation process); drilling muds; drill cuttings; produced sand). According to sources surveyed by EPA (see Section IX), there are no known discharges to POTWs from UOG extraction at the time of this proposal. UOG extraction wastewater is typically managed through disposal via underground injection wells, reuse in subsequent fracturing jobs, or transfer to a privately owned wastewater treatment facility (see Section XII.E). EPA proposes PSES and PSNS that would require zero discharge of pollutants and be effective on the effective date of this rule

EPA does not propose pretreatment standards for wastewater pollutants associated with conventional oil and gas extraction facilities at this time (see Section XIV). EPA proposes to reserve such standards to a future rulemaking, if appropriate.

C. Summary of Costs and Benefits

Because the data reviewed by EPA show that the UOG extraction industry is not currently managing wastewaters by sending them to POTWs, the proposed rule causes no incremental change to current industry practice that EPA measured as compliance costs or monetized benefits.

Still, EPA has considered that while states, localities, and POTWs are not currently approving these wastewaters for acceptance at POTWs, some POTWs continue to receive requests to accept UOG extraction wastewater (DCN SGE00742; DCN SGE00743; DCN SGE00762). This proposed rule would provide regulatory certainty and would eliminate the burden on POTWs to analyze such requests.

The proposed rule would also eliminate the need to develop requirements in states where UOG extraction is not currently occurring, but is likely to occur in the future. There are few states where existing regulations address UOG extraction wastewater discharges to POTWs (see Section VIII.D. and TDD Chapter A.2.). While EPA knows there will likely be some reduction in state and POTW staff time and resources, EPA did not attempt to estimate, quantitatively, monetary savings associated with the reduced burden to states and localities that would result from this proposed rule.

Most POTWs are not able to sufficiently treat TDS and many other pollutants in UOG extraction wastewater, and thus this proposed rule would potentially prevent elevated TDS and the presence of other pollutants in POTW effluent. Prevention of the discharge of TDS accomplished by the proposed rule would further protect water quality because national water quality criteria recommendations have not yet been established for many constituents of TDS.

The proposed rule could impose some costs on industry if discharging wastewaters to POTWs becomes economically attractive to UOG operations relative to other management options such as reuse or disposal via underground injection wells in the future. EPA did not estimate these potential compliance costs or environmental benefits because of the uncertainty about future demand for POTWs to accept UOG extraction wastewaters and the associated incremental costs or benefits.

VII. Solicitation of Data and Comments

EPA solicits comments on the proposed rule, including EPA's rationale as described in this preamble. EPA seeks comments on issues specifically identified in this document as well as any other issues that are not specifically addressed in this document. Comments are most helpful when accompanied by specific examples and supporting data. Specifically, EPA solicits information and data on the following topics.

1. EPA's proposed definitions of UOG and UOG extraction wastewater and specifically whether the proposed definition of unconventional oil and gas is sufficiently clear to enable oil and gas extraction operators and/or pretreatment authorities to determine whether specific wastewaters are from conventional or unconventional sources. See Section XII.

2. Whether or not there are any existing onshore UOG extraction facilities that currently discharge UOG extraction wastewater to POTWs in the U.S. See Section

XII.E.4. If existing discharges to POTWs are identified, EPA requests comment on whether or not the proposed effective date remains appropriate. See Section XVII.

3. Costs and benefits to POTWs, states, and localities associated with the proposed rule. See Section VI.C.

4. Volumes of, and pollutants and concentrations in, wastewater generated from UOG extraction. See Section XII.

5. The nature and frequency of requests received by POTWs to accept UOG extraction wastewater, and the likelihood that such requests will continue to be submitted in the future. EPA is particularly interested in hearing from POTWs and states on this matter. See Section VI.C. and Section XIV.A.2.

6. Volumes of, and pollutants and concentrations in, wastewater generated from conventional oil and gas extraction. See Section XIV.A.2.c.

7. The prevalence of conventional oil and gas wastewater discharges to POTWs, including information on any pretreatment that could be applied, geologic formations the gas or oil is extracted from, and locations within the U.S. See Section XII. and Section XIV.A.2.

8. Removal and "pass through" of UOG extraction wastewater pollutants at POTWs. See Section XIV. and Section XII.E.4.

9. The environmental impacts of UOG extraction wastewater discharges to POTWs. See Section XV.

VIII. Background

A. Clean Water Act

Congress passed the Federal Water Pollution Control Act Amendments of 1972, also known as the CWA, to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. 1251(a). The CWA establishes a comprehensive program for protecting our nation's waters. Among its core provisions, the CWA prohibits the discharge of pollutants from a point source to waters of the U.S., except as authorized under the CWA. Under section 402 of the CWA, discharges can be authorized through a NPDES permit. The CWA establishes a two-pronged approach for these permits, technology-based controls that establish the floor of performance for all dischargers, and water quality-based limits where the technology-based limits are insufficient for the discharge to meet applicable water quality standards. To serve as the basis for the technology-based controls, the CWA authorizes EPA to establish national technology-based effluent limitations guidelines and new source performance standards for discharges from different categories of point sources, such as industrial, commercial, and public sources, that discharge directly into waters of the U.S.

The CWA also authorizes EPA to promulgate nationally applicable pretreatment standards that restrict pollutant discharges from facilities that discharge pollutants indirectly, by sending wastewater to POTWs, as outlined in sections 307(b) and (c) and 33 U.S.C. 1317(b) and (c). Specifically, the CWA authorizes that EPA establish pretreatment standards for those pollutants in wastewater from indirect dischargers that EPA determines are not susceptible to treatment by a POTW or which would interfere with POTW operations. Pretreatment standards must be established to prevent the discharge of any pollutant that can pass through, interfere with, or are otherwise incompatible with POTW operations. CWA sections 307(b) and (c). The legislative history of the 1977 CWA amendments explains that pretreatment standards are technology-based and analogous to BAT effluent limitations for the removal of toxic pollutants. As further explained in the legislative history, the combination of pretreatment and treatment by the POTW is intended to achieve the level of treatment that would be required if the industrial source were making a direct discharge. Conf. Rep. No. 95-830, at 87 (1977), reprinted in U.S. Congress. Senate. Committee on Public Works (1978), A Legislative History of the CWA of 1977, Serial No. 95-14 at 271 (1978).

Direct dischargers (those discharging directly to surface waters) must comply with effluent limitations in NPDES permits. Technology-based effluent limitations in NPDES permits for direct dischargers are derived from effluent limitations guidelines (CWA sections 301 and 304) and new source performance standards (CWA section 306) promulgated by EPA, or based on best professional judgment (BPJ) where EPA has not promulgated an applicable effluent guideline or new source performance standard (CWA section 402(a)(1)(B) and 40 CFR 125.3). Additional limitations based on water quality standards are also required to be included in the permit where necessary to meet water quality standards. CWA section 301(b)(1)(C). The effluent guidelines and new source performance standards are established by regulation for categories of industrial dischargers and are based on the degree of control that can be achieved using various levels of pollution control technology, as specified in the Act.

EPA promulgates national effluent guidelines and new source performance standards for major industrial categories for three classes of pollutants: (1) Conventional pollutants (total suspended solids, oil and grease, biochemical oxygen demand (BOD_5), fecal coliform, and pH), as outlined in CWA section 304(a)(4) and 40 CFR 401.16; (2) toxic pollutants (*e.g.*, metals such as arsenic, mercury, selenium, and chromium; and organic pollutants such as benzene, benzo-a-pyrene, phenol, and naphthalene), as outlined in section 307(a) of the Act, 40 CFR 401.15 and 40 CFR part 423, appendix A; and (3) nonconventional pollutants, which are those pollutants that are not categorized as conventional or toxic (*e.g.*, ammonia-N, phosphorus, and TDS).

B. Effluent Limitations Guidelines and Standards Program

EPA develops ELGs that are technology-based regulations for specific categories of dischargers. EPA bases these regulations on the performance of control and treatment technologies. The legislative history of CWA section 304(b), which is the heart of the effluent guidelines program, describes the need to press toward higher levels of control through research and development of new processes, modifications, replacement of obsolete plants and processes, and other improvements in technology, taking into account the cost of controls. Congress has also stated that EPA need not consider water quality impacts on individual water bodies as the guidelines are developed; see Statement of Senator Muskie (October 4, 1972), *reprinted in* U.S. Senate Committee on Public Works, Legislative History of the Water Pollution Control Act Amendments of 1972, Serial No. 93-1, at 170).

There are four types of standards applicable to direct dischargers (facilities that discharge directly to surface waters), and two types of standards applicable to indirect dischargers (facilities that discharge to POTWs), described in detail below. Subsections 1 through 4 describe standards for direct discharges and subsection 5 describes standards for indirect discharges.

1. Best Practicable Control Technology Currently Available (BPT)

Traditionally, EPA defines BPT effluent limitations based on the average of the best performances of facilities within the industry, grouped to reflect various ages, sizes, processes, or other common characteristics. BPT effluent limitations control conventional, toxic, and nonconventional pollutants. In specifying BPT, EPA looks at a number of factors. EPA first considers the cost of achieving effluent reductions in relation to the effluent reduction benefits. The Agency also considers the age of equipment and facilities, the processes employed, engineering aspects of the control technologies, any required process changes, non-water quality environmental impacts (including energy requirements), and such other factors as the Administrator deems appropriate. See CWA section 304(b)(1)(B). If, however, existing performance is uniformly inadequate, EPA can establish limitations based on higher levels of control than what is currently in place in an industrial category, when based on an Agency determination that the technology is available in another category or subcategory, and can be practically applied.

2. Best Conventional Pollutant Control Technology (BCT)

The 1977 amendments to the CWA require EPA to identify additional levels of effluent reduction for conventional pollutants associated with BCT technology for discharges from existing industrial point sources. In addition to other factors specified in section 304(b)(4)(B), the CWA requires that EPA establish BCT limitations after consideration of a two-part “cost reasonableness” test. EPA explained its methodology for the development of BCT limitations in July 9, 1986 (51 Fed. Reg. 24974). Section 304(a)(4) designates the following as conventional pollutants: BOD_5, total suspended solids (TSS), fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated oil and grease as an additional conventional pollutant on July 30, 1979 (44 Fed. Reg. 44501; 40 CFR part 401.16).

3. Best Available Technology Economically Achievable (BAT)

BAT represents the second level of stringency for controlling direct discharge of toxic and nonconventional pollutants. In general, BAT-based effluent guidelines and new source performance standards represent the best available economically achievable performance of facilities in the industrial subcategory or category. Following the statutory language, EPA considers the technological availability and the economic achievability in determining what level of control represents BAT. CWA section 301(b)(2)(A). Other statutory factors that EPA considers in assessing BAT are the cost of achieving BAT effluent reductions, the age of equipment and facilities involved, the process employed, potential process changes, and non-water quality environmental impacts, including energy requirements and such other factors as the Administrator deems appropriate. CWA section 304(b)(2)(B). The Agency retains considerable discretion in assigning the weight to be accorded these factors. *Weyerhaeuser Co. v. Costle*, 590 F.2d 1011, 1045 (D.C. Cir. 1978).

4. Best Available Demonstrated Control Technology (BADCT)/New Source Performance Standards (NSPS)

NSPS reflect effluent reductions that are achievable based on the best available demonstrated control technology (BADCT). Owners of new facilities have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. As a result, NSPS should represent the most stringent controls attainable through the application of the BADCT for all pollutants (that is, conventional, nonconventional, and toxic pollutants). In establishing NSPS, EPA is directed to take into consideration the cost of achieving the effluent reduction and any non-water quality environmental impacts and energy requirements. CWA section 306(b)(1)(B).

5. Pretreatment Standards for Existing Sources (PSES) and New Sources (PSNS)

As discussed above, section 307(b) of the Act calls for EPA to issue pretreatment standards for discharges of pollutants from existing sources to POTWs. Section 307(c) of the Act calls for EPA to promulgate pretreatment standards for new sources (PSNS). Both standards are designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs. Categorical pretreatment standards for existing sources are technology-based and are analogous to BPT and BAT effluent limitations guidelines, and thus the Agency typically considers the same factors in promulgating PSES as it considers in promulgating BAT. See *Natural Resources Defense Council v. EPA,* 790 F.2d 289, 292 (3rd Cir. 1986). Similarly, in establishing pretreatment standards for new sources, the Agency typically considers the same factors in promulgating PSNS as it considers in promulgating NSPS (BADCT).

C. Oil and Gas Extraction Effluent Guidelines Rulemaking History

EPA promulgated the first Oil and Gas Extraction ELGs (40 CFR part 435) in 1979, and substantially amended the regulation in 1993 (Offshore), 1996 (Coastal), and 2001 (Synthetic-based drilling fluids). The Oil and Gas Extraction industry is subcategorized in 40 CFR part 435 as follows: (1) subpart A: Offshore; (2) subpart C: Onshore; (3) subpart D: Coastal; (4) subpart E: Agricultural and Wildlife Water Use; and (5) subpart F: Stripper.

The existing subpart C regulation covers wastewater discharges from field exploration, drilling, production, well treatment, and well completion activities in the oil and gas industry. Although unconventional oil and gas resources occur in offshore and coastal regions, recent development of UOG resources in the U.S. has occurred primarily onshore in regions to which the regulations in subpart C (Onshore) and subpart E (Agricultural and Wildlife Water Use) apply and thus, the gap in onshore regulations is the focus of this proposed rulemaking effort. For this reason, only the regulations that apply to onshore oil and gas extraction are described in more detail here.

1. Subpart C: Onshore

Subpart C applies to facilities engaged in the production, field exploration, drilling, well completion, and well treatment in the oil and gas extraction industry which are located landward of the inner boundary of the territorial seas – and which are not included in the definition of other subparts – including subpart D (Coastal). The regulations at 40 CFR 435.32 specify the following for BPT: there shall be no discharge of waste water pollutants into navigable waters from any source associated with production, field exploration, drilling, well completion, or well treatment (*i.e.*, produced water, drilling muds, drill cuttings, and produced sand). The existing regulations do not include national categorical pretreatment standards for discharges to POTWs. The existing oil and gas extraction ELGs did not establish requirements that would apply to privately-owned wastewater treatment facilities that accept oil and gas extraction wastewaters but that are not engaged in production, field exploration, drilling, well completion, or well treatment. Discharges from such facilities are not subject to 40 CFR part 435, but rather are subject to requirements in 40 CFR part 437, the Centralized Waste Treatment Category.

2. Subpart E: Agricultural and Wildlife Use

Subpart E applies to onshore facilities located in the continental U.S. and west of the 98th meridian for which the produced water has a use in agriculture or wildlife propagation when discharged into navigable waters. Definitions in 40 CFR 435.51(c) explain that the term “use in agricultural or wildlife propagation” means that (1) the produced water is of good enough quality to be used for wildlife or livestock watering or other agricultural uses; and (2) the produced water is actually put to such use during periods of discharge. The regulations at 40 CFR 435.52 specify that the only allowable discharge is produced water, with an oil and grease concentration not exceeding 35 milligrams per liter (mg/L). The BPT regulations prohibit the discharge of waste pollutants into navigable waters from any source (other than produced water) associated with production, field exploration, drilling, well completion, or well treatment (*i.e.*, drilling muds, drill cuttings, produced sands).

D. State Pretreatment Requirements that Apply to UOG Extraction Wastewater

In addition to applicable federal requirements, some states regulate the management, storage, and disposal of UOG extraction wastewater, including regulations concerning pollutant discharges to POTWs from oil and gas extraction facilities. In addition to pretreatment requirements, some states have indirectly addressed the issue of pollutant discharges to POTWs by limiting the management and disposal options available for operators to use.

During initial development of Marcellus shale gas resources, some operators managed UOG wastewater by transfer to POTWs. EPA did not identify other areas in the U.S. where POTWs routinely accepted UOG extraction wastewaters. Refer to TDD Chapter A.2 which summarizes how Pennsylvania, Ohio, and West Virginia responded to UOG extraction wastewater discharges into their POTWs. EPA did not identify any state level requirements that require zero discharges of pollutants from UOG operations to POTWs in the same manner as the proposed rule.

E. Related Federal Requirements in the Safe Drinking Water Act

As required by the SDWA section 1421, EPA has promulgated regulations to protect underground sources of drinking water through Underground Injection Control (UIC) programs that regulate the injection of fluids underground. These regulations are found at 40 CFR parts 144–148, and specifically prohibit any underground injection not authorized by UIC permit. 40 CFR 144.11. The regulations classify underground injection into six classes; wells that inject fluids brought to the surface in connection with oil and gas production are classified as Class II UIC wells. Thus, onshore oil and gas extraction facilities that seek to meet the zero discharge requirements of the existing

ELGs or proposed pretreatment standard through underground injection of wastewater must obtain a Class II UIC permit for such disposal.

IX. Summary of Data Collection

In developing the proposed rule, EPA considered information collected through site visits and telephone contacts with UOG facility operators, facilities that treat and/or dispose of UOG extraction wastewater, and wastewater management equipment vendors. EPA also collected information through outreach to stakeholders including industry organizations, environmental organizations, and state regulators. EPA conducted an extensive review of published information and participated in industry conferences and webinars. The following describes EPA's data collection activities that support the proposed rule.

A. Site Visits and Contacts with Treatment Facilities and Vendors

EPA conducted seven site visits between May, 2012 and September, 2013 to UOG extraction companies and UOG extraction wastewater treatment facilities. The purpose of these visits was to collect information about facility operations, wastewater generation and management practices, and wastewater treatment and reuse. Six of the seven visits were to facilities in Pennsylvania, and one was in Arkansas, however, information collected often covered operations beyond just those visited during the site visits, at times including company operations in many UOG formations across the U.S. In addition to site visits, EPA conducted 11 telephone conferences or meetings with UOG operators and facilities that treat and/or dispose of UOG extraction wastewater. EPA collected detailed information from the facilities visited and contacted, such as information about the operations associated with wastewater generation, wastewater treatment, and reuse. EPA also contacted 11 vendors of equipment and processes used to manage and treat UOG extraction wastewater. EPA prepared site visit and telephone meeting reports, and telephone call reports summarizing the collected information. EPA has included in the public record site visit reports, meeting reports, and telephone contact reports that contain all information collected for which facilities have not asserted a claim of CBI.

B. Meetings with Stakeholder Organizations

Since announcing initiation of this proposed rulemaking activity, EPA has actively reached out to interested stakeholders to solicit input from well operators, industry trade associations, interested regulatory authorities, technology vendors, and environmental organizations. Stakeholder involvement in the regulatory development process is essential to the success of this effort. EPA will continue to engage with the affected regulated sector and concerned stakeholders throughout the rulemaking process.

1. Stakeholder Organizations

In addition to the site visit related activities described above, EPA participated in multiple meetings with industry stakeholders, their representatives, and/or their members, including America’s Natural Gas Alliance (ANGA), American Petroleum Institute (API) and the Independent Petroleum Association of America (IPAA). The purpose of the meetings was to discuss EPA’s thinking concerning a pretreatment standard for the UOG extraction industry, to better understand industry wastewater management practices, and to gather information to inform its proposed rulemaking (see DCN SGE00967).

EPA participated in conference calls with the environmental stakeholders, Environmental Defense Fund (EDF) and Clean Water Action. The purpose of these meetings was to explain EPA's thinking about the standard under development and learn about the perspectives of these stakeholders regarding wastewater management in the UOG extraction industry.

EPA participated in a two conference calls with the Center for Sustainable Shale Development (CSSD), a collaborative group made up of environmental organizations, philanthropic foundations, and energy companies from the Appalachian Basin. The purpose of these calls was to learn about the performance standards under development by the CSSD for sustainable shale gas development, based on an "independent, third-party evaluation process."

2. State Stakeholders

In an effort to improve future implementation of any UOG regulation, EPA initiated an EPA–State implementation pilot project coordinated by the Environmental Council of States (ECOS) and the Association of Clean Water Administrators (ACWA) to draw on experience of state agency experts. Through this pilot project, EPA has been able to more thoroughly consider the strengths and weaknesses of different approaches in order to select one that produces environmental results while more fully considering implementation burden. This pilot effort with the states has also been an opportunity to hear ideas on how technology innovation can be fostered during both development and implementation of the regulation.

In addition to the state implementation pilot, EPA also reached out to EPA regional, as well as state, pretreatment coordinators. One way EPA did this was by participating in calls, where EPA staff learned about past or present discharges to POTWs from UOG operations. See DCN SGE00742; DCN SGE00743.

C. Secondary Data Sources

EPA conducted an extensive search and review of published information about UOG development, wastewater generation and management practices, and wastewater treatment, disposal, and reuse. Because of the rapid developments in the UOG industry, in addition to reviewing published information, EPA participated in more than 10 industry conferences and webinars between March 2012 and June 2014. Presenters at these conferences provided information about current industry wastewater management practices. EPA also obtained information from EPA Regions and states. EPA Region 3 provided information about the development of the Marcellus shale gas industry and disposal of shale gas wastewater, including discharges to POTWs.

D. Drilling Info Desktop® Data Set

EPA used a propriety database of all oil and gas wells in the U.S., called DI Desktop®, obtained from DrillingInfo. This comprehensive database includes information such as well API number, operator name, basin (*e.g.*, Western Gulf), formation (*e.g.*, Eagle Ford), well depth, drilling type (horizontal, directional, vertical), and completion date. It also includes annual oil, gas, and water production for each well. EPA primarily used this database to quantify and identify locations of existing UOG wells, quantify wastewater generation rates, and supplement geological information (*e.g.*, basin, formation) in other data sources.

E. EPA Hydraulic Fracturing Study

At the request of Congress, EPA's Office of Research and Development is conducting a study to better understand any potential impacts of hydraulic fracturing on drinking water resources. The scope of the research includes the full lifecycle of water in hydraulic fracturing, including wastewater management and disposal. In support of its study, EPA conducted a series of technical workshops, including, among others, a workshop on Wastewater Treatment and Related Modeling. In support of the proposed rule, EPA reviewed information collected in support of the Congressionally-mandated study and attended meetings, workshops, and roundtable discussions pertaining to water and wastewater management and treatment in the UOG extraction industry. See DCN SGE00063, DCN SGE00585, DCN SGE00604, DCN SGE00614, DCN SGE00616, DCN SGE00691, and DCN SGE00721.

X. Description of the Oil and Gas Industry

Oil and Gas Extraction is the exploration and production of crude oil and natural gas from wells. Refer to Section XII for additional background on unconventional gas resources, extraction processes, and wastewater generation. As explained previously, the scope of this proposed rulemaking is limited to pretreatment standards for wastewater generated from unconventional, rather than conventional, oil and gas extraction facilities. The description here provides a broader description of the oil and gas industry in order to provide the context in which the UOG industry lies.

A. *Economic Profile*

The major products of the Oil and Gas Extraction Industry are petroleum, natural gas, and natural gas liquids.[3] Domestic consumption of crude oil and petroleum products is met by a combination of domestic production and imports. Like oil consumption, natural gas consumption is met both by domestic production and imports of natural gas, although imports contribute a much lower share of total domestic consumption for natural gas than for oil. Domestic consumption of natural gas rose throughout the 1980s and 1990s due to low prices relative to prices for oil products. This led to investments in infrastructure for natural gas, especially electric generation facilities (DCN SGE00809). According to 2012 Energy Information Administration (EIA) data, 8 percent of the gross domestic supply of natural gas (from domestic production and imports) was consumed in the natural gas production and delivery process, as lease and plant fuel (5 percent of total) and fuel for pipeline and distribution services (3 percent of total) (DCN SGE00906). The remaining 92 percent of gross supply is available to natural gas consumers, and was delivered to the following sectors: electrical power (36 percent of total), industrial (28 percent of total), residential (16 percent of total), commercial (11 percent of total), and vehicle fuel (0.1 percent of total) (DCN SGE00906).

Natural gas can be produced both from conventional natural gas deposits and unconventional deposits. Natural gas, and especially unconventional natural gas, has become increasingly significant to the U.S. energy economy. The rising importance of

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[3] Natural gas can include “natural gas liquids” (NGLs), components that are liquid at ambient temperature and pressure. NGLs are hydrocarbons—in the same family of molecules as natural gas and crude oil, composed exclusively of carbon and hydrogen. Ethane, propane, butane, isobutane, and pentane are all NGLs.

natural gas results, in part, from its lower air pollution characteristics compared to other fossil fuels; its substantial, and increasing, domestic supply; and the presence of a well-developed processing and transmission/distribution infrastructure in the U.S. (DCN SGE00010). Increased natural gas production from shale formations also has the potential to reduce U.S. dependence on energy-related imports.

Between 2000 and 2012, total marketed production of natural gas in the U.S. as a whole grew by another 25 percent, with an average annual growth rate of 0.8 percent (DCN SGE00908). The sharp rise in production of shale gas contributed to a lower price of natural gas, thereby increasing the gap between prices of gas and oil, which made oil a relatively more attractive option for producers. Beginning in 2005, the disparity between oil and natural gas prices started to grow as oil prices continued to rise while natural gas prices declined. Many firms that produce both gas and oil began to focus on acquisition of, and production from, liquids-rich formations over natural gas production (DCN SGE00817, DCN SGE00832).

Overall, domestic crude oil production steadily declined between 2000 and 2008, while steadily increasing after that. This shift towards liquids production is evident in the sharp rise in production from tight oil resources, including shale, beginning in 2008. From 2007 to 2013, the EIA estimated that tight oil production increased 10-fold, from 0.34 to 3.48 million barrels per day (DCN SGE00902). Future domestic demand for liquid fuels will depend on the future level of activities dependent on liquid fuels, such as transportation. Demand will also be affected by the fuel efficiency of the consumption technology. The transportation sector will continue to account for the largest share of total consumption despite its share of total consumption falling due to improvements in vehicle efficiency. The industrial sector is the only end-use sector likely to see an increase in consumption of petroleum and liquids (DCN SGE00913).

While oil and natural gas are often considered together, the way in which prices are set for each greatly differs. While the price of oil is set at the global level, natural gas prices for the U.S. tend to be set regionally. In recent years, the ratio of oil prices to natural gas prices has reached historically high levels (DCN SGE00547). While these two products have some commonalities in their uses, oil and gas are not perfect substitutes as they require different transportation and processing infrastructure, and have a number of differentiated uses.

EPA gathered information on the industry via the NAICS, which is a standard created by the U.S. Census for use in classifying business establishments within the U.S. economy. The industry category that would be affected by this proposed rule is Oil and Gas Extraction Industry (NAICS 21111). This industry has two subcategories: (1) Crude Petroleum and Natural Gas Extraction (NAICS 211111), which is made up of facilities that have wells with petroleum or natural gas or produce crude petroleum from surface shale or tar sands, and Natural Gas Liquid Extraction (NAICS 211112), which recover liquid hydrocarbons from oil and gas field gases and sulfur from natural gas.

B. Industry Structure and Economic Performance

According to data from the Statistics of U.S. Businesses (SUSB), in 2011 there were 6,528 firms under the overall oil and gas extraction sector. This reflects a total 2 percent growth from 2000 to 2011 and an average annual growth rate of 0.2 percent. The Crude Petroleum and Natural Gas Extraction segment contributed 6,523 (or 99%) firms to the total Oil and Gas Extraction sector, and the Natural Gas Liquid Extraction segment contributed 136 (less than 1%) firms to the overall sector. Although the Natural Gas Liquid Extraction segment is much smaller in numbers compared to the Crude Petroleum and Natural Gas Extraction segment, the total percent change in number of firms from 2000 to 2011 is much higher for natural gas liquids extraction at 62% as compared to 2% for crude petroleum and natural gas extraction. If the ratio of oil-to-natural gas prices remains high, there could be a shift towards drilling in liquids-rich shale formations, making this sector increasingly important to oil and gas extraction firms (DCN SGE00832; DCN SGE00807; DCN SGE00817; DCN SGE00921).

In 2011, 99% of the Oil and Gas Extraction Industry was estimated to be small businesses when using the Small Business Administration definition of a small business as having 500 or fewer employees. Average revenues for firms for the overall oil and gas extraction sector in 2007 were estimated at $54 million. This is an average revenue of $46 million per firm in the crude petroleum and natural gas extraction segment, and average revenue of $414 million per firm in the natural gas liquid extraction segment. The oil and gas extraction sector overall has an average of 18 employees per firm. Breaking it out per segment, the natural gas liquid extraction segment has an average of 74 employees per firm, whereas the crude petroleum and natural gas extraction segment shows an average of 17 employees per firm. See the Industry Profile (DCN SGE00932) for more information.

The oil market is a globally integrated market with multiple supply sources that are connected to multiple markets. Because of the Organization of Petroleum Exporting Countries' (OPEC's) high accounting of global oil reserves, OPEC is able to place producer quotas on members in an effort to manage world oil prices. Other oil producers have relatively smaller reserves and have no influence, individually, on price (DCN SGE00854). On the other hand, global oil prices are also greatly influenced by global demand for oil, with the largest sources of demand being the U.S. and China (DCN SGE00854). While the U.S. is also one of the largest crude oil producers, it remains a major importer (demander) of oil; as a result the level of U.S. imports can significantly influence oil prices. The recent upsurge in U.S. oil production, largely from tight and shale oil resources, with a consequent decline in U.S. imports, has exerted downward pressure on international oil prices.

In North America, specifically within the U.S., there is a relatively mature, integrated natural gas market with a robust spot market for the natural gas commodity. Essentially, the spot market is the daily market, where natural gas is bought and sold for immediate delivery. For understanding the price of natural gas on a specific day, the spot market price is most informative. In U.S. natural gas markets, natural gas spot prices are determined by overall supply and demand (DCN SGE00547).

Large volume consumers of natural gas, mainly industrial consumers and electricity generators, generally have the ability to switch between oil and natural gas. When the price of gas is low relative to oil, these consumers could switch to gas, increasing demand for natural gas and increasing gas prices. Alternatively, when gas prices are high, demand could shift in the opposite direction causing a relative decrease in natural gas prices (DCN SGE00921).

C. Financial Performance

EPA reviewed financial performance of UOG extraction firms and other oil and gas firms. EPA found no deterioration in financial performance and conditions for UOG firms over the previous decade, and this suggests that UOG firms are well-positioned for continued investment in UOG exploration and development. The strong growth in revenue and total capital outlays by the UOG firms during the latter part of the last decade – which coincides with the growth in UOG exploration and production activity – underscores the economic opportunity provided by the emerging UOG resource and the industry's commitment to investing and producing UOG for the foreseeable future. See the Industry Profile (DCN SGE00932) for more information.

XI. Scope

Through the proposed rule, EPA is not reopening the regulatory requirements applicable to direct dischargers. Rather, EPA would amend subpart C only to add requirements for indirect dischargers where there currently are none: specifically, pretreatment standards for facilities engaged in oil and gas extraction from UOG sources that send their discharges directly to POTWs. For purposes of this proposed rulemaking, EPA proposes to define "unconventional oil and gas (UOG)" as "crude oil and natural gas[4] produced by a well drilled into a low porosity, low permeability formation (including, but not limited to, shale gas, shale oil, tight gas, tight oil)." As a point of clarification, although coalbed methane would fit this definition, the proposed pretreatment standards would not apply to pollutant discharges to POTWs associated

[4] Natural gas can include "natural gas liquids," components that are liquid at ambient temperature and pressure.

with coalbed methane extraction. EPA notes that the requirements in the existing effluent guidelines for direct dischargers also do not apply to coalbed methane extraction, as this industry did not exist at the time that the effluent guidelines were developed and was not considered by the Agency in establishing the effluent guidelines (DCN SGE00761). To reflect the fact that neither the proposed pretreatment standards nor the existing effluent guideline requirements apply to coalbed methane extraction, EPA is expressly reserving a separate unregulated subcategory for coalbed methane in the proposed rule. For information on coalbed methane, see http://water.epa.gov/scitech/wastetech/guide/oilandgas/cbm.cfm. The remainder of the information presented in this document is specific to the UOG resources subject to the proposed rule.

XII. Unconventional Oil and Gas Extraction: Resources, Process, and Wastewater

A. Unconventional Oil and Gas Extraction Resources

For purposes of the proposed rule, UOG consists of crude oil and natural gas[5] produced by wells drilled into formations with low porosity and low permeability. UOG resources include shale oil and gas, resources that were formed, and remain, in low permeability shale. UOG resources also include tight oil and gas, resources that were formed in a source rock and migrated into a reservoir rock such as sandstone, siltstones, or carbonates. The tight oil/gas reservoir rocks have permeability and porosity lower than reservoirs of conventional oil and gas resources but with permeability generally greater

[5] Natural gas can include "natural gas liquids," components that are liquid at ambient temperature and pressure.

than shale. As described above, while coalbed methane is sometimes referred to as an unconventional resource, the proposed rule does not apply to this industry.

B. Unconventional Oil and Gas Extraction Process

1. Well Drilling

Prior to the well development processes described in the following subsections, operators conduct exploration and obtain surface use agreements, mineral leases, and permits. These steps can take a few months to several years to complete. When completed, operators construct the well pad and begin the well development process, as described in the following subsections.

Drilling occurs in two phases: exploration and development. Exploration activities are those operations involving the drilling of wells to locate hydrocarbon bearing formations and to determine the size and production potential of hydrocarbon reserves. Development activities involve the drilling of production wells once a hydrocarbon reserve has been discovered and delineated.

Drilling for oil and gas is generally performed by rotary drilling methods, which involve the use of a circularly rotating drill bit that grinds through the earth's crust as it descends. Drilling fluids (muds) are injected down through the drill bit via a pipe that is connected to the bit, and serve to cool and lubricate the bit during drilling. Drilling fluids can be water or synthetic based. Synthetic-based drilling fluids are also referred to as non-aqueous drilling fluids. Air is also used in place of water or synthetic based drilling fluids for the vertical phase of wells. The rock chips that are generated as the bit drills through the earth are termed drill cuttings. The drilling fluid also serves to transport the drill cuttings back up to the surface through the space between the drill pipe and the well wall (this space is termed the annulus), in addition to controlling downhole pressure. As drilling progresses, pipes called "casing" are inserted into the well to line the well wall. Drilling continues until the hydrocarbon bearing formations are encountered.

In UOG resources, the crude oil and natural gas often occur continuously within a formation. As a result, UOG drilling often employs "horizontal drilling." Horizontal drilling involves a sequence of drilling steps: (1) vertical (described above) and (2) horizontal. In horizontal drilling, operators drill vertically down to a desired depth, about 500 feet above the target formation (called the "kickoff point"), and then gradually turn the drill approximately 90 degrees to continue drilling laterally continuously through the target formation. UOG wells are also drilled vertically or directionally,[6] depending on the characteristics of the formation. Directional drilling is a technique used to drill a wellbore at an angle off of the vertical to reach an end location not directly below the well pad; horizontal drilling is considered a type of directional drilling. In UOG well drilling, well depths range from approximately 1,000 to 13,500 feet deep (but the majority of wells are drilled between 6,000 and 12,000 feet), wells often have a long horizontal lateral which can vary in length between 1,000 and 5,000 feet, and it takes approximately 5 to 60 days to complete well drilling. See TDD, Chapter B.3.

2. Well Completion

Once the target formation has been reached, and a determination has been made as to whether or not the formation has commercial potential, the well is made ready for

[6] Shale oil and gas wells, are primarily drilled directionally (and specifically horizontally), while tight oil and gas wells are drilled vertically and directionally.

production by a process termed "well completion." Well completion involves cleaning the well to remove drilling fluids and debris, perforating the casing that lines the producing formation[7], inserting production tubing to transport the hydrocarbon fluids to the surface, installing the surface wellhead, stimulating the well, setting plugs in each stage, and eventually drilling the plugs out of the well and allowing fluids to return to the surface. During perforation, operators lower a perforation gun into the stage using a line wire. The perforation gun releases an explosive charge to create holes that penetrate approximately one foot into the formation rock in a radial fashion. These perforations create a starting point for the hydraulic fractures.

Since UOG resources are extracted from formations with low porosity and low permeability in which the natural reservoir and fluid characteristics do not permit the oil and/or natural gas to readily flow to the wellbore, hydraulic fracturing is often used to complete the well and extract UOG resources.[8] Although there are some vertical and directional UOG wells that are hydraulically fractured, existing literature indicates that the majority of UOG wells are horizontally drilled and hydraulically fractured. Therefore, the remainder of this discussion focuses on the hydraulic fracturing of horizontally drilled UOG wells; however, all drill types (including vertical and directional) would be covered by this proposed rule.

[7] In some instances, open-hole completions may be used, where the well is drilled into the top of the target formation and casing is set from the top of the formation to the surface. Open-hole well completions leave the bottom of the wellbore uncased.

[8] Hydraulic fracturing techniques are also often used to improve recovery from conventional oil and gas wells. However, the scope of this section is focused on UOG extraction, therefore, the application of this process to conventional wells is not further discussed here.

Hydraulic fracturing involves the injection of fracturing fluids (*e.g.*, mixtures of water, sand, and other additives) at high pressures into the well to create small fractures in the rock formation. The primary component of fracturing fluid is the base fluid into which proppant (*e.g.*, sand) and chemicals are added. Currently, the most common base fluid is water; however, other fluids such as liquid nitrogen and propane (LPG) are also used. Historically, base fluid consisted exclusively of freshwater, but as more wastewater is increasingly reused/recycled, base fluid can contain mixtures of fresh water blended with reused/recycled UOG extraction wastewater. Chemical additives, used to adjust the fracturing fluid properties, vary according to the formation, target resource (*e.g.,* shale oil), chemical composition of base fluid (*e.g.,* volume of reused/recycled wastewater in base fluid), and operator preference (DCN SGE00721; DCN SGE00070; DCN SGE00780; DCN SGE00781). Additives commonly include, among other things, acids (*e.g.,* hydrochloric acid), biocides (*e.g.*, glutaraldehyde), friction reducers (*e.g.*, ethylene glycol, petroleum distillate), and gelling agents (*e.g.*, guar gum, hydroxyethyl cellulose) (DCN SGE00721; DCN SGE00070; DCN SGE00780; DCN SGE00781). See TDD, Chapter C.1.

The amount of fracturing fluid required per well typically depends on the well trajectory (*e.g.*, vertical, horizontal), well length, and target resource (*e.g.*, shale oil). UOG wells require between 50,000 to over ten million gallons of fracturing fluid per well (DCN SGE00532; DCN SGE00556; DCN SGE00637.A3). Operators typically fracture a horizontal well in eight to 23 stages using between 250,000 and 420,000 gallons (6,000 and 10,000 barrels) of fracturing fluid per stage (DCN SGE00280). Literature reports that tight oil and gas wells typically require less fracturing fluid than shale oil and gas wells (DCN SGE00533).

Because laterals in horizontally drilled UOG wells are between 1,000 and 5,000 feet long, operators typically hydraulically fracture horizontal wells in stages to maintain the high pressures necessary to stimulate the well over the entire length. Stages are completed starting with the stage at the end of the wellbore and working back towards the wellhead.[9] Operators use anywhere between eight and 23 stages (DCN SGE00280). A fracturing crew can fracture two to three stages per day when operating 12 hours per day or four to five stages per day when operating 24 hours per day.[10] Consequently, a typical well can take between two and seven days to complete (DCN SGE00239; DCN SGE00090).

Once the stage is hydraulically fractured, a stage plug is inserted down the wellbore separating it from additional stages until all stages are completed. After all of the stages have been completed, the plugs are drilled out of the wellbore allowing the fracturing fluids and other fluids to return to the surface. At the wellhead, a combination of liquid (produced water), sand, oil, and/or gas are routed through phase separators that separate products from wastes.

A portion of produced water can return to the wellhead at this time; this waste stream is often referred to as "flowback" and consists of the portion of fracturing fluid injected into the wellbore that returns to the surface during initial well depressurization

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[9] The first stage is fractured with what is known as the pad fracture. The pad is the injection of high pressure water and chemical additives (no proppant) to create the initial fractures into the formation. After the pad is pumped down hole, proppant is introduced to the fracturing fluid for the additional stages.

[10] The hours per day depends on the operator, local ordinances, and weather.

often combined with formation water.[11] Higher volumes of water are generated in the beginning of the flowback process. Over time, flowback rates decrease as the well goes into the production phase. Operators typically store flowback in 500 barrel fracturing tanks onsite before treatment or transport offsite.[12] In addition to flowback, small quantities of oil and/or gas can be produced during the initial flowback process. The small quantities of produced gas could be flared or captured if the operator is using "green completions", which involves capturing the gas rather than flaring.[13]

The flowback period typically lasts from a few days to a few weeks before the production phase commences (DCN SGE00010; DCN SGE00011; DCN SGE00622; DCN SGE00592; DCN SGE00286). At some wells, the majority of fracturing fluid can be recovered within a few hours (DCN SGE00010; DCN SGE00011; DCN SGE00622; DCN SGE00592; DCN SGE00286). See TDD, Chapter B.3.

3. Production

After the initial flowback period, the well begins producing oil and/or gas; this next phase is referred to as the production phase. During the production phase, UOG wells produce oil and/or gas and generate long-term produced water. Long-term produced water, generated during the well production phase after the initial flowback process, consists primarily of formation water and continues to be produced throughout the

[11] Formation water is naturally occurring water contained in the reservoir rock pores.

[12] Fracturing tanks cannot be transported when they contain wastewater. Wastewater is typically transported via trucks with approximately 100 to 120 barrel capacities or via pipe (DCN SGE00635).

[13] On April 17, 2012, the U.S. EPA issued regulations under the Clean Air Act, requiring the natural gas industry to reduce air pollution by using green completions, or reduced emission completions. EPA identified a transition period until January 1, 2015 to allow operators to locate and install green completion equipment (40 CFR part 60 and 63).

lifetime of the well, though typically at much lower rates than flowback (DCN SGE00592). This long-term produced water is typically stored onsite in tanks or pits (DCN SGE00280; DCN SGE00275*;* DCN SGE00636) and is periodically trucked, or sometimes piped, offsite for treatment, reuse, or disposal. See TDD, Chapter B.3.

C. UOG Extraction Wastewater

UOG extraction wastewater, as EPA proposes to define it (see Section VII.B.) includes the following sources of wastewater pollutants[14]:

- Produced water – the water (brine) brought up from the hydrocarbon-bearing strata during the extraction of oil and gas. This can include formation water, injection water, and any chemicals added downhole or during the oil/water separation process. Based on the stage of completion and production the well is in, produced water can be further broken down into the following components:
  - Flowback – After the hydraulic fracturing procedure is completed and pressure is released, the direction of fluid flow reverses, and the fluid flows up through the wellbore to the surface. The water that returns to the surface is commonly referred to as "flowback."
  - Long-term produced water – This is the wastewater generated by UOG wells during the production phase of the well after the

[14] Stormwater is not considered a source of UOG extraction wastewater. In general, no permit is required for discharges of stormwater from any field activities or operations associated with oil and gas production, except as specified in 40 CFR 122.26(c)(1)(iii) for discharges of a reportable quantity or that contribute to a violation of a water quality standard.

flowback process. Long-term produced water continues to be produced throughout the lifetime of the well.

- Drilling wastewater, including pollutants from:
    - Drill cuttings – The particles generated by drilling into subsurface geologic formations and carried out from the wellbore with the drilling fluid.
    - Drilling muds – The circulating fluid (mud) used in the rotary drilling of wells to clean and condition the hole and to counterbalance formation pressure.
- Produced sand – The slurried particles used in hydraulic fracturing, the accumulated formation sands and scales particles generated during production. Produced sand also includes desander discharge from the produced water waste stream, and blowdown of the water phase from the produced water treating system.

EPA identified drilling wastewater and produced water as the major sources of wastewater pollutants associated with UOG extraction, therefore, these wastewaters are described further below.

1. Drilling Wastewater

As discussed in Section XII.B.1., operators inject drilling fluids down the well bore during drilling to cool the drill bit and to remove fragments of rock (drill cuttings) from the wellbore (DCN SGE00090; DCN SGE00274). Drilling fluid can be water or synthetic based. Air has recently been used in place of drilling fluids in the vertical phase of wells. Operators can use a combination of drilling fluids and air during the drilling process of a single well. The drilling fluid used depends on the properties of the formation, the depth, and associated regulations, safety, and cost considerations (DCN SGE00090; DCN SGE00635; TDD Chapter B.3).

When returned to the surface, ground rock removed from the wellbore (drill cuttings) is entrained in the drilling fluid. Operators separate the solids from the drilling fluid on the surface, striving to remove as much solids (drill cuttings) from the drilling fluid as possible. The separation process generates two streams: a solid waste stream referred to as drill cuttings and a liquid waste stream referred to as drilling wastewater. Operators typically transfer their drill cuttings to a landfill (DCN SGE00090; DCN SGE00635). Drilling wastewater is often reused/recycled until well drilling is complete (though in some cases it is processed for discharge and/or disposal).

At the end of drilling, operators use a variety of practices to manage drilling wastewater, primarily reuse/recycle in drilling subsequent wells. The following list presents drilling wastewater management options used by UOG operators (DCN SGE00740):

- Reuse/recycle wastewater in subsequent drilling and/or fracturing jobs[15]
- Disposal via landfill[16]
- Disposal via underground injection wells
- Land application
- Transfer wastewater to a centralized waste treatment (CWT) facility
- On-site burial[16]

[15] Synthetic fluids, which are more expensive than water-based drilling fluid, are almost always reused/recycled in drilling additional wells.

[16] Burial and landfill disposal options are generally limited to "semisolid" waste. Solidification processes may occur prior to transferring the waste to the landfill or they may occur at the landfill. (DCN SGE00139).

Nearly all of the volume of drilling fluid circulated during drilling is recovered as drilling wastewater and requires management. Typical drilling wastewater volumes for UOG drilling vary from 100,000 to 300,000 gallons per well depending primarily on vertical depth, horizontal length, and the well bore diameter (DCN SGE00740).

2. Produced Water

a. Flowback

As explained above, the portion of produced water that returns to the wellhead after the plugs are drilled out of the wellbore is often referred to as "flowback" and the largest daily volume of produced water generated occurs during the flowback period. Over time, flowback rates decrease as the well begins to produce oil and gas. Initially, flowback has characteristics that can resemble the fracturing fluid. During the flowback period, the generated wastewater increasingly resembles characteristics of the underlying formation.

The volume of flowback produced by a well varies, and it is often looked at in relation to the volume of the fracturing fluid used to fracture the well (as explained in Section XII.B.2. above, fracturing fluid volumes used depend on many factors, including the total number of stages drilled). Flowback recovery percentages also vary due to factors such as resource type (*e.g.*, shale oil) and well trajectory and have been documented anywhere between 3 and 75 percent of the volume of the fracturing fluid injected, with median flowback recovery between 4 and 29 percent (DCN SGE00724). These percent recoveries can result in total flowback volumes ranging from less than 210,000 gallons per well to more than 2,100,000 gallons per well (5,000 to 50,000 barrels per well) (DCN SGE00724). See TDD, Chapter C. 2.

b. Long-term Produced Water

After flowback generation, long-term produced water is generated during the well production phase. Long-term produced water has characteristics that primarily reflect the formation. The long-term produced water flow rate from a UOG well gradually decreases over time. In addition, the amount of produced water generated per well varies by formation. Median long-term produced water flow rates vary by resource type (*e.g.*, shale oil) and well trajectory and can be between 200 and 800 gallons per day (4.8 to 19 barrels per day), depending on well trajectory, formation type and well age (DCN SGE00635; DCN SGE00724). See TDD, Chapter C.2.

D. UOG Extraction Wastewater Characteristics

EPA reviewed published characterization data for UOG extraction wastewater. Produced water data included measurements of TDS, anions/cations, metals, hardness, radioactive constituents, and organics. The characteristics of UOG produced water vary primarily depending on the characteristics of the UOG formation (DCN SGE00090). Drilling wastewater characterization data included suspended solids, salts, metals, and organics. Because drilling wastewater is typically recycled/re-used for drilling another well, detailed pollutant specific information is less readily available for drilling wastewater than for produced water. As such, the remainder of this section is specific to produced water.[17]

[17] As explained above, produced water includes both flowback and long-term produced water.

1. TDS and TDS-Contributing Ions

TDS provides a measure of the dissolved matter, including salts (*e.g.*, sodium, chloride, nitrate), organic matter, and minerals (DCN SGE00046). TDS is not a specific chemical, but is defined as the portion of solids that pass through a filter with a nominal pore size of 2.0 micron (µm) or less (EPA Method 160.1). Table XII-1. shows ranges and median TDS concentrations associated with various shale and tight oil and gas formations.

Table XII-1. Concentrations of TDS in Produced Waters in Various UOG Formations

Shale/Tight Oil and Gas Formation	TDS Concentration Range (mg/L)	TDS Median Concentration (mg/L)	Number of Data Points
Bakken	98,000 – 220,000	150,000	13
Barnett	25,000 – 150,000	50,000	40
Bradford-Venango-Elk (Tight)	32,000 – 400,000	180,000	5
Cleveland (Tight)	84,000 – 220,000	120,000	11
Cotton Valley/Bossier (Tight)	110,000 – 230,000	170,000	3
Dakota (Tight)	2,900 – 7,700	6,000	3
Devonian	320 – 250,000	130,000	11
Eagle Ford	3,700 – 89,000	21,000	1,648
Fayetteville	13,000 – 57,000	25,000	6
Haynesville/Bossier	110,000 – 120,000	120,000	2
Marcellus	680 – 350,000	92,000	383
Mississippi Lime (Tight)	--	150,000	1
New Albany	--	88,000	1
Niobrara	39,000 – 140,000	100,000	8
Pearsall	300,000 – 380,000	370,000	3
Spraberry (Tight)	58,000 – 160,000	130,000	26
Utica	6,500 – 44,000	16,000	8
Woodford-Cana-Caney	14,000 – 110,000	36,000	8

Source: See TDD, Chapter C.3.

Salts are the majority of TDS in UOG produced water, and sodium chloride constitutes approximately 50 percent of the TDS in UOG produced water (DCN SGE00046). In addition to sodium and chloride, UOG produced water typically contains divalent cations such as calcium, strontium, magnesium, and, in some formations, barium and radium. Other ions such as potassium, bromide, fluoride, nitrate, nitrite, phosphate, and sulfate can also contribute to TDS in UOG produced water. Metals, other than those contributing to TDS (*e.g.*, calcium, magnesium, strontium), are typically not found in high concentrations in UOG produced water. Table XII-2. presents ranges and median concentrations of TDS and TDS-contributing ions in UOG produced water. Based on available data, concentrations of TDS and TDS-contributing ions, including divalent cations, typically increase from flowback to long-term produced water. See TDD, Chapter C.3.

Table XII-2. Concentrations of TDS and TDS-Contributing Ions in UOG Produced Waters

Constituent	Concentration Range (mg/L)	Median Concentration (mg/L)	Number of Data Points
TDS	20 – 400,000	110,000	2,223
Chloride	64 – 230,000	48,000	2,063
Sodium	64 – 98,000	25,000	1,913
Calcium	13 – 34,000	3,400	2,068
Strontium	0 – 8,000	580	207
Magnesium	3 – 15,000	570	2,030
Bromide	0.2 - 4,300	540	119
Potassium	0 - 5,800	290	344
Barium	0 - 16,000	100	289
Sulfate	0 - 3,400	71	1,585
Phosphate	12 - 88	12	3
Nitrate	5 - 10	5	3
Nitrite	--	5	2
Fluoride	0.045 - 390	2.5	99

Source: See TDD, Chapter C.3.

2. Organic Constituents

Organic constituents in UOG produced water can originate from both the fracturing fluid that is injected down the wellbore and from the UOG formation itself. Organic constituents and hydrocarbons in UOG produced water appear to be less frequently sampled in comparison to the well-documented TDS concentrations. EPA has reviewed available data on organic pollutants in produced water and found a range of pollutant concentrations: phenol (0.7 to 460 parts per billion (ppb)), pyridine (1.1 to

2,600 ppb), benzene (0.99 to 800,000 ppb), ethyl benzene (0.63 to 650 ppb), toluene (0.91 to 1,700,000 ppb), and total xylenes (3 to 440,000 ppb) (DCN SGE00724). See TDD, Chapter C.3.

3. Radioactive Constituents

Oil and gas formations contain varying levels of radioactivity resulting from uranium decay which can be transferred to UOG produced water. Radioactive decay products typically include uranium 238, radium 226, and radium 228. EPA identified available data on some radioactive elements in UOG produced water, including radium 226, radium 228, gross alpha, and gross beta, and, therefore, focused the radioactive constituent discussion and data presentation on data for these parameters. Radium 226, which has a half-life over 1,000 years, has been found in UOG produced water at concentrations up to 16,900 picocuries per liter (pCi/L) (DCN SGE00241; DCN SGE00724). As a point of comparison, the International Atomic Energy Agency (IAEA) published a report in 2014 that included radium isotope concentrations in rivers and lakes. The average of measured concentrations of radium 226 found in U.S. rivers and lakes was 0.56 pCi/L (21 millibecquerel per liter (mBq/L)) and the measured values ranged from 0.01 to 1.7 pCi/L (0.37 to 63 mBq/L) (DCN SGE00769). Data for radium 228 were limited.

Data characterizing produced water radioactivity concentrations were not available for all shale and tight oil and gas formations. However, the available data[18]

[18] A report was released by the Pennsylvania Department of Environmental Protection, titled "Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) Study Report" on January 15, 2015. These data have not yet been incorporated into EPA's analyses. The report presents

from five different tight or shale oil and gas formations show that the concentrations of one or more radioactive constituents (radium 226, radium 228, gross alpha, gross beta) in UOG produced water was above naturally occurring concentrations in rivers and lakes throughout the world. The highest reported radium 228 value was in the Ganges River in India and was measured at 0.07 pCi/L (2.6 mBq/L). (See DCN SGE00769)

E. Wastewater Management and Disposal Practices

Historically, UOG operators primarily managed their wastewater using the following four methods[19]:

- Disposal via underground injection wells;
- Reuse in subsequent fracturing jobs;
- Transfer to a POTW; or
- Transfer to a privately owned wastewater treatment facility (also called a CWT facility).[20]

(DCN SGE00613; DCN SGE00276); DCN SGE00528).

The frequency with which UOG operators use each of the management options listed above varies by operator, formation, and sometimes within each region of the formation (DCN SGE00579; DCN SGE00276). Relative cost is also an important factor for an UOG operator when considering how to manage their wastewater. This proposed rule addresses only transfers to a POTW. Historically, the oil and gas industry has most

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additional data for the Marcellus Shale formation, which is one of the five formations for which EPA has identified additional data sources. See TDD Chapter C.3 and DCN SGE00933.

[19] Occasionally, UOG operators in the western U.S. may use evaporation as a means of wastewater management.

[20] Operators may haul wastewater to CWT facilities that handle the wastewater by (1) treating for reuse; (2) direct discharging to surface water; or (3) indirect discharging to surface water through a POTW.

commonly managed its wastewater by underground injection (DCN SGE00182), but the industry is increasingly turning to reuse, and in some areas transfer to CWT facilities, to manage increasing volumes of UOG extraction wastewater (see TDD, Chapter D).

1. Injection into Disposal Wells

Underground injection involves pumping wastes into a deep underground formation with a confining layer of impermeable rock. The receiving formation must also be porous enough to accept the wastewater. In previous decades, and in most oil and gas basins, drillers found underground injection of oil and gas extraction wastewater to be the most economical and reliable means of disposal; this is similarly the case today (DCN SGE00623). As of 2009, over 90 percent of oil and gas wastewater (conventional and unconventional) was disposed of via Class II injection wells (DCN SGE00623; DCN SGE00132).

The availability of underground injection as a disposal method varies by state. Some states have a large number of Class II disposal wells (*e.g.*, Texas, Oklahoma, Kansas) while others have very few (*e.g.*, Pennsylvania, West Virginia). In many UOG formations, distances from the average producing well to the nearest disposal well are short and disposal capacity is abundant making it the least expensive disposal practice (DCN SGE00635).

2. Reuse in Fracturing

Reuse involves mixing flowback and/or long-term produced water from previously fractured wells with source water[21] to create the base fluid used to fracture a new well (DCN SGE00046). Reused UOG extraction wastewater is typically transported, by truck, from storage to the fracturing site just prior to the start of hydraulic fracturing. When hydraulic fracturing commences, the stored UOG wastewater is pumped from the fracturing tanks and blended with source water to form the base fluid. The blending occurs upstream of other steps such as sand and fracturing chemical addition or pressurization by the pump trucks (DCN SGE00625).

In considering whether to reuse wastewater, operators evaluate wastewater generation rates compared to water demand for new fracturing jobs, water quality and treatment requirements for use in fracturing, and the risks and costs of wastewater management and transportation for reuse compared to disposal, or transfer practices. Typically, for an operator to reuse wastewater, the cost per barrel for reuse must be less than the cost per barrel for disposal or transfer (DCN SGE00095). The cost for reuse depends on several factors that vary by formation and operator; and, therefore, the potential for reusing UOG extraction wastewater for fracturing varies by formation and operator.

Since the late 2000's, UOG operators have increased wastewater reuse (DCN SGE00613). The Petroleum Equipment Suppliers Association (PESA) surveyed 205 UOG operators in 2012 about their wastewater management practices. Survey results

[21] Source waters may include freshwater, ground water, treated municipal wastewater, and other industrial wastewater.

included 143 operators active in major UOG formations. UOG operators reported reusing 23 percent of the total volume of wastewater generated to refracture another well. The survey results also showed that most operators anticipated reusing higher percentages of their wastewater in the two to three years following the survey (DCN SGE00707; DCN SGE00708; DCN SGE00575). EPA participated in several site visits and conference calls with operators in several UOG formations that have been able to reuse 100 percent of the volume of their wastewater under certain circumstances (DCN SGE00625; DCN SGE00635; DCN SGE00275; DCN SGE00636).

3. Transfer to Centralized Waste Treatment Facilities

Some operators manage UOG extraction wastewater by transporting it to CWT facilities for treatment. Following treatment, these facilities can return it to an operator for reuse to fracture another well ("zero discharge") and/or discharge it, either to surface water or to a POTW. Operators can choose to use CWT facilities if they drill and complete relatively few wells, making discharging to CWT facilities more feasible than investing in other management options (DCN SGE00300), or if other wastewater management options are not available or cost effective in the region where they are operating (DCN SGE00139; DCN SGE00182). EPA identified 73 commercial CWT facilities that accept UOG extraction wastewater. See TDD, Chapter D.3. EPA found that the number of CWT facilities available to operators in the Marcellus and Utica Shale formations has increased with the number of wells drilled. A similar trend was observed in the Fayetteville Shale formation in Arkansas (DCN SGE00704).

Operators can haul their wastewater to "zero discharge" CWT facilities that treat but do not discharge UOG extraction wastewater, either to surface water or to a POTW.

Instead, they return the wastewater to UOG operators for reuse in subsequent hydraulic fracturing jobs. Commercial CWT facilities that fall into this category typically allow operators to unload a truck load of wastewater for treatment and take a load of treated wastewater on a cost per barrel basis (DCN SGE00245). Some of these facilities offer operators the option of unloading a truck load of wastewater without taking a load of treated wastewater for a surcharge, as long as other operators are in need of additional treated wastewater. The CWT facility can also provide this service if it can dispose of the wastewater without discharge (DCN SGE00299). For example, one facility in Wyoming treats UOG extraction wastewater for reuse by removing TDS and other pollutants through electrocoagulation followed by reverse osmosis (RO). The facility evaporates the concentrated brine from the RO unit in large evaporation ponds to dispose of wastewater not reused by operators (DCN SGE00374).

Some operators can haul their wastewater to CWT facilities that discharge directly to surface waters. Discharges from these CWT facilities are controlled by NDPES permits that include pollutant discharge limitations based on the technology-based ELGs set out in 40 CFR part 437 (representing the floor), or more stringent WQBELs where the technology-based effluent limits are not sufficiently stringent to meet applicable state water quality standards. The ELGs established by EPA for CWTs do not include limitations for TDS; however, to meet applicable state water quality standards, direct discharging CWT facilities can use treatment processes (*e.g.*, evaporation/condensation, reverse osmosis) that remove TDS.

Finally, other operators can haul their wastewater to CWT facilities that discharge indirectly to a POTW. Discharges from the CWT facility to the POTW are controlled by an Industrial User Agreement (IUA) that must incorporate the pretreatment standards set out in 40 CFR part 437.

4. Transfer to POTWs

Historically, in locations such as in Pennsylvania where disposal wells and CWT facilities were limited, operators managed UOG extraction wastewater by transfer to POTWs (DCN SGE00011; DCN SGE00739; DCN SGE00598). This practice can be problematic because POTWs are not able to remove many of the constituents found in UOG extraction wastewater (DCN SGE00011; DCN SGE00600; DCN SGE00765). Because they are not typical of POTW influent wastewater, UOG extraction wastewater constituents can be discharged, largely untreated, from the POTW to the receiving stream; can disrupt the operation of the POTW (*e.g.*, by inhibiting biological treatment); can accumulate in biosolids, limiting their use; and can facilitate the formation of harmful DBPs (which are a concern for downstream drinking water uses). These constituents can interfere with POTW operations and can increase salt loads in receiving streams to the detriment of downstream water use. (DCN SGE00286; DCN SGE00345; DCN SGE00579; DCN SGE00531; DCN SGE00633). See TDD, Chapter D.5. As discussed above, EPA has not been able to identify any existing UOG discharges at present to POTWs (DCN SGE00579; DCN SGE00286; DCN SGE00345). The lack of existing discharges to POTWs can be attributed to the availability of one or more cost effective alternative wastewater management options (injection for disposal, reuse/recycling, and transfer to a CWT), concerns about inability of POTWs to treat such waste appropriately, and concerns that such discharges can disrupt POTW treatment processes. In a few cases, they can also be associated with state-level drivers (see TDD Chapter A.2).

XIII. Subcategorization

In developing ELGs, EPA can divide an industry category into groupings called "subcategories" to provide a method for addressing variations among products, processes, and other factors, which result in distinctly different effluent characteristics that affect the determination of the "best available" technology. See *Texas Oil & Gas Ass'n. v. US EPA*, 161 F.3d 923, 939-40 (5th Cir.1998). Regulation of a category by subcategories provides that each subcategory has a uniform set of effluent limitations or pretreatment standards that take into account technological achievability, economic impacts, and non-water quality environmental impacts unique to that subcategory. In some cases, effluent limitations or pretreatment standards within a subcategory can be different based on consideration of these same factors, which are identified in CWA section 304(b)(2)(B). The CWA requires EPA, in developing effluent guidelines and pretreatment standards, to consider a number of different factors, which are also relevant for subcategorization. The CWA also authorizes EPA to take into account other factors that the Administrator deems appropriate. CWA section 304(b).

Within the oil and gas extraction category, EPA has already established subcategories. As explained in Section VIII.C., the existing oil and gas extraction ELGs are divided into five subcategories. The scope of the proposed rule is specific to subpart C: onshore. The proposed rule is specific to pollutant discharges from UOG extraction as defined in Section XI. EPA considered whether further subcategorization of the UOG extraction industry was warranted. EPA evaluated a number of factors including available data regarding wastewater chemical constituents, generation volumes, and rates. Although some differences can be observed among these characteristics (between different types of unconventional resource and geologic formations, and sometimes between wells within the same source), EPA proposes that further subcategorization is not appropriate because EPA has not identified any onshore UOG operations that currently discharge to POTWs.

XIV. Proposed Regulation

A. Discussion of Options

1. PSES and PSNS Option Selection

EPA proposes to establish PSES and PSNS that apply to wastewater discharges from onshore UOG extraction facilities. Generally, EPA designs PSES and PSNS to ensure that wastewaters from direct and indirect industrial dischargers are subject to similar levels of treatment prior to discharge to waters of the U.S. This means that, typically, the requirements for indirect dischargers are analogous to those for direct dischargers. As explained in Section VIII.C., the existing requirements for BPT for the Onshore Subcategory are zero discharge of wastewater pollutants into waters of the U.S. from any source associated with production, field exploration, drilling, well completion, or well treatment. As also explained in Section VIII.C., the existing BPT requirements do not apply to discharges to POTWs.

Most POTWs are designed primarily to treat municipally generated wastewater. POTWs typically provide at least secondary level treatment and, thus, are designed to remove settleable solids, suspended solids and organic material using biological treatment. EPA is not aware of any POTWs that are designed to treat dissolved pollutants in UOG extraction wastewater such as TDS (*e.g.,* chlorides, sulfates, metals) or radioactive elements. As a result, the mass of untreated pollutants would be discharged from the POTW to the receiving water, could disrupt the operation of the POTW (*e.g.,* by inhibiting biological treatment) or could facilitate the formation of harmful DBPs.

As explained in Section XII.E., EPA evaluated the practices currently used to manage UOG extraction wastewaters. Based on the information reviewed as part of this proposed rulemaking, EPA identified that current industry practice is not to discharge pollutants from onshore UOG extraction to POTWs. Rather, the vast majority of this wastewater is managed by disposal in underground injection wells and/or re-use in fracturing another well.[22] A small, but in some geographic areas increasing, portion of the industry also transfers its wastewater to privately owned wastewater treatment facilities (also referred to as CWT facilities).

Because of this information, EPA identified one candidate PSES/PSNS option; that is, zero discharge of wastewater pollutants to POTWs. UOG extraction wastewater is discussed in Section XII.C.

The technology basis for the proposed PSES is disposal in UIC wells and/or wastewater reuse/recycling to fracture another well. Because existing UOG extraction facilities currently employ alternative wastewater management practices, the technology basis for meeting a zero discharge requirement is widely available. While EPA estimates that there will be no incremental pollutant reductions associated with the proposed PSES, the technology basis is best performing in that it achieves zero discharges of pollutants in

[22] While pollutant discharges from onshore oil and gas extraction produced water are allowed under subpart E in certain geographic locations for use in agriculture or wildlife propagation, EPA has not found that these types of permits are typically written for unconventional oil and gas extraction wastewater (as defined for the proposed rule).

UOG extraction wastewater. Additionally, because this technology represents current industry practice nationwide, no facilities will incur incremental costs for compliance with the proposed PSES and, therefore, the proposed PSES is economically achievable. For the same reasons, the proposed PSES will result in no incremental non-water quality environmental impacts. Finally, because the proposal represents current industry practice, EPA proposes that PSES requiring zero discharge of wastewater pollutants be effective as of the effective date of this rule.

As previously noted, under section 307(c) of the CWA, new sources of pollutants into POTWs must comply with standards which reflect the greatest degree of effluent reduction achievable through application of the best available demonstrated control technologies. Congress envisioned that new treatment systems could meet tighter controls than existing sources because of the opportunity to incorporate the most efficient processes and treatment systems into the facility design. EPA proposes PSNS that would control the same pollutants using the same technologies proposed for control by PSES. The technologies used to control pollutants at existing sources, disposal in UIC wells and/or wastewater reuse/recycling to fracture another well, are fully available to new sources. They achieve the greatest degree of effluent reduction available: zero discharge of pollutants in UOG extraction wastewater. Furthermore, EPA has not identified any technologies that are demonstrated to be available for new sources that are different from those identified for existing sources. Finally, EPA determined that the proposed PSNS present no barrier to entry into the market for new sources. While EPA cannot say with certainty exactly how new sources will manage their UOG extraction wastewater, information in the record indicates that new sources would manage their UOG extraction wastewater following current industry practice. EPA has found that overall impacts from the proposed standards on new sources would be minimal, as is the case for existing sources, since the costs faced by new sources generally will be the same as those faced by existing sources. EPA projects no (and, therefore, acceptable) incremental non-water quality environmental impacts. Therefore, EPA proposes to establish PSNS that are the same as the proposed PSES.

2. Other Options Considered

a. "No Rule"

In addition to the PSES/PSNS option of zero discharge of wastewater pollutants, EPA also considered the option of no proposed PSES or PSNS, a "no rule" option. Based on the discussion above that no UOG facilities are currently transferring wastewater to POTWs, and given available alternative management options such as disposal in UIC wells and reuse/recycling, EPA considered the option of no proposed rule. A "no rule" option would impose no change to the existing pretreatment regulatory regime, or industry practice, and would, therefore, be a "no incremental cost and pollutant reduction" option.

EPA, however, did not select this "no rule" option for several reasons. First, there is no national federal regulation that would prevent or require pretreatment of such discharges – and, as mentioned above, EPA is not aware of any POTWs that are designed to treat dissolved pollutants common in UOG extraction wastewater. This means that constituents of such wastewater could be discharged to receiving waters when other [available] options such as reuse and proper disposal in a Class II UIC well better protect water quality and aquatic communities and help further the zero discharge goal of the

CWA. CWA section 101(a)(1). Second, as detailed in Chapter A.2 of the TDD, few states have regulations or policies that prevent discharges of pollutants in UOG extraction wastewater to POTWs or that mandate pre-treatment prior to discharge to a POTW. In the absence of such regulations or policies, resource-constrained control authorities and/or POTWs who receive requests to accept UOG extraction wastewater would be in the position of having to evaluate whether to accept transfers of wastewater on a case-by-case basis. Third, history demonstrates that absent controls preventing the transfer of or requiring pretreatment of such wastewater, POTWs can accept it, as occurred in Pennsylvania (see TDD Chapters A.2 and D.5), where POTWs were used to manage UOG extraction wastewater until the state took action, including promulgating new regulations requiring pretreatment. Among the drivers behind these actions taken by Pennsylvania was that some waters were impaired by TDS. (DCN SGE00187).

To avoid future scenarios where POTWs receive UOG extraction wastewater, it is reasonable to codify the good practice already adopted by the industry that is technologically and economically viable. Moreover, it is beneficial to the states as a practical matter to establish federal regulations that mandate this existing practice, in order to avoid the burden for each state to potentially repeat the effort of promulgating state-level regulations. EPA has discussed this proposed rule with several states, who have indicated that a federal pretreatment standard would reduce their administrative burden (DCN SGE00762; DCN SGE00762; DCN SGE00743).

EPA also considered the future burden that continued lack of pretreatment standards can impose on POTWs. The UOG extraction industry is predicted to continue to grow in the future, resulting in the installation, fracturing, and possible refracturing of hundreds of thousands of wells. Well operators will continue to generate UOG extraction wastewater and could request local POTWs to accept their wastewater for discharge. In the absence of federal pretreatment standards, POTWs can legally accept UOG extraction wastewater to the extent that such wastewater transfers are in compliance with state and local requirements. Evaluating each potential customer (industrial user), developing a determination for each new UOG extraction wastewater source on a case-by-case basis could be burdensome for POTWs. In addition, where a POTW determines it can accept this wastewater, complying with applicable reporting requirements could be a significant burden to some POTWs. EPA concluded that a national-level determination that UOG extraction wastewater contains pollutant concentrations that could pass through POTWs, and development of categorical pretreatment standards, will avoid burdening individual POTWs with evaluating each individual request. Thus, the national categorical pretreatment standards will reduce the process burden on pretreatment Control Authorities (*e.g.*, POTWs). While EPA does not have the information to quantify the reductions in administrative burden that will likely result from the proposed rule, states generally support EPA's position that such reductions will be realized (DCN SGE00762; DCN SGE00762; DCN SGE00743).

Moreover, as explained above, because some pollutants of concern in UOG extraction wastewater will not be physically, chemically, or biologically reduced by the treatment processes typically used at POTWs, these pollutants are expected to be discharged from the POTW into receiving waters. In addition, these pollutants can cause operational problems for the POTW's biological treatment processes and alter the POTW's ability to adequately remove BOD, TSS, and other pollutants for which it is regulated. For some UOG pollutants, such as radionuclides, the data indicate POTWs will remove some portion while discharging the remainder (DCN SGE00136). In these cases, some portion of the radionuclides will partition to the POTW biosolids, which can cause the POTW to incur increased costs to change its selected method of biosolids management (DCN SGE00615). See also TDD Chapter D.5.

Finally, EPA did not select the "no rule" option because it concluded that national pretreatment standards provide clear direction and certainty to industry, POTWs, states, and the public that UOG extraction wastewaters are not treated by POTWs and should not be transferred to them. Categorical pretreatment standards support the CWA goal that the discharge of pollutants into the nation's navigable waters be eliminated. CWA section 101(a).

b. Non-Zero Numeric Discharge Pretreatment Requirements

EPA considered an option that would have included non-zero numerical discharge pre-treatment requirements prior to discharge to a POTW. Such an option could be similar to the one adopted in Pennsylvania in 2010 that requires pretreatment of oil and gas wastewaters before discharge to a POTW to meet a maximum TDS concentration of 500 mg/L as well as specific numerical concentrations for other pollutants. Some have suggested this would provide an "escape-valve" for the future in the event that UIC disposal well capacity is exhausted. Others have suggested this would allow the water to be available for re-use (other than in fracturing another well) if technologies become available to pre-treat it to remove dissolved pollutants in a cost effective manner.

EPA does not propose an option with numerical discharge pretreatment requirements prior to discharge to a POTW for the following reasons. First, the existing requirements for direct discharges of UOG extraction wastewater in the Onshore Subcategory require no discharge of pollutants. As explained above, EPA generally establishes requirements for direct and indirect discharges so that the wastewater receives comparable treatment prior to discharge to waters of the U.S.

Second, the option EPA proposes, zero discharge of pollutants in UOG extraction wastewater to POTWs, is widely available, economically achievable and has no incremental (and, therefore, acceptable) non-water quality environmental impacts. Because the proposed zero pollutant discharge requirement is current practice and, therefore, clearly both available and achievable, any option that includes non-zero discharge requirements for any pollutants would potentially increase pollutant discharges from current industry best practices. Such an option would not fulfill the CWA requirement to establish limitations based on “Best Available Technology Economically Achievable” (CWA section 301(b)(2)(A)), or the CWA goals of eliminating the discharge of pollutants into navigable waters (CWA section 101(a)(1)).

Third, EPA does not have any data to demonstrate that UIC capacity nationwide will be expended and that this current management approach will not be available in the future (DCN SGE00613). In fact, industry has been managing oil and gas extraction wastewater through underground injection for decades. In recent years, industry has greatly expanded its knowledge about the ability to re-use UOG flowback and long-term produced water (the major contributors to UOG extraction wastewater by volume) in fracturing another well. Consequently, while the UOG industry continues to grow and new wells are being fractured, the need for UIC capacity for UOG extraction wastewater is decreasing, even in geographic locations with an abundance of UIC capacity (see TDD Chapter D.2).

Fourth, EPA identified technologies that currently exist to treat dissolved pollutants in UOG extraction wastewater. Relative to underground injection and reuse/recycling to fracture another well (the basis for the preferred option EPA proposes), these technologies are costly, would result in more pollutant discharges, and are energy intensive. While EPA did not attempt to calculate a numerical standard for TDS, data collected for this proposed rulemaking demonstrate that the current technologies are capable of reducing TDS (and other dissolved pollutants) well below 500 mg/L. To the extent that these technologies or others are developed in the future to reduce pollutants in UOG extraction wastewater to enable them to be reused for purposes other than fracturing another well, these pre-treated wastewaters can be used directly for the other applications without going through a POTW.[23]

c. Conventional Oil and Gas Wastewater

As explained in Section VIII., while the existing oil and gas regulation applies to both conventional and UOG extraction (except coalbed methane), the proposed rule would add pretreatment standards only for facilities engaged in oil and gas extraction from UOG sources that send their discharges to POTWs. EPA proposes to reserve standards for conventional oil and gas extraction for possible future rulemaking, if

[23] As a point of clarification, except in certain geographic areas, these wastewaters would remain subject to the requirements in the Onshore Subcategory that require no discharge of pollutants to waters of the U.S. (40 CFR 435.30).

appropriate. This is consistent with EPA's stated scope throughout the development of this proposed rule. See specific comment solicitation on conventional oil and gas extraction wastewaters in Section VII.

B. Pollutants of Concern

Since the effectiveness of the technology basis for the proposed standards results in zero discharge of all pollutants, it is not appropriate in this proposed rule to further specify the pollutants of concern. Rather, as is the case for the existing BPT requirements, the proposed PSES/PSNS apply to the discharge of all pollutants in UOG extraction wastewater.

C. POTW Pass Through Analysis

Sections 307(b) and (c) of the CWA authorize EPA to promulgate pretreatment standards for pollutants that are not susceptible to treatment by POTWs or which would interfere with the operation of POTWs. EPA looks at a number of factors in selecting the technology basis for pretreatment standards for existing and new sources. These factors are generally the same as those considered in establishing the direct discharge technology basis. However, unlike direct dischargers whose wastewater will receive no further treatment once it leaves the facility, indirect dischargers send their wastewater to POTWs for further treatment.

Therefore, before establishing PSES/PSNS for a pollutant, EPA examines whether the pollutant "passes through" a POTW to waters of the U.S. or interferes with the POTW operation or biosolids disposal practices. In determining whether a pollutant would pass through POTWs for these purposes, EPA generally compares the percentage of a pollutant removed by well-operated POTWs performing secondary treatment to the percentage removed by a candidate technology basis. A pollutant is determined to pass through POTWs when the median percentage removed nationwide by well-operated POTWs is less than the median percentage removed by the candidate technology basis. Pretreatment standards are established for those pollutants regulated under the direct discharge level of control (typically BAT/NSPS) that passes through. In addition, EPA can regulate pollutants that do not pass through but otherwise interfere with POTW operations or biosolids disposal practices. This approach to the definition of pass through satisfies two competing objectives set by Congress: (1) that standards for indirect dischargers be equivalent to standards for direct dischargers, and (2) that the treatment capability and performance of POTWs be recognized and taken into account in regulating the discharge of pollutants from indirect dischargers.

Historically, EPA's primary source of POTW removal data is its 1982 "Fate of Priority Pollutants in Publicly Owned Treatment Works" (also known as the 50 POTW Study) (see DCN SGE00765). The 50 POTW study presents data on the performance of 50 POTWs achieving secondary treatment in removing certain toxic pollutants. While the 50 POTW study demonstrates a wide variability in the effectiveness of POTWs in removing toxic pollutants, it demonstrates that POTWs remove these pollutants by less than 100%. Although this study does not contain information on pollutant removals for TDS, as explained earlier, secondary treatment technologies are generally understood to be ineffective at removing TDS and as such little to no TDS removals are likely to occur at POTWs through secondary treatment (DCN SGE00011; DCN SGE00600). While the POTW study also does not contain information for other pollutants that may be present in

UOG extraction wastewater, it is reasonable for EPA to conclude that removal of UOG extraction wastewater pollutants by a well-operated POTW would be less than 100%, the percentage removal by the candidate technology basis for the proposed rule, and therefore would if discharged to a POTW "pass through" the POTW, as the term applies under the CWA, into waters of the U.S.

XV. Environmental Impacts

UOG production generates significant volumes of wastewater that need to be managed. As described in Section XII.C.2, wells can produce flowback volumes ranging between 210,000 and 2,100,000 gallons during the initial flowback process.[24] During the production phase, wells typically produce smaller volumes of water (median flow rates range from 200-800 gallons per day) and continue producing wastewater throughout the life of the well.

In general, evidence of environmental impacts to surface waters from discharges of UOG extraction wastewater is sparsely documented. Some of the environmental impacts documented to date, such as increased DBP formation in downstream drinking water treatment plants, resulted from wastewater pollutants that passed untreated through POTWs in Pennsylvania (TDD, Chapter D.5).

A. Pollutants

As described in Section XII.D., high concentrations of TDS are common in UOG extraction wastewater. As shown in Table XII-2. (in Section XII.D.), major inorganic

[24] As explained in the TDD (Chapter B) the length of the flowback process is variable. Literature generally reports it as 30 days or less (DCN SGE00532).

constituents leaching from geologic formations such as sodium, potassium, bromide, calcium, fluoride, nitrate, phosphate, chloride, sulfate, and magnesium represent most of the TDS in UOG extraction wastewater. TDS in produced water can also include barium, radium, and strontium. Based on available data, TDS cations (positively charged ions) in UOG extraction wastewater are generally dominated by sodium and calcium, and the anions (negatively charged ions) are dominated by chloride (DCN SGE00284). TDS concentrations vary among the UOG formations. Table XII-1. (in Section XII.D.), presents the varying TDS concentrations in tight and shale oil and gas formations. The highest median TDS concentration (370,000 mg/L) is found in the Pearsall shale gas formation. For comparison, sea water contains approximately 35,000 mg/L TDS.

B. Impacts from the Discharge of Pollutants Found in UOG Extraction Wastewater

Conventional POTW treatment operations are designed primarily to treat organic waste and remove total suspended solids and constituents responsible for biochemical oxygen demand, not to treat waters with high TDS. When transfers of UOG extraction wastewater to POTWs were occurring in Pennsylvania, these POTWs, lacking adequate TDS removal processes, diluted UOG extraction wastewaters with other sewage flows and discharged TDS-laden effluent into local streams and rivers. POTWs not sufficiently treating TDS in UOG extraction wastewater were a suspected source of elevated TDS levels in the Monongahela River in 2009 (DCN SGE00525). Also see TDD, Chapter D.5 for additional examples.

In addition to UOG wastewater pollutants passing through POTWs, other industrial discharges of inadequately treated UOG extraction wastewater pollutants have also been associated with in-stream impacts. One study reviewed by EPA of discharges from a CWT facility in western Pennsylvania that treats UOG extraction wastewater examined the water quality and isotopic compositions of discharged effluents, surface waters, and stream sediments (DCN SGE00629).[25] The study found that the discharge of the effluent from the CWT facility increased downstream concentrations of chloride and bromide above background levels. The chloride concentrations 1.7 kilometers downstream of the treatment facility were two to ten times higher than chloride concentrations found in similar reference streams in western Pennsylvania. Radium 226 levels in stream sediments at the point of discharge were approximately 200 times greater than upstream and background sediments. EPA intends to further study the frequency and magnitude of such impacts from CWTs.

C. Impact on Surface Water Designated Uses

UOG extraction wastewater TDS levels are high enough, if discharged untreated to surface water, to affect adversely a number of designated uses of surface water, including drinking water, aquatic life support, livestock watering, irrigation, and industrial use.

1. Drinking Water Uses

Available data indicate the levels of TDS in UOG extraction wastewaters can often significantly exceed recommended drinking water concentrations. Because TDS concentrations in drinking water sources are typically well below the recommended drinking water levels, few drinking water treatment facilities have technologies to remove

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[25] Discharges from CWT facilities are subject to ELGs in 40 CFR part 437 and would not be subject to the proposed rule. However, the effect of discharges of treated oil and gas wastewaters from CWT facilities that lack high level treatment is similarly representative of POTWs.

TDS. Two published standards for TDS in drinking water include the U.S. Public Health Service recommendation and EPA's secondary maximum contaminant level recommendation that TDS in drinking water should not exceed 500 mg/L. High concentrations of TDS in drinking water primarily degrade its taste rather than pose a human health risk. Taste surveys found that water with less than 300 mg/L TDS is considered excellent, and water with TDS above 1,100 mg/L is unacceptable (DCN SGE00939). The World Health Organization dropped its health-based recommendations for TDS in 1993, instead retaining 1,000 mg/L as a secondary standard for taste (DCN SGE00947).

EPA also reviewed a study concerning unintentional creation of harmful DBPs due to insufficient removal of bromide and other UOG wastewater constituents by POTWs accepting UOG extraction wastewaters (DCN SGE00535; DCN SGE00587). DBPs have been shown to have both adverse human health and ecological affects. The study found that UOG extraction wastewaters contain various inorganic and organic DBP precursors that can react with disinfectants used by POTWs to promote the formation of DBPs, or alter speciation of DBPs, particularly brominated-DBPs, which are suspected to be among the more toxic DBPs (DCN SGE00535; DCN SGE00985). These precursors are a concern for drinking water managers wherever they can enter raw water intakes. See TDD, Chapter D.5 for further discussion of DBP formation associated with UOG extraction wastewaters.

2. Aquatic Life Support Uses

TDS and its accompanying salinity play a primary role in the distribution and abundance of aquatic animal and plant communities. High levels of TDS can impact aquatic biota through increases in salinity, loss of osmotic balance in tissues, and toxicity of individual ions. Increases in salinity have been shown to cause shifts in biotic communities, limit biodiversity, exclude less-tolerant species and cause acute or chronic effects at specific life stages (DCN SGE00946). A detailed study of plant communities associated with irrigation drains, reported substantial changes in marsh communities in part because of an increase in dissolved solids (DCN SGE00941). Observations over time indicate a shift in plant community coinciding with increases in dissolved solids from estimated historic levels of 270 to 1170 mg/L, as species that are less salt tolerant such as coontail (*Ceratophyllus demersum*) and cattail (*Typha* sp.) were nearly eliminated. A related study found that lakes with higher salinity exhibit lower aquatic biodiversity, with species distribution also affected by ion composition (DCN SGE00940).

It is often a specific ion concentration in TDS that is responsible for adverse effects to aquatic ecosystems. For example, a TDS concentration of 2,000 mg/L with chloride as the primary anionic constituent is acutely toxic to aquatic life, but the same TDS concentration composed primarily of sulfate is nontoxic. Sodium chloride accounts for about 50 percent of the TDS typically found in UOG extraction wastewater. As reported in Table XII-2 (in Section XII.D.), chloride has been measured at concentrations up to 230,000 mg/L. Macroinvertebrates, such as fresh water shrimp and aquatic insects that are a primary prey of many fish species, have open circulatory systems that are especially sensitive to pollutants like chloride. Based on laboratory toxicity data from EPA's 1988 chloride criteria document and more recent studies, invertebrate sensitivity to chloride acute effect concentrations ranged from 953 mg/L to 13,691 mg/L. Chronic effect concentrations of chloride ranged from 489 mg/L to 556 mg/L. In addition to the laboratory data, EPA also reviewed data from a 2009 Pennsylvania Department of Environmental Protection violation report documenting a fish kill attributed to a spill of diluted produced water in Hopewell Township, PA. TDS at the location of the fish kill was as high as 7,000 mg/L. While not related to UOG extraction wastewater, negative impacts of high TDS, including fish kills, were documented during 2009 at Dunkard Creek located in Monongalia County, Pennsylvania. (DCN SGE00001 and DCN SGE00001.A01)

EPA has published chemical-specific national recommended water quality criteria for some of the TDS constituents in UOG extraction wastewater, such as barium, chloride, manganese, and iron, based on a variety of human health or ecological benchmarks. A review of state and tribal water quality standards in 2012 indicated that 26 states had adopted a numeric or narrative criterion for TDS, either for state-wide or site-specific application (DCN SGE00945). The TDS criteria levels and the designated uses they are intended to protect vary greatly from state to state. For example, Alaska has a criterion of 1,500 mg/L TDS to protect aquatic life; Mississippi has a criterion of 750 mg/L monthly average for protection of fish, wildlife and recreation criteria, and Illinois has a statewide 1,000 mg/L TDS criterion for aquatic life and a 1,500 mg/L TDS criterion for secondary contact recreation and indigenous aquatic life. TDS criteria adopted specifically for the protection of aquatic life have been developed for at least 16 of the 26 states, with some criteria applying only to specific waterbodies. Oregon has the most stringent TDS criterion using a standard of 100 mg/L for all freshwater streams and tributaries in order to protect aquatic life, public water use, agriculture, and recreation.

3. Livestock Watering Uses

POTW discharges to surface waters containing high concentrations of TDS can impact downstream uses for livestock watering. High TDS concentrations in water sources for livestock watering can adversely affect animal health by disrupting cellular osmotic and metabolic processes (DCN SGE01053). Domestic livestock, such as cattle, sheep, goats, horses, and pigs have varying degrees of sensitivity to TDS in drinking water as shown in Table XV-1. Sheep seem to be more tolerant of saline water than most domestic species, but will only drink it if introduced to the saline water over a period of several weeks (DCN SGE00937).

Table XV-1. Tolerances of Livestock to TDS in Drinking Water

Livestock	Total Dissolved Solids (TDS) (mg/L)		
	No adverse effects on animals expected	Animals can have initial reluctance to drink or there can be some scouring, but stock should adapt without loss of production	Loss of production and a decline in animal condition and health would be expected. Stock can tolerate these levels for short periods if introduced gradually
Beef cattle	0–4,000	4,000–5,000	5,000–10,000
Dairy cattle	0–2,400	2,400–4,000	4,000–7,000
Sheep	0–4,000	4,000–10,000	10,000–13,000
Horses	0–4,000	4,000–6,000	6,000–7,000
Pigs	0–4,000	4,000–6,000	6,000–8,000
Poultry	0–2,000	2,000–3,000	3,000–4,000

Source: Australia and New Zealand Water Quality Guidelines 2000. Chapter 3 Primary Industries- 9.3 Livestock drinking water guidelines (DCN SGE00937).

4. Irrigation Uses

If UOG extraction wastewater discharges to POTWs increase TDS concentrations in receiving streams, downstream irrigation uses of that surface water can be negatively affected. Elevated TDS levels can limit the usefulness of water for irrigation. Excessive salts affect crop yield in the short term, and the soil structure in the long term. Primary direct impacts of high salinity water on plant crops include physiological drought, increased osmotic potential of soil, specific ion toxicity, leaf burn, and nutrient uptake interferences (DCN SGE00938). In general, for various classes of crops the salinity tolerance decreases in the following order: forage crops, field crops, vegetables, fruits.

The suitability of water for irrigation is classified using several different measurements, including TDS and electrical conductivity (EC). Table XV-2. shows a classification of TDS concentrations for irrigation suitability.

Table XV-2. Permissible Limits for Classes of Irrigation Water

Class of Water	Concentrations of TDS	
	Electrical Conductivity[a] (dS/m)	TDS by gravimetric (mg/L)
Class 1. Excellent	0.250	175
Class 2. Good	0.250-0.750	175-275
Class 3. Permissible[b]	0.750-2.0	525-1,400
Class 4. Doubtful[c]	2.0-3.0	1.400-2,100
Class 5. Unsuitable[c]	3.0	>2,100

a = TDS (mg/L) ≈ Electrical Conductivity (EC) (deci-Siemen/meter (dS/m)) x 640 for EC < 5 dS/m;
b = leaching needed if used
c = good drainage needed and sensitive plants will have difficulty obtaining stands.

Source: Fipps (2003) (DCN SGE00936).

In addition to short-term impacts to crop plants, irrigating with high TDS water can result in gradual accumulation of salts or sodium in soil layers and eventual decrease in soil productivity. The susceptibility of soils to degradation is dependent on the soil type and structure. Sandy soils are less likely than finely textured soils to accumulate salts or sodium. Soils with a high water table or poor drainage are more susceptible to salt or sodium accumulation. The most common method of estimating the suitability of a soil for crop production is through calculation of its sodicity as estimated by the soil's sodium absorption ratio (SAR). The SAR value is calculated by the equation[26]: $\frac{[Na^{+}]}{\sqrt{\frac{[Ca^{2+}]+[Mg^{2+}]}{2}}}$.

The impact of irrigation water salinity on crop productivity is a function of both the SAR value and the electrical conductivity. The actual field-observed impacts are very site-specific depending on soil and crop system. (DCN SGE00938)

5. Industrial Uses

POTW discharges to surface waters are often upstream of industrial facilities that withdraw surface waters for various cooling and process uses. High levels of TDS can adversely affect industrial applications requiring the use of water in cooling tower operations, boiler feed water, food processing, and electronics manufacturing. Concentrations of TDS above 500 mg/L result in excessive corrosivity, scaling, and sedimentation in water pipes, water heaters, boilers and household appliances. Depending on the industry, TDS in intake water can interfere with chemical processes within the plant. Some industries requiring ultrapure water, such as semi-conductor manufacturing facilities, are particularly sensitive to high TDS levels due to the treatment cost for the removal of TDS.

XVI. Non-Water Quality Environmental Impacts Associated with the Proposed Rule

Because the elimination or reduction of one form of pollution can create or aggravate other environmental problems, EPA considers non-water quality environmental impacts (including energy impacts) that can result from the implementation of proposed

[26] The variables in the equation are defined as follows: $[Na^{+}]$ – Sodium concentration (mg/L); $[Ca^{2+}]$ – Calcium concentration (mg/L); $[Mg^{2+}]$ – Magnesium concentration (mg/L).

regulations. EPA evaluated the potential impact of the proposed pretreatment standards on air emissions, solid waste generation, and energy consumption.

The proposed PSES/PSNS would prohibit the discharge to POTWs of wastewater pollutants associated with UOG extraction. Because EPA knows of no POTWs that are currently accepting UOG extraction wastewater, the proposed PSES will require no changes in current industry wastewater management practices and, consequently, will have no incremental impacts on air emissions, solid waste generation, or energy consumption. Based on the reasoning that new sources will follow current industry practice, EPA projects no incremental non-water quality environmental impacts associated with PSNS.

XVII. Implementation

A. Implementation Deadline

Because the requirements of the proposed rule are based on current practice, EPA proposes that the PSES/NSPS standards based on the regulatory options being proposed apply on the effective date of the final rule.

B. Upset and Bypass Provisions

A “bypass” is an intentional diversion of waste streams from any portion of a treatment facility. An “upset” is an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. EPA’s regulations for indirect dischargers concerning bypasses and upsets are set forth at 40 CFR 403.16 and 403.17.

C. *Variances and Modifications*

The CWA requires application of effluent limitations established pursuant to section 304 for direct dischargers and section 307 for all indirect dischargers. However, the statute provides for the modification of these national requirements in a limited number of circumstances. Moreover, the Agency has established administrative mechanisms to provide an opportunity for relief from the application of the national pretreatment standards for categories of existing sources.

EPA can develop pretreatment standards different from the otherwise applicable requirements for an individual existing discharger if it is fundamentally different with respect to factors considered in establishing the standards applicable to the individual discharger. Such a modification is known as a "fundamentally different factors" (FDF) variance. See 40 CFR 403.13. EPA, in its initial implementation of the effluent guidelines program, provided for the FDF modifications in regulations. These were variances from the BCT effluent limitations, BAT limitations for toxic and nonconventional pollutants, and BPT limitations for conventional pollutants for direct dischargers. FDF variances for toxic pollutants were challenged judicially and ultimately sustained by the Supreme Court in *Chemical Manufacturers Association v. Natural Resources Defense Council*, 479 U.S. 116, 124 (U.S. 1985). FDF variances, however, are not available for new sources. *E.I. Dupont v. Train*, 430 U.S. 112, 138 (U.S. 1977).

Subsequently, in the Water Quality Act of 1987, Congress added new CWA section 301(n). This provision explicitly authorizes modifications of the otherwise applicable BAT effluent limitations or categorical pretreatment standards if a discharger is fundamentally different with respect to the factors specified in CWA section 304 or

403 (other than costs) from those considered by EPA in establishing the effluent limitations or pretreatment standards. CWA section 301(n) also defined the conditions under which EPA can establish alternative requirements. Under section 301(n), an application for approval of a FDF variance must be based solely on (1) information submitted during rulemaking raising the factors that are fundamentally different or (2) information the applicant did not have an opportunity to submit. The alternate limitation must be no less stringent than justified by the difference and must not result in markedly more adverse non-water quality environmental impacts than the national limitation or standard.

The legislative history of section 301(n) underscores the necessity for the FDF variance applicant to establish eligibility for the variance. EPA's regulations at 40 CFR 403.13 are explicit in imposing this burden upon the applicant. The applicant must show that the factors relating to the discharge controlled by the applicant's permit that are claimed to be fundamentally different are, in fact, fundamentally different from those factors considered by EPA in establishing the applicable pretreatment standards. In practice, very few FDF variances have been granted for past ELGs. An FDF variance may be available to an existing source subject to the proposed PSES, but an FDF variance is not available to a new source that would be subject to PSNS.

XVIII. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review

This action is a "significant regulatory action" under the terms of Executive Order 12866 (58 FR 51735, October 4, 1993). Accordingly, EPA submitted this action to the

Office of Management and Budget (OMB) for review under Executive Orders 12866 and 13563 (76 FR 3821, January 21, 2011) and any changes made in response to OMB recommendations have been documented in the docket for this action.

B. Paperwork Reduction Act

This action does not impose an information collection burden under the provisions of the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. Burden is defined at 5 CFR 1320.3(b). This proposal would codify current industry practice and would not impose any additional reporting requirements.

C. Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any proposed rule that would be subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of the proposed rule on small entities, small entity is defined as: (1) a small business that is primarily engaged in Crude Petroleum and Natural Gas Extraction and Natural Gas Liquid Extraction by NAICS code 211111 and 211112 with fewer than 500 employees (based on Small Business Administration size standards).

After considering the economic impacts of the proposed rule on small entities, I certify that this action will not have a significant economic impact on a substantial number of small entities. The small entities that would be subject to the requirements of this proposed rule are small businesses that engage in UOG extraction as defined in Section XI. No small businesses will experience an impact because the proposed rulemaking does not impose any new requirement that is not already being met by the industry.

D. Unfunded Mandates Reform Act

This proposed rule does not contain a Federal mandate that can result in expenditures of $100 million or more for state, local, and tribal governments, in the aggregate, or the private sector in any one year. As explained in Section VI.C., this proposed rule has no costs. Thus, this proposed rule would not be subject to the requirements of sections 202 or 205 of the Unfunded Mandates Reform Act (UMRA).

This proposed rule also would not be subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments. EPA has not identified any oil and gas facilities that are owned by small governments.

E. Executive Order 13132: Federalism

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. The proposed rule would not alter the basic state-federal scheme established in the CWA under which EPA authorizes states to carry out the NPDES permit program. EPA expects the proposed rule would have little effect on the relationship between, or the distribution of power and responsibilities among, the federal and state governments. Thus, Executive Order 13132 does not apply to this action. Although this order does not apply to this action, as explained in Section IX., EPA coordinated closely with states through a workgroup, as well as outreach efforts to pretreatment coordinators and pretreatment authorities.

F. Executive Order 13175: Consultation and Coordination with Indian Tribal Governments

This action does not have tribal implications, as specified in Executive Order 13175 (65 FR 67249, November 9, 2000). It will not have substantial direct effects on tribal governments, on the relationship between the Federal government and Indian tribes, or on the distribution of power and responsibilities between the Federal government and Indian tribes. The proposed rule contains no Federal mandates for tribal governments and does not impose any enforceable duties on tribal governments. Thus, Executive Order 13175 does not apply to this action.

Although Executive Order 13175 does not apply to this action, EPA coordinated with tribal officials in developing this action. EPA coordinated with federally recognized tribal governments in May and June of 2014, sharing information about the UOG pretreatment standards proposed rulemaking with the National Tribal Caucus and the National Tribal Water Council. As part of this outreach effort, EPA collected data about UOG operations on tribal reservations, UOG operators that are affiliated with Indian tribes, and POTWs owned or operated by tribes that can accept industrial wastewaters (see DCN SGE00785). Based on this information, there are no tribes operating UOG wells that discharge wastewater to POTWs nor are there any tribes that own or operate

POTWs that accept industrial wastewater from UOG facilities; therefore, this proposed rule will not impose any costs on tribes.

G. Executive Order 13045: Protection of Children from Environmental Health and Safety Risks

EO 13045 (62 FR 19885, April 23, 1997) applies to rules that are economically significant according to EO 12866 and involve a health or safety risk that can disproportionately affect children. This proposed action would not be subject to EO 13045 because it is estimated to cost less than $100 million and does not involve a safety or health risk that can have disproportionately negative effects on children.

H. Executive Order 13211: Energy Effects

This proposed action is not subject to Executive Order 13211, because it not a "significant energy action" as defined in Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use" (66 FR 28355, May 22, 2001). This action will not have a significant adverse effect on the supply, distribution, or use of energy, as described in Section XVI. of the proposed rule.

I. National Technology Transfer Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 ("NTTAA"), Public Law No. 104-113, 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (*e.g.*, materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This proposed rulemaking does not involve technical standards. Therefore, EPA is not considering the use of any voluntary consensus standards.

J. Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order 12898 (59 FR 7629 (Feb. 16, 1994)) establishes federal executive policy on environmental justice. Its main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the U.S.

EPA determined that this proposed rule will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it does not affect the level of protection provided to human health or the environment. The proposed rule changes the control technology required but will neither increase nor decrease environmental protection (as described in Section VII.C.).

EPA welcomes comments on this aspect of the proposed rulemaking and, specifically, invites the public to identify potential environmental justice considerations associated with this proposed regulation.

List of Subjects in 40 CFR Part 435

Environmental protection, Pretreatment, Waste treatment and disposal, Water pollution control, Unconventional oil and gas extraction.

Dated: March 31, 2015.

Gina McCarthy,
Administrator.

Therefore, it is proposed that 40 CFR part 435 be amended as follows:

PART 435—OIL AND GAS EXTRACTION POINT SOURCE CATEGORY

1. The authority citation for part 435 continues to read as follows:

Authority: 33 U.S.C. 1311, 1314, 1316, 1317, 1318, 1342 and 1361.

2. Add §435.33 to read as follows:

§435.33 Pretreatment standards of performance for existing sources (PSES).

(a) *PSES for Wastewater from Conventional Oil and Gas Extraction*. [Reserved]

(b) *PSES for Wastewater from Unconventional Oil and Gas Extraction*. Except as provided in 40 CFR 403.7 and 403.13, any existing source subject to this section, must achieve the following pretreatment standards for existing sources (PSES).

(1) There shall be no discharge of wastewater pollutants associated with production, field exploration, drilling, well completion, or well treatment for unconventional oil and gas extraction (e.g., drilling muds, drill cuttings, produced sand, produced water) into publicly owned treatment works.

(2) For the purposes of this section,

(i) *Unconventional oil and gas* means crude oil and natural gas produced by a well drilled into a low porosity, low permeability formation (including, but not limited to, shale gas, shale oil, tight gas, tight oil).

(ii) *Drill cuttings* means the particles generated by drilling into subsurface geologic formations and carried out from the wellbore with the drilling fluid.

(iii) *Drilling muds* means the circulating fluid (mud) used in the rotary drilling of wells to clean and condition the hole and to counterbalance formation pressure.

(iv) *Produced sand* means the slurried particles used in hydraulic fracturing, the accumulated formation sands, and scales particles generated during production. Produced sand also includes desander discharge from the produced water waste stream, and blowdown of the water phase from the produced water treating system.

(v) *Produced water* means the water (brine) brought up from the hydrocarbon-bearing strata during the extraction of oil and gas, and can include formation water, injection water, and any chemicals added downhole or during the oil/water separation process.

3. Add §435.34 to read as follows:

§435.34 Pretreatment standards of performance for new sources (PSNS).

(a) *PSNS for Wastewater from Conventional Oil and Gas Extraction*. [Reserved]

(b) *PSNS for Wastewater from Unconventional Oil and Gas Extraction*. Except as provided in 40 CFR 403.7 and 403.13, any new source with discharges subject to this section must achieve the following pretreatment standards for new sources (PSNS).

(1) There shall be no discharge of wastewater pollutants associated with production, field exploration, drilling, well completion, or well treatment for unconventional oil and gas extraction (e.g., drilling muds, drill cuttings, produced sand, produced water) into publicly owned treatment works.

(2) For the purposes of this section, the definitions of unconventional oil and gas, drill cuttings, drilling muds, produced sand, and produced water are as specified in §435.33(b)(2)(i) through (v).

4. Add subpart H to read as follows:

Subpart H—Coalbed Methane Subcategory [Reserved]

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