Natural Gas Drilling in the Marcellus Shale
NPDES Program Frequently Asked Questions

1) What is the Marcellus Shale?

The Marcellus Shale is an organic rich rock that has been estimated to contain from 50 to 500 trillion cubic feet of natural gas[1]. It was deposited in the Appalachian Basin 350 million years ago as part of an ancient river delta and consists of the bottom layer of an Upper Devonian age sedimentary rock sequence. Like most shale, the Marcellus was deposited as extremely fine grained sediment, with small pore spaces and low permeability that prevents gas from easily migrating[1]. Often called the Marcellus Black Shale due to its color, the formation exists under much of southern New York, Pennsylvania, West Virginia, eastern Ohio, and far western Maryland. Although the shale outcrops at its namesake, Marcellus, New York, it generally lies at depths of 5,000 to 9,000 feet throughout much of the area.[2] The Marcellus Shale generally ranges in thickness from 50 to 200 feet.

2) Why is the Marcellus Shale gas extraction suddenly important for natural gas production?

The combination of advances in drilling and fracturing technology, the large volume of natural gas reserves, and its proximity to eastern cities have made the Marcellus Shale an important resource. Although the first commercial shale gas well was drilled in New York in 1821, extensive drilling and extraction of natural gas from shale deposits in the United States did not begin until the 1980's.[3,4] Horizontal drilling techniques, that make gas extraction viable in the Marcellus Shale, did not become commercially available until the late 1980s.[5] Fracturing techniques that are needed to economically extract gas from impermeable shale deposits, like the Marcellus, also recently became refined.[6] Analysis of the Marcellus formation geology suggests that areas in the north central and northeastern regions of Pennsylvania have a high potential to produce significant amounts of gas. This area of the country has not traditionally seen extensive gas well drilling.[7]

---

[1] Soeder, D.J., and Kappel, W.M., 2009, Water Resources and Natural Gas Production from the Marcellus Shale: U.S. Geological Survey Fact Sheet 2009–3032, 6 p.

[2] USGS, 2006, Assessment of Appalachian Basin Oil and Gas Resources: Devonian Shale-Middle and Upper Paleozoic Total Petroleum System.

[3] Hill, D.G., etal, 2003 , Fractured Shale Gas Potential in New York, posted at: http://www.pe.tamu.edu/wattenbarger/public_html/Selected_papers/--Shale%20Gas/fractured%20shale%20gas%20potential%20in%20new%20york.pdf

[4] Shirley, K., 2001, Shale Gas Exciting Again, Explorer, posted at: http://www.aapg.org/explorer/2001/03mar/gas_shales.cfm

[5] Energy Information Administration, Office of Oil and Gas, U.S. Department of Energy, Drilling Sideways – A Review of Horizontal Well Technology and its Domestic Application, April, 1993.

[6] Ground Water protection Council, 2009, Modern Shale Gas Development in the United States: A Primer, 116 p., posted at: www.gwpc.org

[7] Reference: "Drilling for Natural Gas in the Marcellus Shale Formation - Frequently Asked Questions" as written by the Pennsylvania Department of Environmental Protection and posted at http://www.dep.state.pa.us/dep/deputate/minres/oilgas/new_forms/marcellus/marcellus.htm.

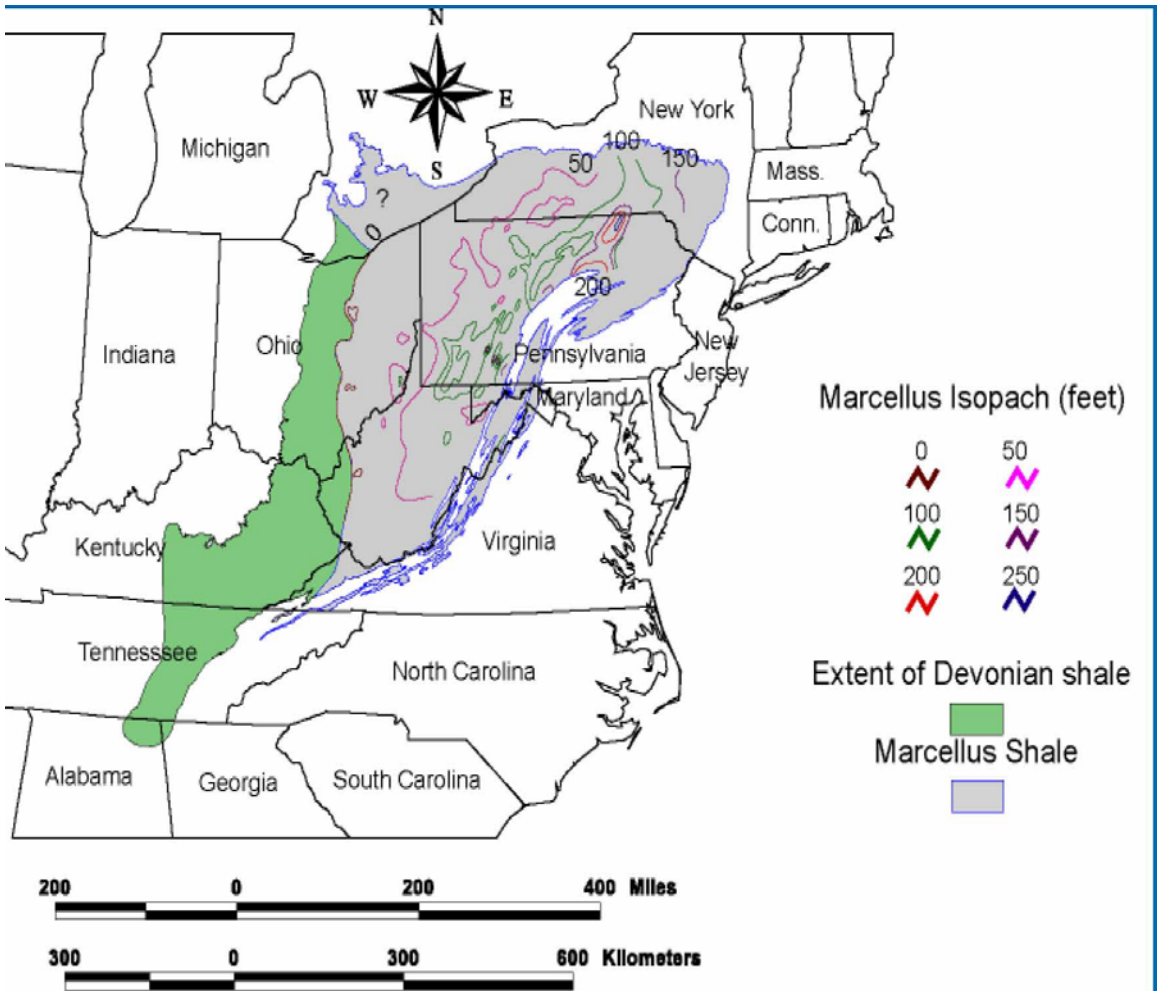

Figure 1: Location of Marcellus Shale[8]

3) How is extraction from the Marcellus Shale different from other natural gas extraction?

Marcellus gas extraction is considered "unconventional" by the Department of Energy's Energy Information Administration because the gas is found within a shale formation rather than a more normal sandstone or limestone rock layer.[9] Conventional gas extraction typically involves drilling through an impervious rock formation into a porous formation saturated with gas and trapped by the impervious cap rock. Conventional extraction typically relies on the high permeability of the rock that allows gas to readily flow to the well for production. Although horizontal wells have become more common

[8] Milici, R.C., USGS Open File Reports 2005-1268, Assessment of Undiscovered Natural Gas Resources in Devonian Black Shales, Appalachian Basin, Eastern United States, 2005
[9] See http://www.eia.doe.gov/oiaf/analysispaper/unconventional_gas.html.

over time for conventional gas extraction, wells are more typically relatively straight and vertical.

Unconventional gas extraction includes: deep gas (greater than 15,000 feet), tight gas, shale gas, coal bed methane, gas from geopressurized zones, and methane hydrates. Like tight gas which is extracted from sandstone and limestone deposits that have a low permeability, shale gas extraction requires techniques such as fracturing and horizontal drilling that are less commonly used in conventional extraction. Horizontal drilling is commonly used in shale gas extraction as a means to increase potential production. Horizontal drilling results in a well extending through a much larger portion of the shale; thereby increasing the area from which a well can produce and the amount of gas produced.

In addition to greater use of horizontal drilling, operators make extensive use of hydraulic fracturing as a means to economically produce gas from deposits with low permeability, such as the Marcellus Shale. Hydraulic fracturing requires drillers to pump large amounts of water mixed with sand or other proppants into the shale formation under high pressure (approximately 10,000 psi) to fracture the shale formation adjacent to the wellbore and to create paths that connect the gas to the well. This allows the natural gas to flow freely up the well for compression, transmission, and sale. Once the hydraulic fracturing process is completed and the wellbore pressure is released, approximately one-third of the water flows out of the well[11]. That hydraulic fracturing flowback water (HFFW) must be treated to remove chemicals and minerals.[1] Horizontal wells in the Marcellus Shale require 3 to 5 million gallons for hydraulic fracturing, whereas conventional wells of a similar depth required approximately 1 million gallons of water.[10] The greater quantity of water used for fracturing in shale gas wells is due in part to the extended reach of horizontal wells in addition to the amount of fracturing required to extract gas from a rock that has low permeability[11].

[10] Gaudlip, A.W., et. al., 2008, Marcellus Shale Water Management Challenges in Pennsylvania, SPE 119898

[11] University of Maryland, Reconciling Shale Gas Development with Environmental Protection, Landowner Rights, and Local Community Needs, Schools of Public Policy, July, 2010.

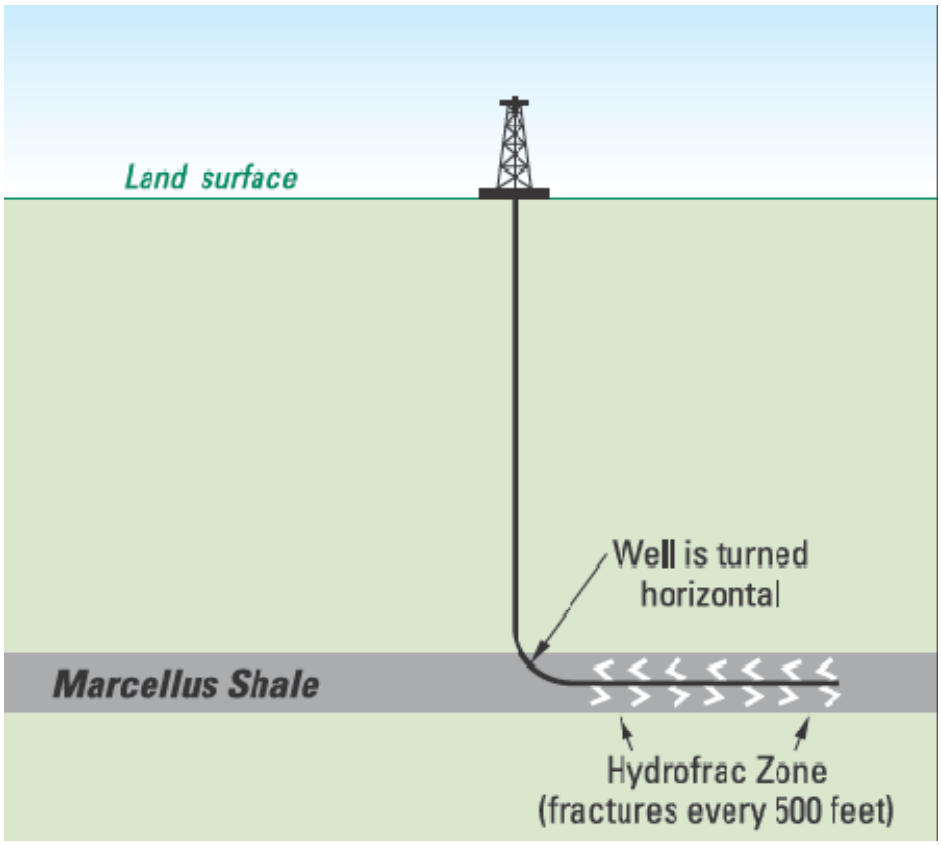

Figure 2: Example of a Horizontal Well[1]

4) How many wells could be expected at a Marcellus gas extraction site?

The number of wells drilled at a site is highly variable and is dependent on local drilling activity, recycling practices of operators, state regulations on well spacing, and local ordinances, among other factors. In general, 1 to 8 wells can be placed on a well pad. A site is expected to consist of only one well pad. Since each well will require numerous trucks to haul away HFFW, a treatment facility (Publicly Owned Treatment Works (POTW) or Centralized Waste Treatment facility (CWT)) would be expected to receive a number of truck loads from a single site.

5) How similar is the Marcellus Shale to other shale deposits where natural gas is currently extracted?

Major shale deposits currently being developed in the United States include the Antrim, Barnett, Fayetteville, Haynesville, Marcellus, and Woodford Shale. Those shale deposits all have the common characteristic of low porosity and permeability. Extraction almost universally requires horizontal drilling combined with extensive hydraulic fracturing. There are some differences in depth, aerial extent, gas content, and thickness that distinguish between the different shale deposits. A comparison follows in Table 1. Gas

extraction activities at all of those shale deposits will present the same challenges for waste disposal.

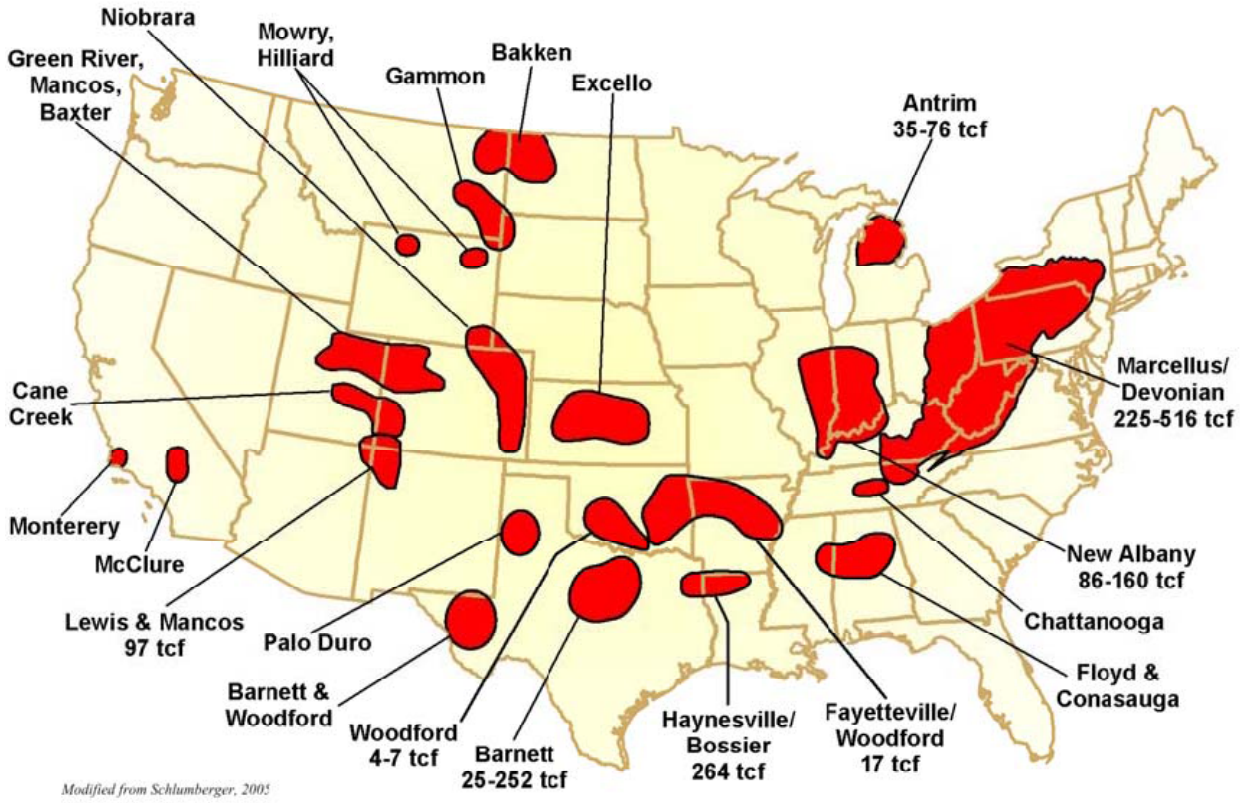

Figure 3: Shale Gas Plays in the United States[12]

Table 1: Comparison of Data for the Gas Shales in the United States[12]

Gas Shale Basin	Estimated Basin Area (mi^2)	Depth (ft)	Net Thickness (ft)	Gas Content (scf/ton)
Antrim	12,000	600-2,200	70-12	40-100
Barnett	5,000	6,500-8,500	100-600	300-350
Fayetteville	9,000	1,000-7,000	20-200	60-220
Haynesville	9,000	10,500-13,500	200-300	100-330
Marcellus	95,000	4,000-8,500	50-200	60-100
Woodford	11,000	6,000-11,000	120-220	200-300

[12] Arthur, J., et.al., 2008, An Overview of Modern Shale Gas Development in the United States, ALL Consulting, 21 p., posted at: http://www.all-llc.com/publicdownloads/ALLShaleOverviewFINAL.pdf

6) **Does the Clean Water Act apply to discharges from Marcellus Shale Drilling operations?**

Yes. Natural gas drilling can result in discharges to surface waters. The discharge of this water is subject to requirements under the Clean Water Act (CWA).

The CWA prohibits the discharge of pollutants by point sources into waters of the United States, except in compliance with certain provisions of the CWA, including section 402. 33 U.S.C. 1311(a). Section 402 of the CWA establishes the National Pollutant Discharge Elimination System ("NPDES") program, under which EPA, or an authorized state agency, may issue a permit allowing the discharge of pollutants into waters of the U.S. 33 U.S.C. 1342(a). When developing effluent limitations for an NPDES permit, a permit writer must consider limits based on both the technology available to control the pollutants (i.e., technology-based effluent limits) and limits that are protective of the water quality standards of the receiving water (i.e., water quality-based effluent limits). CWA section 301, 33 U.S.C. § 1311; 40 CFR 125.3(a). The technology-based requirements for direct discharges from oil and gas extraction facilities into surface waters are found in 40 Code of Federal Regulations (CFR) Part 435 (see question7, below).

In addition to direct discharges, wastewaters may be indirectly discharged into waters of the U.S. through sewer systems connected to publicly owned treatment works (POTW) that discharge directly to waters of the U.S. or by being introduced by truck or rail into a POTW that discharges directly. EPA regulations set standards for the pretreatment of wastewater introduced to a POTW including prohibiting introduction of wastes that interferes with, passes through or are otherwise incompatible with POTW operations. 33 U.S.C. § 1317(b)(1). EPA has developed other nationally applicable pretreatment standards under section 307(b) in its General Pretreatment Regulations for Existing and New Sources of Pollution (Pretreatment Regulations) at 40 C.F.R. Part 403. These pretreatment standards are applicable to any user of a POTW, defined as a source of an indirect discharge. 40 C.F.R. 403.3(h). These national pretreatment standards include: 1) a general prohibition and 2) specific prohibitions. 40 C.F.R. 403.5.(a)(1) and (b). The general prohibition prohibits any user of a POTW to introduce a pollutant into the POTW that will cause pass through or interference. The regulations define both pass through and interference. Section 307(d) of the Act prohibits discharge in violation of any pretreatment standard. 33 U.S.C. § 1317(d). See questions 10 and11, below, for additional information on pretreatment requirements.

Wastewater may also be disposed of at centralized waste treatment facilities (CWTs). Technology-based standards for CWTs can be found at 40 CFR Part 437. Issues and requirements associated with CWTs are discussed below under questions13, 14 and 15.

7) Do the Oil and Gas Extraction effluent guidelines for onshore operations, found at 40 CFR Part 435, Subpart C, apply to Marcellus Shale gas drilling?

Yes. The technology-based regulations (40 CFR Part 435, Subpart C) apply to onshore facilities "engaged in the production, field exploration, drilling, well completion and well treatment in the oil and gas extraction industry." Gas drilling in the Marcellus Shale fits squarely within this applicability statement. Although, as discussed in Question 3 above, Marcellus Shale gas extraction may be considered "unconventional" gas extraction, the wastestreams generated by processes used in such extraction, such as hydraulic fracturing, were considered and covered by the effluent guideline. *See, e.g.* 41 Fed. Reg. 44946 (Oct. 13, 1976); Technical Development Document at 22-23, 96, 137. Accordingly, the discharge prohibitions in 40 CFR Part 435, Subpart C, apply to Marcellus Shale gas extraction.

The effluent guidelines at 40 CFR 435, Subpart C establish best practicable control technology currently available (BPT) requirements for onshore facilities: "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)." During the issuance process for the guidelines, EPA identified different technologies that operators can use to comply with this technology-based regulation (e.g., underground injection, use of pits/ponds for evaporation).

8) Since 40 CFR Part 435, Subpart C applies to the Marcellus Shale drilling activity, may an NPDES permit authorize onsite discharge of this wastewater to a water of the U.S.?

No. Because all applicable technology based requirements must be applied in NPDES permits under the CWA section 402(a) and implementing regulations at 40 CFR 125.3, an NPDES permit issued for the drilling activity would need to be consistent with 40 CFR Part 435, Subpart C, which states that 'there shall be no discharge of wastewater 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)." [13]

9) Are facilities subject to 40 CFR Part 435, Subpart C required to obtain an NPDES permit that imposes the "no discharge" requirement for the activities identified in Subpart C?

No. EPA's regulations at 40 CFR 122.21(a) require permits only for facilities that "discharge or propose to discharge." Accordingly, facilities subject to a "no discharge"

[13] Note: Shale gas wells from other formations that are located west of the 98th meridian may be regulated under the Agriculture and Wildlife Water Use Subcategory of the Oil and Gas Extraction Category (40 CFR Part 435, Subpart E). Produced water discharges can be authorized under that subcategory if they are of good enough quality to be used by agriculture or wildlife watering and actually are put to that use. The subcategory only allows the discharge of produced water. The discharge of all other waste streams, such as completion fluids, cannot be authorized under Subpart E.

limit that do not discharge or propose to discharge are not required to apply for NPDES permits. States can use their own authority to ensure that the no discharge requirement in the effluent guideline is properly applied and to ensure that operator compliance is demonstrated.

Facilities subject to a zero discharge requirement may apply for permit coverage to qualify for the upset or bypass defense in the event of an unanticipated discharge resulting from an exceptional incident that otherwise would trigger a CWA Section 301 violation for discharging without a permit. *See* 40 CFR 122.41(m) and (n).

10) May Shale Gas extraction (SGE)[14] wastewaters be discharged to a POTW?

POTWs may accept SGE wastewater under certain circumstances. Process wastewater from such operations may be introduced to POTWs but only to the extent that such wastewater discharges are in compliance with all Federal, State, and local requirements governing the introduction of such wastewaters into the POTW. EPA has generally promulgated pretreatment standards that apply to wastewater introduced to POTWs along with effluent guideline for industrial categories.

The current Federal regulations at 40 CFR 435, Subpart C do not include pretreatment standards that address the disposal of Marcellus Shale wastewater to POTWs. However, EPA's General Pretreatment regulations prohibit the introduction of wastewater into a POTW in certain defined circumstances, including the introduction of any pollutants which "pass through" or cause "interference" with POTW operations. 40 CFR Part 403.3(k)(1) defines interference as inhibiting or disrupting the POTW, its treatment processes or operations, or its sludge processes, use or disposal. Therefore, in addition to prohibiting the introduction of pollutants into the POTW that would disrupt the treatment process, the general regulations also prohibit the introduction of pollutants in concentrations that contaminate biosolids and make them inconsistent with the POTW's chosen method of use or disposal. Pass through is defined at 40 CFR 403.3(p) to mean "a discharge which exits the POTW into waters of the United States in quantities or concentrations which, alone or in conjunction with a discharge or discharges from other sources, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude of a violation)." All non-domestic discharges must comply with these requirements. See 40 CFR 403.5(a) and (b).

Note: SGE wastewater that is discharged to a POTW from a CWT may have the same issues as wastewater taken directly to a POTW from a shale gas extraction well and pass through and interference will also need to be addressed.

11) What requirements do POTWs need to meet in order to accept shale gas wastewater?

[14] SGE wastewater includes HFFW, produced water, spent drilling fluids, and spent well completion and treatment fluids that have result from shale gas extraction activities.

POTWs need to comply with their NPDES permit terms and conditions. In accordance with the NPDES permitting regulation at 40 CFR 122.42(b)[15], permits must include conditions that require - - -"all POTWs must provide adequate notice to the Director [EPA and/or the state NPDES permitting/pretreatment authority[16]] of the following:

(1) Any new introduction of pollutants into the POTW from an indirect discharger which would be subject to section 301 or 306 of the CWA if it were directly discharging those pollutants; and
(2) Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the [POTW's] permit.
(3) For the purposes of this paragraph, adequate notice shall include information on (i) the quality and quantity of effluent introduced into the POTW, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW."

To the extent that a permit so requires, when considering the acceptance of such wastewater, a POTW needs to collect information from the industry on the quality and quantity of the SGE wastewater proposed to be introduced to the POTW and assess the potential impact to the POTW if the POTW were to accept the wastewater. For SGE wastewater, that discharge characterization should include the concentrations of total dissolved solids, specific ions, such as chlorides and sulfate, specific radionuclides, metals, and other pollutants that could reasonably be expected to be present in wastewater from a well. In addition to the ions, radionuclides, and metals that can be expected to be present in wastewater produced from a well, the characterization should include all chemicals used in well drilling, completions, treatment, workover, or production, that could reasonably be expected to be present in wastewater. Pursuant to the permit, this information must generally be reported to EPA and/or the State program before the POTW may accept the HFFW. "Adequate notice" is meant to provide the EPA (or the state NPDES permitting authority) with enough time to determine if the POTW NPDES permit needs to be modified in order to address potential effects due to the potential new indirect discharger. In cases such as Pennsylvania, where the state is the permitting authority and EPA is the approval authority for pretreatment, the POTW must submit the required information to both agencies. In addition to this notification, all industrial user discharges to a POTW must comply with the specific prohibitions of 40 CFR 403.5(b), any applicable categorical standards, and any state and local limits.

EPA Regions, in their oversight role, should work with authorized States to ensure that NPDES permits for POTWs include the pretreatment notification requirements and

[15]Applicable to State NPDES programs, see 40 CFR 123.25.
[16] Under 40 CFR 122.2, "*Director*means the Regional Administrator or the State Director, as the context requires, or an authorized representartive. When there is no "approved State program" and there is an EPA administered program, "Director" means the Regional Administrator." Where a State not have an approved State pretreatment program, the Regional Administrator is the Director of the pretreatment program under this provision.

definitions of 40 CFR 122.2, 122.42(b), and 403.5(b). By including those requirements in permits, the permitting authorities will help prevent potential oversights of the notification requirements by POTW operators.

EPA recognizes that POTW operations vary due to site-specific factors. All POTWs with approved pretreatment programs, and all other POTWs designated by EPA or the state as having experienced or having the potential to experience pass through or interference, must develop technically-based local limits where necessary to comply with the general pretreatment standards. See 40 CFR 403.5(c) & 403.8(a). To assist in this evaluation, EPA has issued guidance on establishing local limits: Local Limits Development Guidance, EPA-833-R-04-002A, July 2004.[17] [18]

12) What are the main potential pollutants of concern for POTWs accepting SGE wastewaters?

Constituents in SGE wastewater such as total dissolved solids (TDS) have been found to be present at concentrations ranging from 280 mg/l to 345,000 mg/l.[19] Chloride has been reported in concentrations up to 196,000 mg/l.[20] TDS is not significantly removed by most conventional POTW treatment systems; therefore, pretreatment of the wastewater would be required prior to discharge to the POTW. However, very little comprehensive data have been collected nationwide on TDS treatment capability at POTWs. Common constituents of TDS include calcium and magnesium (also a measure of "hardness"), phosphates, nitrates, sodium, potassium, sulfates, chloride, and even barium, cadmium, and copper. A literature data search revealed that some of these individual constituents of TDS may result in POTW process inhibition in activated sludge, nitrification, and anaerobic digestion processes. POTWs may exhibit these process inhibitions from these individual constituents at concentrations that are several magnitudes lower than the composite TDS found in SGE wastewater (example: sulfate at 400-1000 mg/l disrupting anaerobic digestion processes; chloride at 180 mg/l disrupting nitrification processes[21]). High concentrations of chlorides, such as in Marcellus SGE wastewater, can disrupt biological treatment units. Some POTWs that had previously accepted oil and gas extraction waste through their pretreatment programs experienced operational problems due to high concentrations and spikes in concentrations of TDS.[22] In addition, some of the constituents in oil and gas extraction waste, such as metals, can precipitate during the

[17] Available at: http://cfpub.epa.gov/npdes/home.cfm?program_id=3
[18] Guidance Manual for the Control of Wastes Hauled to Publicly owned treatment works" EPA 833-B-98-003, September 1999.
[19] Haynes, Thomas, 2009, Sampling and Analysis of Water Streams Associated with the Development of Marcellus Shale Gas, Gas Technology Institute, Des Plaines, IL.
[20] NYSDEC, 2009, Supplemental Generic Environmental Statement on the Oil, Gas, and Solution Mining Regulatory Program, Well Permit Issuance for Horizontal Drilling and High-Volume Fracturing to Develop the Marcellus Shale and Other Low Permeability Gas Reservoirs, Appendix 13, available at: http://www.dec.ny.gov/energy/58440.html
[21] USEPA, Local Limits Development Guidance Appendices, EPA 833-R-04-002B, July, 2004
[22] Record of communications between Scott Wilson (EPA, OWM), Morgan City, LA pretreatment program, and Ted Palit (EPA Region 6)

treatment process and contaminate biosolids which may require expensive decontamination of biosolids drying beds or change the chosen method of use or disposal. Bromide, which can be present in SGE wastewater in significant concentrations, has the potential to be present in POTW effluent as a disinfection byproduct and may cause an increase in whole effluent toxicity[21].

Because there is a significant possibility that SGE wastewater may "pass through" the POTW, causing the POTW to violate its permit, cause "interference" with the POTW's operation, or contamination of biosolids, acceptance of the waste is not advisable unless it's effects on the treatment system are well understood and the wastewater is not reasonably expected to cause pass through or interference. POTWs cannot accept Marcellus wastewater if acceptance of the wastewater would result in violations of the POTW's permit, the POTW's requirement under 40 CFR 403.5(c) to develop and enforce local limits to implement the general and specific prohibitions of 403.5(a)(1) and (b), or contamination that interferes or disrupts biosolids processes, uses, or disposal. NPDES permits for discharges from POTWs to water of the U.S. also must meet applicable water quality-based requirements that are discussed in more detail in question number 21.

Radionuclides in Marcellus SGE wastewater also pose a challenge for POTWs. Radionuclides are discussed below in the response to question number 19.

These same pollutants may be of concern to POTWs that accept wastewater from CWTs that themselves accept SGE wastewaters. Many CWTs may not effectively treat SGE wastewater. Appropriate limits and pretreatment requirements will need to be developed by the permitting authority and the pretreatment control authority.

13) Could SGE wastewater be transferred to a CWT facility for treatment and discharge?

Yes. Although the direct discharge of wastewater from drilling operations is not authorized, the wastewater may be transported to a CWTs for treatment and subsequent discharge. Discharges from a CWT are subject to the effluent limitations guidelines and standards established under 40 CFR Part 437.

Additional limits may be required to address pollutants in the wastewater that were not considered in developing the CWT effluent guideline. For such pollutants, EPA's NPDES regulations require that permit writers include technology-based limits developed on a case-by-case, "best professional judgment" (BPJ) basis. *See* 40 CFR §125.3(c)(3) ("Where promulgated effluent limitations guidelines only apply to certain aspects of the discharger's operation, or to *certain pollutants*, other aspects or activities are subject to regulation on a case by case basis…"). In developing technology-based BPJ limits, the permit writer must consider the factors specified in 40 CFR 125.3(d), the same factors that EPA considers in establishing categorical effluent guidelines.

In developing the CWT effluent guideline, EPA did not evaluate certain pollutants that are likely to be present in SGE wastewater, such as radionuclides. Consequently, the permitting authority will need to develop best professional judgment technology based effluent limits to address those pollutants identified in the effluent but not considered by the CWT Effluent Guidelines and incorporate these limits in the CWT's NPDES permit.

For some pollutants, such as total dissolved solids (TDS), EPA considered, but did not establish, pollutant limitations in the effluent guidelines. TDS levels in Marcellus Shale wastewaters have been measured to be present in concentrations up to 345,000 mg/l[20]. High concentrations of TDS will require advanced waste water treatment, such as distillation, and may cause scaling which requires frequent cleaning of equipment[10]. In addition to any applicable technology-based requirements, NPDES permits for discharges from CWTs to waters of the U.S. also must meet applicable water quality-based permitting requirements. See question number 21 for more detail on water quality permitting.

14) What Subpart of 40 CFR Part 437 should be used for the Marcellus Shale wastewater?

40 CFR Part 437 includes three subparts to address different industries that may dispose of wastewater in a CWT. Those subparts include: Metals Treatment and Recovery, Oils Treatment and Recovery, and Organics Treatment and Recovery. When the Effluent Limitations Guidelines were promulgated, EPA understood that industrial wastes would not always clearly fit under one of the subcategories. To address the issue of categorization of wastewater, EPA developed guidance for permit writers to determine which subpart of the 40 CFR Part 437 ELGs best addresses waste accepted by a CWT.[23] Chapter 5 of the guidance lists different waste sources that were examined during development of the ELG and were determined to best be addressed under each subpart. For waste sources not listed, the guidance contains additional criteria based on oil and grease content and metals concentrations that can be used for this determination. Available data for Marcellus shale extraction waste water show that the waste does not fit under the Oils or Metals Subcategories. The guidance suggests regulating waste under the Organics Subcategory for cases where it does not fit under the other Subcategories.[23] However, this determination was made only using Marcellus shale waste data. CWTs are expected to receive waste containing different pollutant types and concentrations originating from a variety of sources.[24] The permit writer will need to reexamine this determination based on site specific information when drafting a permit.

15) How is transportation of waste by pipeline addressed by the CWT regulations?

[23] USEPA, Small Entity Compliance Guide, Centralized Waste Treatment Effluent Limitations Guidelines and Pretreatment Standards (40 CFR Part 437), EPA-821-B-01-003, June, 2001, posted online at: http://www.epa.gov/waterscience/guide/cwt/CWTcompliance_guide.pdf
[24] 64 FR 2286, January 13, 1999

CWTs may accept wastewater transported to the CWT via pipeline. The CWT would be subject to applicable limitations imposed on its discharge through its NPDES permit or pretreatment program control mechanism. The CWT ELGs are only applicable to CWT discharges of treated piped wastewater if the treated piped wastewater is comingled with other wastewater covered by the CWT ELG. If the piped wastes are not commingled, the permitting authority will need to develop best professional judgment technology based effluent limits for discharges of piped wastewater from the CWT. The CWT regulations at 40 CFR 437.1(b)(3) address waste received via pipeline from offsite as follows:

> "(b) This part does not apply to the following discharges of wastewater from a CWT facility:
> .
> .
> .
> (3) Wastewater from the treatment of wastes received from off-site via conduit (e.g., pipelines, channels, ditches, trenches, etc.) from the facility that generates the wastes unless the resulting wastewaters are commingled with other wastewaters subject to this provision. A facility that acts as a waste collection or consolidation center is not a facility that generates wastes."

The requirement was included in the regulations to address wastes that are not as variable as those that were typically found to be treated at the CWT facilities studied during development of the ELGs. Unlike traditional CWT facilities, pipeline customers and wastewater sources do not change and are limited by the physical and monetary constraints associated with pipelines. In addressing this issue, the preamble to the proposed regulation states:

> "EPA has concluded that the effluent limitations and pretreatment standards for centralized waste treatment facilities should not apply to such pipeline treatment facilities because their wastes differ fundamentally from those received at centralized waste treatment facilities. In large part, the waste streams received at centralized waste treatment facilities are more concentrated and variable, including sludges, tank bottoms, off-spec products, and process residuals. The limitations and standards developed for centralized waste treatment facilities, in turn, reflect the types of waste streams being treated and are necessarily different from those promulgated for discharges resulting from the treatment of process wastewater for categorical industries."[25]

This issue was also addressed in the final rule which further clarified that waste delivered via pipeline would have a more uniform flow rate and with a relatively consistent pollutant concentration. Wastes delivered solely by pipeline would be more consistent with a traditional manufacturing facility that did not accept waste from a variety of different sources.[26]

[25] 60 FR 5463 - 5506, January 27, 1995
[26] 65 FR 81241 - 81313, December 22, 2000

16) What potential hazardous waste issues apply to the acceptance of oil & gas extraction wastewater at a POTW or CWT via truck, train, or dedicated pipe?

Waste generated by activities associated with the exploration, development, and production of crude oil or natural gas, at primary field operations, are exempt from regulation under RCRA Subtitle C. See 40 CFR 261.4(b)(5). See also the July 1988 Regulatory Determination (53 FR 25466) and the March 1993 clarification of the Regulatory Determination (58 FR 15284) at http://www.epa.gov/epawaste/nonhaz/industrial/special/oil/index.htm. These wastes include drilling fluids, produced water, and other wastes associated with the exploration, development, or production of crude oil or natural gas. According to the legislative history, the term "other wastes associated" specifically includes waste materials intrinsically derived from primary field operations associated with the exploration, development, or production of crude oil and natural gas (e.g., spent hydraulic fracturing fluids). The exemption does not apply to excess supplies, such as unused drilling fluids or treatment chemicals. POTWs or CWTs receiving exempt oil and gas extraction wastewaters would not be receiving hazardous wastes and thus would not need to meet RCRA hazardous waste requirements, including RCRA permit or permit-by-rule requirements. For additional clarity on this issue regarding the status of oil and gas exploration and production wastes that are exempt from RCRA subtitle C regulations, see: http://www.epa.gov/epawaste/nonhaz/industrial/special/oil/oil-gas.pdf.

17) Does Part 435 Subpart G apply to the treatment and discharge of wastewaters from the Onshore Subcategory if those wastewaters were sent off-site for treatment and discharge at a facility covered by another ELG, such as a Centralized Waste Treatment (CWT) facility under Part 437?

No. EPA promulgated Subpart G, in part, to eliminate the practice of sending wastewaters from one Part 435 subcategory to another to take advantage of less stringent discharge requirements. Thus, for example, a facility regulated by the Coastal subcategory limitations located near a facility subject to the Offshore subcategory limitations might have sent its wastewater for treatment at the Offshore facility in order to get around the no discharge requirements. Under Subpart G, even if the Coastal subcategory facility transports its wastewater for treatment and/or disposal at the Offshore subcategory facility, the discharge would still be subject to the more stringent no discharge limitations for discharge to navigable waters.

If, however, an Onshore subcategory facility transports its wastewaters to an off-site centralized waste treatment facility, Subpart G would not apply. In this case, the wastewater discharge would be regulated by Part 437. *See* 40 CFR §437.1 (providing that Part 437 applies to "[t]reatment and recovery of … industrial metal-bearing waters, oily wastes and organic-bearing wastes received from off-site"). In this scenario, transferring wastewaters off-site for authorized disposal meets the no discharge

requirement in Part 435 Subpart C ("no discharge of waste water pollutants into navigable waters").

18) What is the definition of "off-site" in regard to SGE wastewater treated at CWTs?

From 40 CFR 122.2:
Site means the land or water area where any "facility or activity" is physically located or conducted, including adjacent land used in connection with the facility or activity.
Facility or activity means any NPDES "point source" or any other facility or activity (including land or appurtenances thereto) that is subject to regulation under the NPDES program.

For gas drilling activities, the land identified in the drilling permit; including the locations of wells, access roads, lease areas, and any lands where the facility is conducting its exploratory, development or production activities, or adjacent lands used in connection with the facility or activity, would constitute the site. Land that is outside the boundaries of that area is considered to be "off-site." (see also 40 CFR 437.2(n)

19) The Marcellus Shale is often referred to as a radioactive black shale in literature[27]. Are radionuclides an issue of concern with natural gas extraction and wastewater disposal?

Radionuclides associated with oil and gas extraction, also referred to as Naturally Occurring Radioactive Material (NORM), are a long standing waste management issue. Many states have addressed the issues associated with NORM in oil and gas extraction through their regulatory programs.[28,30,6] Radionuclides often exist in low concentrations in oil and gas waste and have been found to form deposits over time in piping and equipment. The issues commonly related to radionuclides in oil and gas extraction waste are decontamination of equipment and human health risk for workers.[29,30] Several states with extensive oil and gas extraction activity have also developed requirements for disposal facilities that accept radionuclide contaminated waste.[28] Since oil and gas extraction waste is not discharged in many states, water quality and human health issues associated with discharges under NPDES permits have not been been extensively examined.

[27] Milici, R.C. and C.S. Sweeney, 2006, Assessment of Appalachian Basin Oil amd Gas Resources: Devonian Shale – Middle and Upper Paleozoic Total Petroleum System, Open File Report Series 2006-1237, U.S. Department of Interior, USGS.
[28] http://norm.iogcc.state.ok.us/reg/dsp_statereg.cfm
[29] USGS, 1999, Naturally Occurring Radioactive Materials (NORM) in Produced Water and Oil Field Equipment – an Issue for the Energy Industry, USGS Fact Sheet FS-142-99
[30] Railroad Commission of Texas, NORM – Naturally Occurring Radioactive Material, posted at: http://www.rrc.state.tx.us/environmental/publications/norm.php

The Marcellus Shale has been found to contain NORM that can be in fairly high concentrations in oil and gas extraction wastewater. Radium 226 has been found to be present in concentrations up to 16,030 pCi/l in Marcellus Shale produced water.[31] HFFW from the Marcellus Shale has not been monitored extensively for radionuclides; however, Alpha particles have been found to be present at concentrations up to 18,950 pCi/l.[31] Those radionuclide concentrations exceed the drinking water Maximum Contaminant Levels of 5 pCi/L for Radium 266 and 15 pCi/l for Alpha particles. Although few studies are available that would help to understand the issue of NORM in POTW or CWT effluent, EPA is working with Pennsylvania to gather information and determine whether additional permit limits are needed to protect downstream drinking water supplies. Based on existing information on NORM associated with oil and gas extraction, it appears that care should be taken to address impacts to treatment facilities, such as scale buildup in equipment and contamination of sludge [biosolids]. Contamination of biosolids at POTWs that requires a change of disposal practice (e.g., radioactivity, etc.) is considered to be interference under the pretreatment program. See 40 CFR 403.3(k)(2) and 403.5(a)(1).

The discharge of shale gas wastewater from POTWs or CWTs has the potential to result in a discharge of radioactive contaminants. Such discharges must be characterized to determine whether reasonable potential exists for impacts to downstream Public Water Systems and other applicable water quality standards. If so, appropriate permit limits must be established.

When the 40 CFR Part 437 effluent limitations guidelines were developed, EPA found that CWTs were not designed to remove radionuclides. Many CWTs also discharge to POTWs rather than directly discharging to Waters of the United States. The same issues that apply to POTWs accepting wastewater from gas well operators also apply to wastewater accepted from CWTs[32].

20) Can any of the Marcellus Shale gas extraction activity fall under Part 435 Subpart F – Stripper Subcategory?

No. The Stripper Subcategory is clearly limited to onshore facilities which produce 10 barrels per well per calendar day or less of crude oil. The Marcellus Shale activity is gas extraction.

[31] NYSDEC, 2009, Supplemental Generic Environmental Statement on the Oil, Gas, and Solution Mining Regulatory Program, Well Permit Issuance for Horizontal Drilling and High-Volume Fracturing to Develop the Marcellus Shale and Other Low Permeability Gas Reservoirs, Appendix 13, available at: http://www.dec.ny.gov/energy/58440.html

[32] *Development Document for the CWT Point Source Category*, Final Rule: Development Document, USEPA, Washington, DC, 2000, available online at:. http://water.epa.gov/scitech/wastetech/guide/treatment/develop_index.cfm

21) What water quality-based requirements may apply in NPDES permits for discharges of Marcellus Shale Wastewater from POTWs and CWTs to waters of the U.S.?

EPA's NPDES regulations also require permit writers to include any more stringent requirements necessary to meet applicable water quality standards. Specifically, the regulations require limits to control all discharges that have the reasonable potential to cause or contribute to exceedences of water quality standards. 40 CFR 122.44(d)(1)(i). Accordingly, where, after application of technology-based effluent limits, the discharge of Marcellus Shale wastewater has a reasonable potential to cause or contribute to exceedences of water quality standards, the permit writer will need to develop water quality based effluent limits (WQBELs) for the POTWs or CWT's NPDES permit to protect water quality. Additional requirements may be needed to comply with other State regulations.[33]

WQBELs may be needed for TDS, in particular, where discharges of the pollutant from CWTs or POTWs have the reasonable potential to exceed state numeric or narrative water quality criteria. Since few states have established numeric water quality criteria for TDS, permitting authorities may need to develop a numeric translator to protect the state's narrative water quality criteria. In the Marcellus Shale wastewater, chloride typically constitutes about 50% of the total makeup of Total Dissolved Solids (TDS) in a sample. Elevated chloride levels can interfere with an aquatic organism's ability to maintain osmotic balance/control with its environment, as well as cause other effects. Some states have applicable numeric water quality criteria for chloride. Where a state has a numeric criterion, NPDES permit regulations require that permitting authorities assess reasonable potential and established permit limits where necessary to protect water quality based on the applicable numeric criterion. Where a state has not developed a numeric criterion for chloride, EPA recommends that permitting authorities use a numeric translation of the applicable narrative criterion pursuant to 40 CFR 122.44(d)(1)(vi). In developing such translation, EPA recommends using EPA's current 304(a) national recommended criteria for chloride for protection of aquatic life. These criteria were published by EPA in 1988. The current national criteria for Chloride are: acute aquatic life criteria of 860 mg/l, and chronic aquatic life criteria of 230 mg/L. EPA is currently in the process of updating these recommended criteria to reflect the latest science. That update is expected to be proposed by the end of 2011 and finalized in 2012.

22) Does EPA's storm water definition at 40 CFR 122.26(b)(14)(iii) include discharges from a natural gas drilling operation?

40 CFR 122.26(b)(14)(iii) does include natural gas activities, but only to the extent that they require permit coverage as described in 122.26(a)(2)(ii) and 122.26(c)(1)(iii).

[33] PA Environmental Quality Board, Proposed Rulemaking, 39 Pa.B. 64671, November 7, 2009 Available at: http://www.pabulletin.com/secure/data/vol39/39-45/2065.html

In general, the Director may not require a permit for discharges of storm water from any field activities or operations associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities, including activities necessary to prepare a site for drilling and for the movement and placement of drilling equipment, whether or not such field activities or operations may be considered to be construction activities.[34]

Exceptions to the above general exemption may be found at 122.26(c)(1)(iii), which states: *"The operator of an existing or new discharge composed entirely of storm water from an oil or gas exploration, production, processing, or treatment operation, or transmission facility is not required to submit a permit application in accordance with paragraph (c)(1)(i) of this section, unless the facility:*

> *(A) Has had a discharge of storm water resulting in the discharge of a reportable quantity for which notification is or was required pursuant to 40 CFR 117.21 or 40 CFR 302.6 at anytime since November 16, 1987; or*
>
> *(B) Has had a discharge of storm water resulting in the discharge of a reportable quantity for which notification is or was required pursuant to 40 CFR 110.6 at any time since November 16, 1987; or*
>
> *(C) Contributes to a violation of a water quality standard."*

While oil and gas-related construction is subject to the conditional exemption, operators should still implement best management practices when undertaking earth disturbing activities to prevent discharging pollutants, including sediment, that would cause or contribute to water quality violation, and which would trigger storm water permitting requirements.

General Note

These Q&As provide advice on how to issue National Pollutant Discharge Elimination System permits for discharges from natural gas drilling in the Marcellus Shale. These Q&As do not impose legally binding requirements on EPA, states, tribes, other regulatory authorities, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA, state, tribal and other decision makers retain the discretion to adopt approaches on a case-by-case basis that differ from those provided in the Q&As where appropriate. EPA may update these Q&As in the future as better information becomes available.

[34] See CWA section 402(l)(2) and CWA section 502(24) as amended by the Energy Policy Act of 2005 section 323