



Produced Water Reuse in Oklahoma: Regulatory Considerations and References



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**Oklahoma Produced Water Project Summary Report
Prepared by the Ground Water Protection Council**

Introduction

In 2012 approximately 21.2 billion barrels of water were co-produced with oil and gas during E&P operations nationwide. This equates to about 2.4 billion gallons of produced water per day. Of this total about 20.55 billion barrels came from onshore and 625 million from offshore operations. This distinction is important because almost all of the water produced offshore is disposed of by ocean discharge while nearly 98% of the water produced onshore is reinjected underground under the authority of the Class II underground injection control (UIC) program. Although a large amount of injected water is used for enhanced recovery operations (About 45.1%) this still leaves nearly 45.6% or about 9.4 billion barrels which were injected for disposal, either onsite or via commercial disposal wells. This means that only about 411 million barrels of produced water were disposed of using techniques such as evaporation, beneficial reuse or surface discharge.¹ Although discharge permits have been obtained in some areas such as Arkansas, Pennsylvania and Wyoming these permits require a lengthy permitting process that minimizes their value.

In Oklahoma over 2.3 billion barrels of water were co-produced during E&P operations in 2012. This represents about 11% of all U.S. produced water. During 2012 about 1.1 billion barrels of produced water were reinjected for enhanced recovery and about 1.3 billion barrels were reinjected for underground disposal. No produced water was surface discharged, beneficially reused for non oil and gas purposes or evaporated.²

The reuse of produced water for non oil and gas purposes is being considered in many areas of the country and is driven by several factors including drought, injection induced seismicity potential, contamination concerns, disposal costs, the need for alternate sources of water and others.

The principal objective of this project was to compile information in order to better understand produced water discharge, disposal, and re-use issues, regulatory requirements, options and opportunities in the state of Oklahoma. This study included the following tasks:

1. survey state regulatory agencies to catalog the regulatory requirements that exist with respect to the re-use or re-cycling of oil and gas produced water (this includes the treatment, transport, surface management and disposal options for fluids and associated waste residuals)
2. support for development of produced water characteristics listings, limitations for alternate uses for management of treated produced water
3. investigate the tribal regulatory requirements for re-use of treated produced water and identifying the contacts critical to any discussions about these requirements related to accomplishing the project objective, and
4. investigate the federal regulatory requirements for re-use of treated produced water and identifying the contacts critical to any discussions about these requirements related to accomplishing the project objective.

¹ Veil, John, U.S. Produced Water Volumes and Management Practices in 2012, April 2015, 119 pp.
http://www.gwpc.org/sites/default/files/Produced%20Water%20Report%202014-GWPC_0.pdf

² ibid

Reuse Regulations

There appear to be no state regulations in Oklahoma governing the reuse or re-cycling of produced water from either conventional or unconventional oil or gas development. This includes regulations governing treatment or transport of produced water. Regulations governing surface management and disposal will be discussed in this section. The principal controlling factors regarding reuse and re-cycling appear to be:

- Disposal of effluent after reuse: With respect to reuse for oil and gas purposes such as makeup water for enhanced recovery, water for hydraulic fracturing or water for well drilling the same requirements would apply to the reused water as to the original produced water since the water reused may qualify as a waste “intrinsically derived” from primary field operations.³ The important question that must be answered with respect to reuse for non oil and gas purposes is whether or not such reuse changes the status of the eventual waste in a manner which might make it eligible as an industrial or municipal discharge under the Oklahoma standards.⁴ Under Title 252:606-1-5 of the OPDES standards, USEPA effluent limitation guidelines for industry categories and pollutants was incorporated by reference.
- Disposal of treatment residuals: While produced water is a RCRA Subtitle C exempt waste as specified in the USEPA Regulatory Determination for Wastes from the Exploration, Development and Production of Crude Oil, Natural Gas and Geothermal Energy⁵, the residuals from treatment of produced water may not qualify for this exemption. Regulatory clarification from USEPA may be needed with respect to the disposal of these residuals.⁶

These disposal options pose significant regulatory barriers to the reuse of produced water where such reuse is outside of the oilfield or requires treatment of the produced water resulting in treatment residuals.

Discharge to Surface Water

One important question that arises from an analysis of the regulatory requirements for discharge to surface water is whether or not the state has primary permitting and enforcement authority (primacy) for the National Pollutant Discharge Elimination System (NPDES) authorized under the Clean Water Act (CWA) for oil and gas co-produced water (see Appendix 1⁷). Without primacy, control over surface discharge falls under the jurisdiction of the U.S. Environmental Protection Agency (USEPA).

Our research indicates that Oklahoma does not have primacy for the NPDES program as it relates to discharge of oil and gas produced wastewater to surface water. Consequently, the Regional USEPA office directly administers the federal CWA NPDES requirements and any surface discharge permits or authorization would have to be approved by them.

USEPA promulgated the Oil and Gas Extraction (O&G) effluent guidelines and standards (40 CFR Part 435) in 1979, and amended the regulation in 1993, 1996, and 2001. The regulation covers wastewater

³ 43 FR 58942, December 18, 1978

⁴ Title 252. Department of Environmental Quality Chapter 606. Oklahoma Pollutant Discharge Elimination System (OPDES) Standards, September 15, 2015

⁵ 58 FR. 15284, March 22, 1993

⁶ 42 U.S.C. §6901 et seq. (1976), 40 C.F.R. parts 239-282

⁷ Appendix 1: Produced Water Management Practices and Applicable Regulations for Surface and Surface Water Discharges

discharges from field exploration, drilling, production, well treatment and well completion activities. These activities take place on land, in coastal areas and offshore. The O&G effluent guidelines and standards are incorporated into NPDES permits. The regulations apply to conventional and unconventional oil and gas extraction with the exception of coalbed methane.

Under the federally administered NPDES program for Oklahoma, the only surface water discharges allowed are for agricultural or livestock propagation and generally must occur west of the 98th meridian. Discharges east of the 98th meridian would likely be limited or prohibited. Subpart E of 40 CFR Part 435.50 specifies that where water has a use in agriculture or wildlife propagation, the only allowable discharge is produced water that meets “good enough quality” (see Appendix 1) and actual use requirements and has an oil and grease concentration not exceeding 35 mg/L.⁸ Under 40 C.F.R. Part 435.51(c), use for agricultural or wildlife propagation means:

1. The produced water is of good enough quality to be used for wildlife or livestock watering or other agricultural uses⁹; and
2. The produced water is actually put to such use during periods of discharge.

In addition, the Bureau of Land Management (BLM) has adopted [Onshore Oil and Gas Order \(OOGO\) No. 7](#) which applies to disposal of produced water from completed wells on federal and Indian (except Osage) oil and gas leases. It requires that all produced water from federal and Indian leases must be disposed of by either (1) injection into the subsurface; (2) into lined or unlined pits; or (3) by other acceptable methods approved by the authorized officer, including surface discharge under National Pollutant Discharge Elimination System (NPDES) permits (see Appendix 1 and Appendix 4¹⁰). Operators are encouraged to contact the appropriate authorized officer before filing an application for disposal of produced water so that the operator may be apprised of any existing agreements outlining cooperative procedures between the BLM and either the State/Indian Tribe or the USEPA concerning Underground Injection Control (UIC) permits for injection wells, and of any potentially significant adverse effects on surface and/or subsurface resources. The approval of the USEPA or a State/Tribe shall not be considered as granting approval to dispose of produced water from leased Federal or Indian lands until and unless BLM approval is obtained.

No discharge of produced water to surface water is allowed in Oklahoma east of the 98th meridian. West of this line, a discharge permit issued by the USEPA regional office would be required. Our research has not found a general permit issued by USEPA for allowable discharges of produced water for agricultural or wildlife propagation. Therefore, any USEPA permit for produced water discharge to surface water would be a site specific point source discharge and would need to meet the antidegradation standard for the designated use of the stream segment, and would be consistent with water quality standards and NPDES discharge requirements that have been adopted by the state as part of Oklahoma’s delegated NPDES program (See Appendix 1, Appendix 3¹¹, and Appendix 5¹²).

⁸ Attachment 16, USEPA, Technical Development Document for Proposed Effluent Limitations Guidelines and Standards for Oil and Gas Extraction, March 2015, 190 pp.

⁹ Appendix 2: Produced Water Quality Considerations for Agricultural, Livestock, and Aquatic Instream Habitats

¹⁰ Appendix 4: Tribal Information

¹¹ Appendix 3: Oklahoma Water Quality Standards References

¹² Appendix 5: Surface Water Quality Data, Impaired Water Bodies, and NPDES.

Discharges to water quality impaired stream segments will have more stringent permitting requirements related to constituents that are the cause of the impairment (Appendix 5). Oklahoma has 1,133 causes of impairment for CWA 303(d) Listed Waters. Salinity/Total Dissolved Solids/Chlorides/Sulfates is listed as the single largest cause of impairment, affecting 304 stream segments and 17 segments have been impacted by oil and grease.

At this time, no distinction is made between “conventional” and “unconventional” produced water for discharges to surface water west of the 98th meridian. On April 7, 2015, USEPA proposed a new NPDES rule under 40 CFR Part 435 regarding effluent limitations guidelines and standards for the oil and gas extraction point source category (Addendum A, Attachment 3). In the preamble, the USEPA states that the proposed regulation is intended to protect the operational integrity of publicly owned treatment works (POTWs) by establishing pretreatment standards that would prohibit nationwide the discharge of pollutants in wastewater from onshore unconventional oil and gas (UOG) extraction facilities to POTWs. Because these UOG produced waters 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). The proposed federal regulation defines unconventional oil and gas (UOG) as “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). For the purpose of the proposed rule, the definition of UOG does not include CBM”.

In a letter dated February 1, 2013 (Addendum A, Attachment 9) the USEPA notified operators of Publicly Owned Treatment Works (POTWs) in Pennsylvania of the specifications they must follow to accept oil and gas waste into their treatment streams. Acceptance of oil and gas wastewater or other drilling waste that was not previously included in the permit application or permit would generally be considered a new introduction of pollutants or may be a substantial change in the volume or character of pollutants being introduced into the POTW. Unless a POTW has previously identified and provided analyses for all of the parameters, concentrations and volumes of the oil and gas extraction wastes in its NPDES permit application and received authorization to accept and discharge the waste through its NPDES permit, notification requirements to both the permitting authority and the pretreatment authority apply.

Clearly, the letter contemplates, that within certain guidelines POTWs could accept oil and gas waste streams (including produced water) in the same manner that it would accept and treat other industrial wastewater stream. One could reasonably conclude, therefore, that after proper notification, waste stream characterization, and application of pretreatment requirements, a POTW could accept both conventional and unconventional produced water and, after treatment, discharge it to waters of the US. However the April 7, 2015 USEPA proposed NPDES rule regarding effluent limitations guidelines and standards for the oil and gas extraction point source category and its proposed pretreatment standards that prohibits nationwide the discharge of pollutants in wastewater from onshore unconventional oil and gas (UOG) extraction facilities to POTWs, would imply that there is such a difference between conventional and unconventional produced water that it would be infeasible to for a POTW to treat *UOG under any permitting conditions* (Appendix 1).

Other Surface Discharge

The Oklahoma Corporation Commission (OCC) prohibits the discharge of produced water to surface water. However surface discharge of produced water to the land surface is allowed under certain circumstances (See Appendix 1). To discharge produced water to the land surface, a permit must be obtained from the OCC. The water discharged must meet the following standards:¹³

165:10-7-11 (d) (Surface Discharge of Produced Water)

Site restrictions — Discharge of produced water (by spray irrigation or other approved methods) shall only occur **on land** having an **Exchangeable Sodium Percentage¹⁾ (ESP) no greater than 15**, and all of the following characteristics as determined by the appropriate Soil Conservation District²⁾ or by a qualified soils expert:

- **A maximum slope of five percent**
- **Depth to bedrock at least 20 inches**
- **Slight salinity** (defined as electrical conductivity of less than 4,000 micromhos/cm) in the topsoil or upper six inches of the soil
- **A water table deeper than six feet** from the soil surface, except a perched water table
- **A minimum distance of 100 feet from any stream** designated by Oklahoma Water Quality Standards or **any fresh water pond, lake, or wetland³⁾**.
- **Water quality limitations** — A surface discharge permit shall not be issued if the produced water to be discharged exceeds either of the following concentrations:
- **Total Dissolved Solids (TDS): 5,000 mg/l**
- **Oil and Grease: 1,000 mg/l**

The regulations provide for requirements governing **sampling, analysis, permitting, and maximum application rates⁴⁾**.

¹⁾ Exchangeable Sodium Percentage (ESP) “Exchangeable Sodium Percentage (ESP)” is the relative amount of the sodium ion present on the soil surface, expressed as a percentage of the total Cation Exchange Capacity (CEC). Since the determination of CEC is time consuming and expensive, a practical and satisfactory correlation between the Sodium Adsorption Ratio (SAR) and ESP was established. The SAR is defined elsewhere in this Section. ESP can be estimated by the following empirical formula: $ESP = [100 (-0.0126 + 0.01475 \times SAR)] / [1 + (-0.0126 + 0.01475 \times SAR)]$. Source: Corporation Commission, Oil and Gas Conservation, Oklahoma Administrative Code 165:10, February 2013.

²⁾ Information regarding soil types and other related information can be found in Published Soil Surveys for Oklahoma at <http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=OK> and

¹³ Oklahoma Title 165, Chapter 10, Section 7 Amended at Rule Making 97000002, Eff 7-1-97

at Web Soil Survey (WSS) which provides soil data and information produced by the National Cooperative Soil Survey <http://websoilsurvey.nrcs.usda.gov/app/>

³⁾ There is a minimum distance of 100 feet to any stream designated by Oklahoma Water Quality Standards or any fresh water pond, lake, or wetland designated by the National Wetlands Inventory Map Series prepared by the U.S. Fish and Wildlife Service

⁴⁾ Further, the water to be discharged and the receiving soil must be sampled and the OCC must be given two days notice prior to sampling. The samples of soil and produced water must be analyzed by a laboratory operated by the State of Oklahoma or certified by the OWRB unless exempted by the OCC.

In addition to the general provisions for surface discharge, the OCC has adopted rules governing the commercial recycling of “deleterious substances” which includes produced water and flowback water. These requirements can be found at 165:10-9-4 et al. [Effective August 27, 2015]

Oklahoma Groundwater Quality Standards

Water quality standards for both groundwater and surface water have been established by the Oklahoma Water Resources Board (OWRB). OWRB has promulgated groundwater quality standards for the state in Oklahoma Administrative Code (OAC) 785:45, Subchapter 7, Groundwater quality standards. The standards are comprised of three elements: Designation of beneficial uses of groundwater, Classification of groundwater based on water quality criteria, and Protective Measures. Beneficial uses have been assigned to all groundwaters in the state that have a mean concentration of Total Dissolved Solids of 10,000 mg/L or less. Beneficial uses are defined in the regulations and include, but are not limited to: Public and Private Water Supply (PPWS), including municipal use and domestic use; Agriculture, including the subcategories of irrigation and non-irrigation use; Industrial uses; Recreation; and Fish and Wildlife propagation (F&W).

The OWRB also has the responsibility for administering the state’s water rights program. Permits are granted for the use of both surface water and groundwater. Artificial recharge is considered a use under a specific provision, 785:30-13-8. Artificial Recharge Requirements, requires a permit for artificial recharge. The permit would also include water quality protection in 785:30-1-3(b) to prevent pollution and/or waste of water.

Class I or Special Source Groundwater includes groundwaters of exceptional water quality, irreplaceable sources of water, outstanding groundwater resources, and ecologically important groundwaters. This class of groundwater is considered to be highly vulnerable to contamination. Special Source Groundwaters are located beneath the watersheds of surface waters designated as Scenic Rivers; underneath lands located within the boundaries of areas with waters of ecological and/or recreational significance; and underneath lands located within the boundaries of a state-approved wellhead protection area for public water supply. Class II or General Use Groundwater are groundwaters capable of being used as a drinking water supply with no treatment or with conventional treatment methods, having the potential for multiple beneficial uses, and with mean Total Dissolved Solids (TDS) levels less than 3000 mg/l. Class III or Limited Use Groundwater are poor quality groundwaters due to naturally occurring contaminants, which require extensive treatment for use as a drinking water source, having mean TDS levels of 3000 mg/l and greater. Protective measures or water quality standards contain numerical criteria to protect beneficial uses. Permits are an example of protective measures incorporating criteria that limit effluent concentrations so that the criteria are not violated. The implementation rules of each authorizing agency describe how the

criteria are translated into permit limits. Exceeding permit limits for regulated constituents may constitute groundwater pollution and require corrective action.

The "Oklahoma Water Quality Standards" are found at OAC 785:45. State law provides that the environmental regulatory agencies including the Oklahoma Conservation Commission and the Oklahoma Department of Environmental Quality adopt and enforce OWRB-required Water Quality Standards Implementation Plans relevant to their resource protection and environmental regulatory authorities. When regulating activities that have the potential to contaminate groundwater from the surface, state environmental agencies shall consider the vulnerability level of an affected hydrogeologic basin as developed in OWRB Technical Report 99-1, [Statewide Groundwater Vulnerability Map of Oklahoma](#) for surface activities with the potential to contaminate groundwater.

Water Quality Standards Implementation

The OCC's policy is to maintain existing defined beneficial uses for surface and groundwater throughout the state for Tiers 1-3, surface water and Class II General Use Groundwater. Very little of the Oil and Gas related activities regulated by the Commission are located where they could affect the High Quality Waters and Sensitive Water Supplies of the state, or waters of ecological and/or recreational significance (Tier 2), or Class I Special Source Groundwater (OAC 785:45-7-3). The Commission does not regulate point source discharges and does not geographically have significant oil & gas operations where Tier 3 outstanding resource waters are located. Tier 3 antidegradation for surface waters, though applicable, would rarely, if ever, need to be applied to oil and gas operations.

Environmental impacts resulting from oil and gas activities regulated by OCC almost always involve petroleum compounds, brine (salinity) components, excess sediments in erosional runoff, and/or (rarely) heavy metals. When possible, action levels for these substances are based on Oklahoma Water Quality Standards (OWQS). However, the existing numerical salinity standards in Appendices C and F (See OAC 785:45-7) address only TDS, chloride, and sulfate as defined for agricultural beneficial uses, but not for other uses such as PPWS or F&W.

Discharge permit criteria allow the ODEQ to include measures for the protection of groundwater quality, and require the responsible party to report all spills of reportable quantities and respond accordingly to protect waters of the state including groundwater. Additionally, ODEQ may add requirements for the protection of groundwater to general discharge permits. Class I, Class III, or Class V injection well facilities are subject to the underground injection control construction and operation requirements of OAC 252:652 through permitting and rule authorization to protect groundwater quality. Facilities in compliance with the rules contained in chapters listed in OAC 252:690-1-1 are not subject to any additional measures unless they are found to be contaminating groundwater. The requirements in OAC 252:611 for Groundwater Pollution Control must be followed for groundwater remediation projects.

Standards Implementation for both OCC and ODEQ rules are concerned primarily with addressing contaminant spills or unauthorized discharges. The Standards are the basis for enforcement and corrective action requiring cleanup to specified water quality levels. Any discharge to waters of the state resulting from remediation of groundwater requires an authorization or permit under rules of the Oklahoma Pollutant Discharge Elimination System Act (OAC 252:605), or a 401 water quality certification, as appropriate. Other disposal methods may also require separate permits, plans or authorizations from the Department. Discharge permit criteria allow ODEQ to include measures for the protection of groundwater

quality, and require the responsible party to report all spills of reportable quantities and respond accordingly to protect waters of the state including groundwater.

Oklahoma Underground Injection Control Program

USEPA has developed and adopted the federal Underground Injection Control Program to regulate the emplacement of fluids in the subsurface and protect Underground Sources of Drinking Water (USDW). Class I injection wells are used to inject industrial or municipal waste to a depth beneath the lowermost USDW. Class II wells are used to dispose of fluids associated with the production of oil and natural gas. Class III wells are used to inject fluids to aid in the extraction of minerals. Class IV wells were used to dispose of hazardous or radioactive wastes into or above a USDW, but have been banned in all 50 states. Class V wells are all wells not included in Classes I-IV that are used to inject or dispose of non-hazardous waste or fluids into or above a USDW. Class VI wells are used to dispose of the greenhouse gas carbon dioxide; a by-product of fossil fuel use, cement processing and other industrial processes.¹⁴ The definition of a USDW in 40CFR Part 146 §146.3 contains a water quality standard of 10,000 mg/L total dissolved solids. The definition identifies aquifers that require protection from underground injection activities. USEPA rules in Section 144.12 require that no owner or operator shall conduct any injection activity in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 CFR part 142 or may otherwise adversely affect the health of persons.

Both ODEQ and OCC administer federally delegated (USEPA) Underground Injection Control Programs in Oklahoma. The UIC program for Class I, III, IV, and V wells in the State of Oklahoma, except those on Indian lands, is administered by ODEQ. The Class II injection well program for produced water and oil and gas waste is administered by OCC. The UIC program for all wells on Indian lands in Oklahoma, except Class II wells on the lands of the Five Civilized Tribes (OCC), is administered by USEPA (See the Discharge to Surface Water Section above for a discussion of BLM OOGO No. 7 which addresses produced water disposal and UIC). The UIC program for Class II wells on the Osage Mineral Reserve consists of the requirements set forth in CFR - Title 40, Part 147, Subpart GGG. The UIC program for all other wells on Indian lands consists of the requirements set forth in Subpart III of this Part.

OCC operates a full regulatory program (OAC 165:10-5) for Class II wells. ODEQ has adopted the federal UIC regulations Title 40 CFR Parts 124 (Subpart A), 144, 145, 146, 147, and 148 by reference. Some additional provisions have been adopted related to fees and permits. Significant additional regulations have been added for Class I injection wells. ODEQ Class V well regulations are essentially the same rules as USEPA's federal program with an additional requirement for groundwater monitoring and an analysis of injected fluids. Class V wells are a broad category of generally shallow injection wells introducing a wide variety of fluids into and above USDWs. According to USEPA Region VI, none of the tribes in Oklahoma have a UIC program (Personal communication with USEPA Region VI office).

Class V Injection Wells - Aquifer Recharge Wells and Aquifer Storage and Recovery Wells

According to USEPA Fact Sheets, Aquifer recharge and ASR wells are used to replenish water in an aquifer for subsequent use. While an aquifer recharge well is used only to replenish the water in an

¹⁴ Attachment 2, Injection Wells: A Guide to their Use, Operation and Regulation, GWPC, 2014, 30 pp.

aquifer, ASR wells are used to achieve two objectives: (1) storing water in the ground; and (2) recovering the stored water (from the same well) for a beneficial use. Both of these types of wells, however, may have secondary objectives, such as subsidence control and prevention of salt water intrusion into fresh water aquifers. Increasingly, ASR is used to supplement or provide for public drinking water supplies.¹⁵

A national ASR survey reported 44 possible Aquifer Recharge (AR) and no Aquifer Storage and Recovery (ASR) wells for Oklahoma.¹⁶ Recharge source water and Injectate water quality were not available for wells in Oklahoma. Sources of injectate quality for AR wells across the country included untreated surface (river) water, treated drinking water, treated surface water and reclaimed water, treated and untreated groundwater, surface water with disinfection only, and untreated ground water at mine dewatering sites. Two aquifer recharge projects, in the South Dakota and Texas regions of the High Plains aquifer, injected surplus surface water such as high river flows to recharge aquifers.¹⁷ Comparison of constituent concentrations in aquifer waters with corresponding recharge waters suggest that the injected water may often be of better quality than that of the receiving aquifer. In addition, all constituents in the recharge waters, for which chemical analysis data are available, meet drinking water standards.

Sources of injectate for ASR wells inventoried in Florida included potable drinking water (from a drinking water plant), surface water (treated or untreated), ground water (treated or untreated), and reclaimed water.

The most common injectate for states other than Florida was surface water treated to drinking water standards. The 1999 study did not identify any known contamination incidents associated with the use of aquifer recharge and ASR wells. In cases where injectate constituents react with ambient groundwater causing an increase in constituent concentrations or the formation of new compounds, pretreatment techniques are used. For example, injectate of ASR wells at the Swimming River site in New Jersey is pretreated in order to control excessive iron concentrations (i.e., concentrations above secondary drinking water standards) in the recovered water. In Florida, injectate water has caused the release of arsenic from the aquifer matrix in some wells. USEPA concerns in these cases have led to additional USEPA requirements for the Florida UIC Program to address arsenic impacts to public drinking water.¹⁸

As noted earlier, aquifer recharge and ASR wells are used to replenish water in an aquifer. In most cases, aquifer recharge and ASR wells inject water into USDWs. The injectate from these wells, especially ASR wells, is typically treated to drinking water standards established under Section 1412 of the SDWA. With respect to ASR, the USEPA has stated that any injection into a USDW may not degrade the USDW at the “point of compliance”, which USEPA indicates is the same as the “point of injection”. Under this interpretation, the use of produced water for ASR purposes would require substantial treatment to achieve drinking water standards. However, the GWPC has discussed this issue with USEPA in the hopes that the “point of compliance” could be revised to be the “point of withdrawal”. This would allow for the injection of water that does not meet drinking water standards with the expectation that upon withdrawal

¹⁵ USEPA Class V Fact Sheets - http://www2.USEPA.gov/sites/production/files/2015-08/documents/fs-aq_rechrg_wells.pdf

¹⁶ Frederick Bloetscher, Ph.D., P.E., A Summary of ASR Findings From a Comprehensive National Survey Updated as of July 1, 2013, USEPA’s inventory of Class V wells in 1999

¹⁷ Attachment 17, The Class V Underground Injection Control Study, Volume 21, Aquifer Recharge and Aquifer Storage and Recovery Wells, USEPA/816-R-99-014u, September 1999-
http://www2.USEPA.gov/sites/production/files/2015-08/documents/classvstudy_volume21-aquiferrecharge.pdf

¹⁸ *ibid*

the water would have to be treated to meet established National Primary Drinking Water Standards for contaminants that may have an adverse public health effect. Other considerations are: known or likely occurrence in public water systems with a frequency and at levels of public health concern and regulation of the contaminant presents a meaningful opportunity for health risk reduction. The PWS Program actively reviews potential contaminants to determine health effects and periodically updates standards to include new chemicals.

In Oklahoma, ODEQ sets the operation standards for Public Water Supply systems so they may provide safe drinking water. Their program is analogous to the federal PWS program. Rules in OAC 252:631-3-1 for PWS criteria require:

(b) Public water supply systems must comply with all applicable Primary Drinking Water Standards in 40 CFR Part 141, which includes, but is not limited to, the following:

- (1) Microbiological standards in 40 CFR Section 141.63;
- (2) Inorganic chemicals standards in 40 CFR Section 141.62;
- (3) Organic chemical standards in 40 CFR Section 141.61;
- (4) Disinfectant byproduct standards in 40 CFR Section 141.64;
- (5) Radiochemical standards in 40 CFR Section 141.66;
- (6) Turbidity standards in 40 CFR Sections 141.73, 141.173 and 141.550-553; and
- (7) Residual disinfectant level standards in 40 CFR Section 141.65....

<http://www.ODEQ.state.ok.us/rules/631.pdf>

Groundwater Discharge Discussion

Discharge of treated produced water to groundwater would be accomplished through injection into a Class V well, most likely a recharge or an aquifer storage and recovery well. The regulatory agency for Class V wells is the ODEQ. The current regulatory framework is the federal program as adopted and modified by ODEQ. AR and ASR Class V wells are authorized by rule subject to compliance with the regulations, including at a minimum, inventory information for the facility. A permit is not necessary; however ODEQ may require a permit at their discretion. AR wells have been used historically and successfully to recharge aquifers in Oklahoma.

OWRB in its water rights permitting and water quality standards authority would permit the use of water for artificial recharge for both injection wells and other recharge methods including, for example, spreading basins. Aquifer recharge and ASR wells would require a water rights permit which must be in compliance with Protection Standards in 785:45-7-2. Criteria for groundwater protection in this provision can be interpreted to require preservation of background groundwater quality. NOTE: The OWRB may not have permitting authority over injection of water with TDS content greater than 10,000 mg/L where the injection zone also contains water greater than 10,000 mg/L

The State legislature in 2008 commissioned a report on artificial recharge, as a component of the 2012 update of the state's Comprehensive Water Plan. A Supplemental Report focusing on AR was published in 2010, which developed selection criteria. This report also evaluated and prioritized potential AR sites in the state for further consideration. More recently an interagency work group has been formed to examine ASR issues including water rights, groundwater quality, and permitting issues.

Potential barriers to use of treated produced water for aquifer recharge are ASR water quality issues and water rights. In general groundwater intended for potable use must meet drinking water standards. Some states require that drinking water standards be met at the point of injection, regardless of the travel time and potential for aquifer water quality interactions. Public drinking water supplies are required to meet the drinking water standards at their point of delivery. The prohibition of fluid movement standard in §144.12(a) provides that a well is authorized unless the injection may result in the presence of a contaminant that may cause a public water system to not comply with any primary drinking water regulation or may otherwise adversely affect the health of persons. For Class V wells, including AR and ASR, there can be some regulatory flexibility in this provision, as noted in the Florida arsenic situation.¹⁹ An alternative to the point of injection, often the last monitoring point of the system, is the use of monitor wells located at the edge of the injection plume or property boundary.

State Regulatory constraints may also be placed on the uses of water based on existing water rights, protection of domestic uses, and environmental concerns. OWRB implements an established groundwater rights program and issues water rights permits for groundwater uses including specific permitting for aquifer recharge. The regulations, however, do not allow degradation of existing background groundwater quality. This standard is a significant limitation when considering ASR projects. Use of treated produced water for AR/ASR will likely raise water rights questions. The introduction of essentially recycled water from deeper aquifers does not appear to be addressed by current regulations.

http://www2.USEPA.gov/uic/class-v-wells-injection-non-hazardous-fluids-or-above-underground-sources-drinking-water#well_use

For further discussion on ASR wells injecting reclaimed water, see the sewage treatment effluent well summary, which is Volume 7 of the Class V UIC Study.

Oklahoma Comprehensive Water Plan

In 2008 a report was commissioned by the Oklahoma State Legislature as a component of technical work performed under the 2012 Update of the Oklahoma Comprehensive Water Plan (OCWP). The report presents the results of a technical workgroup study, supported by the OWRB and CDM, to evaluate the potential for water supply augmentation through implementation of artificial aquifer recharge projects in

OCWP Study Workgroup & Supplemental Reports

- Water Policy & Related Recommendations for OK
- Climate Issues & Recommendations
- Agricultural Water Issues & Recommendations
- Water Quality Issues & Recommendations
- Instream Flow Issues & Recommendations
- Tribal Water Issues & Recommendations
- Marginal Quality Water Issues & Recommendations
- Artificial Aquifer Recharge Issues & Recommendations
- Infrastructure Financing Needs & Opportunities
- Water Conveyance Study

¹⁹ Attachment 15, USEPA Correspondence to Florida Department of Environmental Protection- Gravatt, USEPA OWDW Letter dated September 27, 2013

Oklahoma. More specifically, this report presents recommended criteria for evaluating aquifer recharge project locations where most feasible throughout the state.²⁰

Classification of Treated Water and Residuals

The disposal of water produced from conventional oil and gas exploration and production can be accomplished using underground injection wells permitted under the Class II Underground Injection Control (UIC) program. Although the UIC program specifically uses the term “conventional” with respect to Class II wells, it is also well settled that water produced from “unconventional” oil and gas exploration and production may also be disposed of in Class II wells. However, what is not settled is:

1. the status of produced water once it has been treated for reuse.
2. the status of residuals arising from the treatment of produced water

For example, while it is possible that the use of treatment residuals for enhanced recovery might be acceptable, it is less clear that simple disposal of treatment residuals in a Class II disposal well would be permissible because such wells may only be used to dispose of waste associated with oil and gas production and the residuals from treatment may not qualify as “associated” waste.

Once produced water has been treated for an alternate use it is unclear as to whether or not the treated water remains “produced water”. If the post treatment water becomes a “product” derived from produced water, the restrictions on surface water discharge of and other potential prohibitions may not apply. (Addendum A, Appendix 1). Therefore, the questions that must be answered are whether or not the ultimate disposition of the waste stream is controlled by:

1. the original source of the water; or
2. if it is considered to be sourced from the water treatment facility or other secondary use of the water.

Produced Water Ownership and Liability

Another important point that must be addressed involves the ownership of produced water. In Oklahoma there are statutes dealing with the ownership of water. §60-60. Ownership of water - Use of running water of the Oklahoma Statutes, 1963 indicates that groundwater, i.e. water flowing under the surface but not forming a definite stream is owned by the owner of the land. The statute does not differentiate between fresh water and saline water. Therefore, it is likely that any water extracted from the ground including brackish or saline water produced from oil and gas zones would remain the property of the landowner. Regardless, Oklahoma law appears to recognize a riparian right to reasonable use.²¹ However, in the 1936 case of *Canada V. City of Shawnee* the court restricted the use of the groundwater and stated that use of the water off the premises where it is pumped is per se unreasonable.²² This would seem to prevent the transport and use or reuse of groundwater, including produced water, pumped during

²⁰ Addendum A, Attachment 1, OWRB, Oklahoma Comprehensive Water Plan, Executive Report, 2012, 159 pp. http://www.owrb.ok.gov/supply/ocwp/pdf_ocwp/WaterPlanUpdate/draftreports/OCWP%20Executive%20Rpt%20FINAL.pdf

²¹ *Franco-American Charolaise, Ltd. V. OWRB*, 1990 OK 44 855 P .2d 568, 61 OBJ 1114, Case Number: 59310, 4/24/1990

²² *Canada v. City of Shawnee*, 1936 OK 803 64 p .2d 694, 179 Okla. 53, Case Number 24873, 12/15/1936

oil and gas exploration and production by the operator unless lease provisions allowed for such use or reuse of the water. Regardless, attorneys with the Oklahoma Water Resources Board have indicated it is their opinion that if the water is not fresh (< 10,000 TDS) and no permit is required, it is not a permittable withdrawal, and therefore, the produced water belongs to the oil and gas operator who produced it. These apparent contradictions in ownership will require additional research and may even require some resolution through legislative or legal action.

In addition to the issue of produced water ownership there is also a question of liability associated with potential reuse of produced water. For example, the issue of residual or by-product waste management and disposal carries its own liability factors, especially where such wastes would be considered hazardous or toxic. Unless liability or tort protections for the management of these wastes are developed the ability to reuse and re-cycle produced water, *outside of the oilfield*, will be limited.²³ (italics added). Another potential source of liability relative to produced water may arise when an operator provides produced water to a third party for a specific use such as wetlands reconstruction and then cannot provide sufficient water to maintain the reconstruction efforts. Under this scenario it is possible the operator could be sued for violation of environmental laws regarding destruction of wetlands. Additionally, there may be liability related to the treated produced water inasmuch as it is not possible to test such water for all potentially harmful constituents or “constituents of concern”. Consequently, a treated water stream may contain constituents that render it harmful to human health or the environment. This could result in residual liability for the entity treating and selling or otherwise transferring the water to another entity and for the entity that receives it. Additionally, there may be liability related to the treated produced water inasmuch as it is not possible to test such water for all potentially harmful constituents or “constituents of concern”. New constituents of concern are identified periodically that may not have previously been sampled for or identified in the produced water (for example USEPA has just released a proposed unregulated contaminant monitoring rule (UCMR 4) for Public Water Systems (See Addendum A, Attachment 18). Consequently, a treated water stream may contain constituents that render it harmful to human health or the environment. (See Addendum A, Attachment 18) There will likely be many additional liability risks associated with the reuse of produced water. Therefore, a thorough analysis of potential liability risks must be included in any evaluation of produced water reuse

Produced Water Characteristics

Because produced water was initially seawater that was trapped in porous sedimentary rock strata millions of years ago along with the oil and gas, it is typically saline in nature with salt concentrations ranging from just a few parts per thousand to saturated brines greater than 300,000 mg/L. An analysis of elements/ ions in produced water from rocks of various ages yields a range of concentrations that varies widely as shown in Table 1²⁴

²³ Attachment 5, Atlantic Council Energy & Environment Program, Produced Water: Asset or Waste?, May 2014, 40 pp.

²⁴ After Collins, A.G. 1975 Geochemistry of Oilfield Waters. Elsevier Scientific Publishers, New York. 496 pp

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| Element/ Ion | Seawater | Produced Water | |
|--------------|----------|---|------------------------------|
| | | Highest Concentration (Age ₁) | Range of Mean Concentrations |
| Salinity | 35,000 | --- | <5,000-300,000 |
| Sodium | 10,760 | 120,000 (J) | 23,000-57,300 |
| Chloride | 19,353 | 270,000 (P) | 46,100-141,000 |
| Calcium | 416 | 205,000 (P) | 2,530-25,800 |
| Magnesium | 1294 | 26,000 (D) | 530-4,300 |
| Potassium | 387 | 11,600 (D) | 130-3,100 |
| Sulfate | 2712 | 8,400 (T) | 210-1,170 |
| Bromide | 87 | 6,000 (J) | 46-1,200 |
| Strontium | 0.008 | 4,500 (P) | 7-1,000 |
| Ammonium | --- | 3,300 (P) | 23-300 |
| Bicarbonate | 142 | 3,600 (T) | 77-560 |
| Iodide | 167 | 1,410 (P) | 3-210 |
| Boron | 4.45 | 450 (T) | 8-40 |
| Carbonate | --- | 450 (M) | 30-450 |
| Lithium | 0.17 | 400 (J) | 3-50 |

(D) Devonian, (J) Jurassic, (M) Mississippian, (P) Pennsylvanian, (T) Tertiary

Table 1 Major ion concentrations (Parts Per Million) in seawater and produced water from various geologic ages (After Collins, 1975)

Water produced from oil and gas bearing zones in Oklahoma also has a wide range of analytical values for major cations and anions. For example, in samples from the Woodford (a Devonian age shale) compiled for 4 Oklahoma counties (Blaine, Caddo, Canadian and Grady) from 2009 to 2012 the ranges of analytes/ measurements show substantial variations (Table 2).²⁵

| County | Analytes/ Measurements | Ranges (mg/L) | |
|--------|------------------------|---------------|-------|
| | | Low | High |
| Blaine | | | |
| | pH | 4.7 | 8.68 |
| | Ba | -2 | 39 |
| | CO2 | 88 | 1540 |
| | HCO3 | 452 | 2196 |
| | Ca | 24 | 401 |
| | Cl | 1000 | 35390 |
| | Fe Tot | -2 | 128 |
| | Mg | 5 | 73 |
| | Na | 1054 | 8812 |
| SO4 | -2 | 600 | |

²⁵ USGS Produced Waters Geochemical Database v2.1 (Provisional)
<http://energy.usgs.gov/EnvironmentalAspects/EnvironmentalAspectsofEnergyProductionandUse/ProducedWaters.aspx#3822349-data>

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| | | | |
|-----------------|--------|-------|--------|
| | H2S | -2 | 6 |
| Caddo | | | |
| | pH | 5.9 | 8.72 |
| | Ba | -2 | 78 |
| | CO2 | 110 | 1100 |
| | HCO3 | 512 | 1830 |
| | Ca | 24 | 355.38 |
| | Cl | 999.8 | 19000 |
| | Fe Tot | -2 | 116 |
| | Mg | 10 | 122 |
| | Na | 3587 | 12453 |
| | SO4 | -2 | 390 |
| | H2S | 0.5 | 12 |
| Canadian | | | |
| | pH | 4.6 | 9.29 |
| | Ba | -2 | 34 |
| | CO2 | 22 | 2247 |
| | HCO3 | 10.5 | 3645 |
| | Ca | 0.2 | 7984 |
| | Cl | 0.5 | 74000 |
| | Fe Tot | -2 | 174 |
| | Mg | 5 | 875 |
| | Na | 14.7 | 25593 |
| | SO4 | -2 | 2000 |
| | H2S | -2 | 20 |
| Grady | | | |
| | pH | 6.2 | 8.33 |
| | Ba | -2 | 3 |
| | CO2 | 110 | 440 |
| | HCO3 | 488 | 1222 |
| | Ca | 64 | 241 |
| | Cl | 2984 | 12000 |
| | Fe Tot | -2 | 108 |
| | Mg | 12 | 122 |
| | Na | 4782 | 8060 |
| | SO4 | 7 | 470 |
| | H2S | 0.5 | 5 |

Table 2 Analysis ranges for the Woodford shale in four Oklahoma counties Source: After USGS Produced Waters Geochemical Database v2.1 (Provisional)

Although the presence of individual constituents appears to be similar regardless of location, the range of constituent levels substantially changes depending upon the locations and dates of the samples. In Blaine County, for example Figure 1 represents a total of 22 separate sampling points and 301 different sampling events. In one sampling location alone a total of 22 sampling events occurred between November, 2010 and July, 2012. Within this single location the change in analytical results was significant over time as shown in Table 3.²⁶

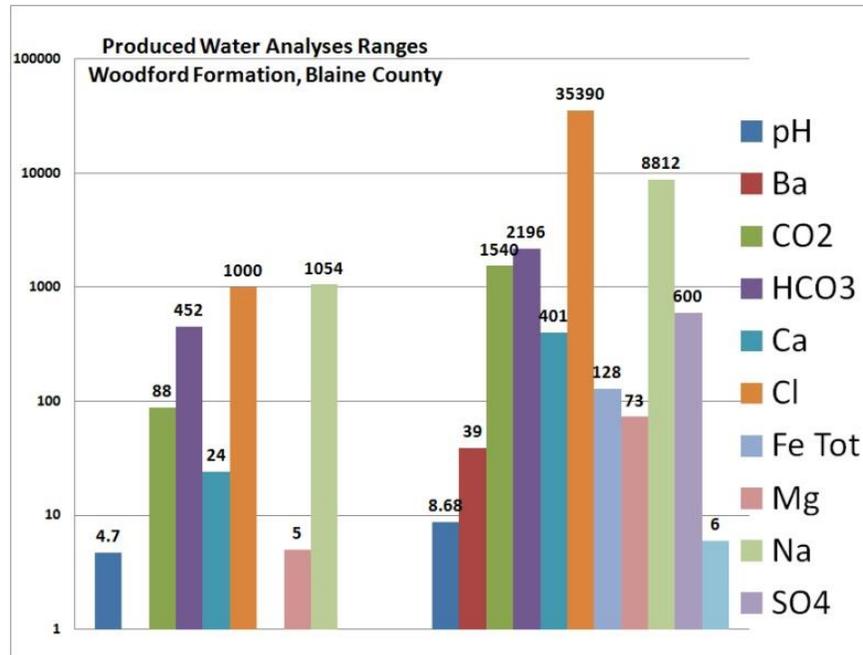


Figure 1 Analysis of water characteristics of the Woodford shale in Blaine County, Oklahoma

| DATESAMPLE | TEMP | PH | Analyses in mg/l | | | | | | | | | |
|------------|------|------|------------------|-----|-----|------|-----|------|-------|----|----|-----|
| | | | Ba | CO2 | CO3 | HCO3 | Ca | Cl | FeTot | Mg | Na | SO4 |
| 11/29/2010 | 70 | 8.36 | | | | 1443 | 80 | 7950 | -2 | | | 120 |
| 11/29/2010 | 69 | 8.28 | | | | 1214 | 80 | 7958 | -2 | | | 180 |
| 11/30/2010 | 70 | 8.51 | | | | 1091 | 80 | 6957 | -2 | | | 140 |
| 11/30/2010 | 69 | 8.34 | | | | 1201 | 80 | 6957 | -2 | | | 150 |
| 11/30/2010 | 70 | 8.53 | | | | 1140 | 119 | 7950 | -2 | | | 150 |
| 11/30/2010 | 70 | 8.46 | | | | 1249 | 80 | 6957 | -2 | | | 160 |
| 12/1/2010 | 70 | 8.68 | | | | 1078 | 80 | 7950 | -2 | | | 110 |
| 12/1/2010 | 70 | 8.38 | | | | 1078 | 119 | 6957 | -2 | | | 140 |
| 12/1/2010 | 70 | 8.42 | | | | 1078 | 79 | 7943 | -2 | | | 150 |
| 12/1/2010 | 70 | 8.42 | | | | 1091 | 119 | 8953 | -2 | | | 150 |
| 12/2/2010 | 70 | 8.37 | | | | 1090 | 119 | 8935 | -2 | | | 110 |
| 12/2/2010 | 69 | 8.31 | | | | 981 | 119 | 7943 | -2 | | | 120 |
| 12/2/2010 | 69 | 8.35 | | | | 1042 | 119 | 8935 | -2 | | | 120 |
| 12/3/2010 | 69 | 8.28 | | | | 1006 | 79 | 7943 | -2 | | | 150 |
| 12/3/2010 | 68 | 8.26 | | | | 1018 | 119 | 7943 | -2 | | | 160 |
| 12/4/2010 | 69 | 8.01 | | | | 981 | 119 | 8935 | -2 | | | 130 |

²⁶ ibid

| | | | | | | | | | | | | |
|-----------|-----|------|----|------|--|------|-----|-------|-----|----|------|-----|
| 12/4/2010 | 68 | 8.19 | | | | 1054 | 119 | 7943 | -2 | | | 150 |
| 12/5/2010 | 69 | 8.19 | | | | 981 | 119 | 6950 | -2 | | | 170 |
| 4/4/2011 | 80 | 6.5 | -2 | 242 | | 817 | 64 | 11000 | 7 | 15 | 7413 | 154 |
| 6/17/2011 | 102 | 7.4 | -2 | 374 | | 1000 | 60 | 12000 | 13 | 15 | 8133 | 148 |
| 9/20/2011 | 96 | 7.5 | 2 | 396 | | 452 | 72 | 12000 | 7 | 19 | 7874 | 85 |
| 1/16/2012 | 75 | 7.1 | 3 | 1826 | | 634 | 24 | 10000 | 6 | 10 | 6708 | 65 |
| 7/26/2012 | 82 | 8.23 | | 1210 | | 1708 | 80 | 10000 | 217 | 19 | 7001 | |

Table 3 Twenty-two individual sampling events with analytical results for a single location in Blaine County, Oklahoma Source: After USGS Produced Waters Geochemical Database v2.1 (Provisional)

Within this sample set chlorides alone range from a low of 6950 mg/L to as much as 12,000 mg/L. While the reasons for the variations among the analytes cannot be ascertained, the sampling indicates there is no consistent concentration of ions that can be applied to produced water over time even when the formation and location remain the same. Therefore, with respect to samples in Oklahoma for different formations, locations and times the variability in analytical results for produced water can be expected to be substantial.²⁷

Unfortunately, the sample sets available had very few analytical results for Total Organic Carbon (TOC) or Organic Acids; both of which could be expected to occur in produced water. Consequently, we cannot evaluate these constituents with respect to samples of produced water from Oklahoma. Because petroleum hydrocarbons are of paramount concern to the environmental aspects of produced water management, further sampling and analysis are needed to determine the treatment technologies that would be required to reduce or eliminate these constituents to the degree needed for alternate uses and surface discharge.

Limitations and Criteria for Alternate Uses

There are many potential alternate uses for produced water including, agricultural, industrial, wildlife support, drinking water, stream flow augmentation, power generation, dust control, and others. In most cases the alternate use of produced water will be governed by the ultimate quality of the water. Given the characteristics of produced water, most alternate uses will require treatment of the water to meet quality standards. The capability, cost and availability of treatment technologies will dictate the suitability of treated produced water for alternate uses. In some cases such as use for dust control, oil and gas and some industrial uses, a minimal treatment regime will be required to make the water suitable for use. For other uses such as drinking water, agricultural and stream flow augmentation, the level of treatment may be substantial. Consequently, the capability, availability and cost of technologies used to treat water for high end uses may make these uses unlikely, except under extraordinary circumstances.

A good example of an assessment concerning a likely alternate use for produced water can be found in the report of the National Energy Technology Laboratory's Program on Technology Innovation: Water Resources for Thermoelectric Power Generation.²⁸ This report assessed the use of produced water as a supplemental supply for cooling of the San Juan Generating Station near Farmington, New Mexico. The assessment included an evaluation of elements such as the regulatory framework, produced water

²⁷ Addendum B, Sample set of produced water analyses from various counties in Oklahoma

²⁸ Attachment 4, U.S. Department of Energy, National Energy Technology Laboratory, Program on Technology Innovation: Water Resources for Thermoelectric Power Generation, Produced Water Resources, Wet-Surface Air Cooling, and WARMF Decision Support Framework, Final Report, November 2006, 322 pp

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quantity, future produced water quantities, produced water chemistry, treatment and disposal analysis, emerging treatment technologies, water compatibility, and a cost benefit analysis. Analyses of this nature are critical to any evaluation of alternate use of produced water because they factor in the elements which can be used to develop the matrix for making a go/ no-go decision regarding alternate use.

In order for produced water to be reused, there are many criteria that must be met. A partial list of these criteria is included below:

1. Favorable produced water chemistry and/or favorable Hydraulic Fracturing (HF) stimulation formulations
2. Economical water treating technology, if treating is needed at all
3. Favorable proximity of water supply to water need
4. Water infrastructure (pits and pipe) already in place or worth the capital investment
5. Cooperative industry partners that do not see each other as competitors and are willing to share their 1-3 year development schedules
6. Favorable timing of water supply versus water demand amongst all the participants for these 1-3 year schedules
7. Favorable regulatory framework

Appendix 1: Produced Water Management Practices and Applicable Regulations for Surface and Surface Water Discharges

Federal Regulatory Requirements

Our research has identified two relevant federal regulatory agencies with jurisdiction, the U.S. Environmental Protection Agency (USEPA) and the Department of the Interior's Bureau of Land Management (BLM).

USEPA regulations

(Modified from: <http://www.netl.doe.gov/research/coal/crosscutting/pwmis/fed-state-regulations>)

Surface Water Discharge Operations — The Clean Water Act (CWA) requires that all discharges of pollutants to surface waters (streams, rivers, lakes, bays, and oceans) must be authorized by a permit issued under the National Pollutant Discharge Elimination System (NPDES) program. The two basic types of NPDES permits issued are individual and general permits. Individual NPDES permits are specifically tailored to individual facilities. General NPDES permits cover multiple facilities within a certain category located in a specific geographical area.

The USEPA has published federal NPDES regulations under the CWA, and may authorize states—as well as Territories and Tribes—to implement all or parts of the national program. Once approved, a state gains the authority to issue permits and administer the program. However, the USEPA retains the opportunity to review the permits issued by the state, and formally object to elements deemed in conflict with federal requirements. The USEPA's website depicts state program status.

The USEPA has not approved permitting authority for oil and gas in Texas, Oklahoma, New Mexico and Alaska, and still issues permits for produced water discharges in those states.

Calculation of Effluent Limits — In order to meet the goals and requirements of the CWA, NPDES permit writers must consider two types of effluent limits when identifying effluent limits for produced water discharges: **technology-based effluent limits** and **water quality-based effluent limits**. Specifically, Federal regulations require NPDES permit writers to identify for each permitted wastewater discharge any applicable technology-based effluent limits (see 40 CFR 125.3). The permit writer must base the effluent limits in the permit on the more stringent of these two approaches. The permit writer can find these technology-based effluent limits in USEPA and State regulations. In the absence of applicable national technology-based limits for an industrial wastewater or pollutant discharge (known as **effluent limitations guidelines** or "ELGs"), permit writers will use Best Professional Judgment (BPJ) to identify technology-based limitations on a case-by-case basis.

Technology-based Effluent Limits — For oil and gas extraction operations, the USEPA has codified national technology-based ELGs in the Code of Federal Regulations (CFR) at 40 CFR Part 435—Oil and Gas Extraction Point Source Category.

Onshore — USEPA established ELGs for the Oil and Gas Extraction point source category on 13 April 1979 (44 FR 22075). USEPA imposed a zero-discharge requirement for all produced waters in the onshore subcategory (40 CFR 435.32). Some onshore wells are not subject to this discharge prohibition.

Oil wells with very small production (i.e., **stripper wells** producing less than 10 bbl/day of oil) are not regulated by the onshore subcategory but are regulated by the Stripper subcategory (40 CFR 435.60). The permitting authority will use best professional judgment (BPJ) and water quality standards to determine whether or not to allow the discharge of produced water and any appropriate effluent limitations.

Oil and gas wells located **west of the 98th parallel** (roughly the western half of the United States) may be regulated by the effluent limits in the Agricultural and Wildlife Water Use subcategory (40 CFR 435.50) and may be able to discharge produced water if the following conditions are met:

The produced water must be used in agriculture or wildlife propagation when discharged into navigable waters (40 CFR 435.50); and

The produced water discharges must not exceed an oil and grease daily maximum limitation of 35 mg/L (40 CFR 435.52(b)).

Additionally, USEPA defined the term use in agriculture or wildlife propagation by stating "the produced water is of good enough quality to be used for wildlife or livestock watering or other agricultural uses, and the produced water is *actually put to such use during periods of discharge*." (40 CFR 435.51(c)) [Emphasis added].

To assist State and Federal permitting authorities in addressing treatment and disposal of wastewater from shale gas extraction, USEPA issued a March 17, 2011 memo from James Hanlon, Director of USEPA's Office of Wastewater Management to the USEPA Regions titled, "[Natural Gas Drilling in the Marcellus Shale under the NPDES Program Frequently Asked Questions](#) (1 pg, 312K)", and [shale gas extraction FAQs](#) (18 pp, 648K). While the original document was intended to specifically answer questions related to the Marcellus Shale, the FAQs document was also intended to be guidance to the 10 USEPA regional offices and states. USEPA states that "The purpose of this memorandum, and the attached frequently asked questions (FAQs), is to provide you with information to assist in outreach concerning wastewater issues resulting from shale gas extraction."

The following discussion of the applicability of the NPDES program to surface water discharges to waters of the US was modified from the [shale gas extraction FAQs](#).

Shale gas extraction produces large volumes of wastewater from hydraulic fracturing in addition to relatively small volumes of produced water from the formation. That wastewater can contain high concentrations of dissolved solids (salts), naturally occurring radionuclides, and metals, as well as other pollutants used in drilling and completion of wells.

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 USEPA, 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.

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. USEPA 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)

USEPA 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 CFR, 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 CFR 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).

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.

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.” The guidelines establish best practicable control technology currently available (BPT) requirements for onshore facilities. For facilities that are east of the 98th meridian, BPT states: “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).”

Produced water from operations that are located west of the 98th meridian is 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.* [Emphasis added].

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).”

BLM regulations

BLM Produced Water Management Practices and Applicable Regulations—modified from <http://www.netl.doe.gov/research/coal/crosscutting/pwmis/fed-state-regulations/blm>

BLM regulations governing onshore oil and gas operations are codified at [43 CFR Part 3160 \(Onshore Oil and Gas Operations\)](#). General requirements for operating rights of owners and operators include **compliance with applicable laws and regulations**, the **lease terms**, **Onshore Oil and Gas Orders, Notices to Lessees and Operators (NTLs)**, and other orders and instructions of the **authorized officer**. Onshore oil and gas orders (OOGOs) implement and supplement the regulations found at [43 CFR Part 3160](#) for conducting oil and gas operations on federal or Indian lands ([43 CFR § 3164.1](#)). Notices to lessees (NTLs) implement and supplement the OOGOs and the regulations ([43 CFR § 3164.2](#)). Disposal of produced water is governed by [Onshore Oil and Gas Order \(OOGO\) No. 7](#), published in the Federal Register on November 2, 1993, at 58 FR 58506. A summary of the highlights of OOGO No. 7 follows this paragraph. The full text of OOGO No. 7 is available at, or through, most BLM State Office websites.

Scope — OOGO No. 7 applies to disposal of produced water from completed wells on **federal and Indian (except Osage) oil and gas leases**. It does not apply to approval of disposal facilities on lands other than federal or Indian lands. Separate approval under the OOGO is not required if the disposal method has been covered under an enhanced recovery project approved by the authorized officer.

Approval Requirement — Operators of onshore federal and Indian oil and gas leases may not dispose of produced water **unless and until approval** is obtained from the authorized officer.

Disposal Methods — All produced water from federal and Indian leases must be disposed of (1) by **injection** into the subsurface; (2) into **lined or unlined pits**; or (3) by **other acceptable methods** approved by the authorized officer, including surface discharge under National Pollutant Discharge Elimination System (NPDES) permits. Injection is generally the preferred method of disposal.

On-lease and Off-lease Disposal Operations — Operators shall submit a [Sundry Notice, Form 3160-5](#) when they request approval for on-lease disposal of produced water in injection wells and in lined or unlined pits. When requesting approval for removal of water and off-lease disposal on leased or non leased federal and Indian lands in a pit, operators shall submit a [Sundry Notice, Form 3160-5](#). If the water is to be disposed of in injection wells, operators must also submit a copy of the Underground Injection Control (UIC) permit (unless the well is authorized by rule). Off-lease disposal on state and privately owned lands requires submission of a [Sundry Notice Form 3160-5](#), along with a copy of the UIC permit for injection wells or pit permit, as required.

Other Requirements — In addition, [OOGO No. 7](#) identifies **informational requirements** for injection wells and pits; requirements governing **pit design, construction, maintenance, abandonment, and reclamation**; requirements for **other disposal methods**; and **reporting** requirements for disposal facilities. Operators may request variances from the standards of the OOGO.

State Regulatory Requirements

Oklahoma Corporation Commission

Water quality is the prime limiting factor that will allow for the discharge to surface water and land application of produced water. Although not discussed in detail within this report, ownership of produced water first must be assessed, and proper permitting must be acquired. The [Oklahoma Corporation Commission](#) has rules that prohibit the discharge of produced water to surface water. However surface discharge of produced water is allowed under certain circumstances.

[165:10-7-18 \(Discharge to Surface Waters\)](#)

Discharge of **deleterious substances to streams** or other **surface waters** is **prohibited except** by order of the OCC; **unless** permitted by a valid National Pollutant Discharge Elimination System (NPDES) permit issued by USEPA.

165:10-7-11 (d) (Surface Discharge of Produced Water)

Site restrictions — Discharge of produced water (by spray irrigation or other approved methods) shall only occur **on land** having an **Exchangeable Sodium Percentage (ESP) no greater than 15**, and all of the following characteristics as determined by the appropriate Soil Conservation District¹⁾ or by a qualified soils expert:

- **A maximum slope of five percent**
- **Depth to bedrock at least 20 inches**
- **Slight salinity** (defined as electrical conductivity of less than 4,000 micromhos/cm) in the topsoil or upper six inches of the soil
- **A water table deeper than six feet** from the soil surface, except a perched water table
- **A minimum distance of 100 feet from any stream** designated by Oklahoma Water Quality Standards or **any fresh water pond, lake, or wetland.**
- **Water quality limitations** — A surface discharge permit shall not be issued if the produced water to be discharged exceeds either of the following concentrations:
- **Total Dissolved Solids (TDS): 5,000 mg/l**
- **Oil and Grease: 1,000 mg/l**

The regulations provide for requirements governing **sampling, analysis, permitting, and maximum application rates**²⁾.

¹⁾ Information regarding soil types and other related information can be found in Published Soil Surveys for Oklahoma at <http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=OK> and at Web Soil Survey (WSS) which provides soil data and information produced by the National Cooperative Soil Survey <http://websoilsurvey.nrcs.usda.gov/app/>

²⁾ Further, the water to be discharged and the receiving soil must be sampled and the OCC must be given two days notice prior to sampling. The samples of soil and produced water must be analyzed by a laboratory operated by the State of Oklahoma or certified by the OWRB unless exempted by the OCC.

Another important source of information comes for the OCC adopted Oil & Gas Conservation Water Quality Standards Implementation Plan, effective July 1, 2001. It addresses Statutory Authority, Definitions, Standards, Jurisdiction, and Beneficial Uses and Protocols http://www.occeweb.com/og/wqsip_05c.htm. The following standards are from that Plan.

Section D. Pertinent Oklahoma Water Quality Standards

Surface Water

Pursuant to Section 303 of the CWA, Oklahoma's surface water quality standards are promulgated by the OWRB at OAC 785:45, Subchapter 5 Surface water quality standards are comprised of three elements:

Beneficial uses, designated to apply to specific water bodies or defined water body segments, as listed in Appendix A to OAC 785:45, and which generally address the goals of the CWA. Certain default beneficial uses are assumed for waters not listed in Appendix A until a UAA may indicate otherwise. The subset of beneficial uses which address water quality (as opposed to quantity) are:

- Public and Private Water Supply (PPWS) (OAC 785:45-5-10);
- Fish and Wildlife Propagation (F&W) (OAC 785:45-5-12), according to one of four fishery subcategories:
 - Habitat-Limited Aquatic Community (HLAC)
 - Warm Water Aquatic Community (WWAC)
 - Cool Water Aquatic Community (CWAC)
 - Trout Fishery (Put and Take)
- Agriculture (Ag) (OAC 785:45-5-13);
- Primary Body Contact Recreation (PBCR) (OAC 785:45-5-16);
- Secondary Body Contact Recreation (OAC 785:45-5-17);
- Fish Consumption (OAC 785:45-5-20)

Numerical and narrative criteria (OAC 785:45-5) apply statewide. Numerical criteria are substance-specific and apply to a water body according to its beneficial uses in accordance with OAC 785:45. Narrative criteria are generally referred to as free from prohibitions.

Numerical salinity water quality standards have been set only for agricultural beneficial uses (irrigation and watering livestock). Stream segment averages of historic data for chlorides, sulfates, and TDS are available in Appendix F for most stream segments statewide. The WQS also allows for use of upstream/background data and data from surrounding streams instead of these averages if this data provides a more appropriate basis for setting standards for a specific stream (OAC 785:45-5-13(f & g)). OAC 785:45-5-13 (e) states that Increased mineralization from other elements such as calcium, magnesium, sodium, and their associated anions shall be maintained at or below a level that will not restrict ANY BENEFICIAL USE, which OWRB interprets as meaning that neither salinity nor other minerals shall be allowed to impair the PPWS, F&W, PBCR, and other beneficial uses listed for streams in the WQS. Even though there are no numerical standards for salinity set for these other beneficial uses, it is Corp Commission O&Gs goal to act within its regulatory authority so as to protect such uses from adverse impacts, including the setting of site specific numerical water quality criteria.

Oklahoma WQS contain numeric standards for some of the common components of petroleum (e.g. benzene, ethylbenzene, and toluene) known to have adverse health effects which can be used as indicators of the presence of petroleum for PPWS and F&W (toxicity to aquatic life and toxicity of fish flesh to humans) beneficial uses. Corp Commission O&G has set risk-based criteria for some of the other petroleum compounds with no numeric standards. Narrative criteria including no visible oil also apply. Excess sediment impacts may be addressed through the numeric turbidity standards established for F&W. metal numerical WQ standards have been set by OWRB for many beneficial uses

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Water quality anti-degradation policy, which applies statewide and is consistent with the goals of the CWA, is found at OAC 785:45, Subchapter 3. Anti-degradation policy implementation is found at OAC 785:45-5-25 and OAC 785:46, Subchapter 13. There are three levels of protection:

1. Attainment or maintenance of existing or designated beneficial uses (Tier 1).
2. Maintenance of beneficial uses and water quality in higher quality waters and sensitive water supplies of the state, as well as in waters of ecological and/or recreational significance (Tier 2).
3. Prohibition of any water quality degradation for waters designated as outstanding resource waters (Tier 3).

Appendix 2: Produced Water Quality Considerations for Agricultural, Livestock, and Aquatic Instream Habitats

Four different potential uses for produced water are discussed in this Appendix: Livestock Watering, Irrigation, Stream Flow Augmentation, and Rangeland Restoration. The text was adapted from Guerra, K., Dahm, K., and Dundorf, S., 2011, Science and Technology Program Report No. 157, Oil and Gas Produced Water Management and Beneficial Use in the Western United States, U.S. Department of the Interior, Bureau of Reclamation, 113 p. <http://www.usbr.gov/research/AWT/reportpdfs/report157.pdf>

Livestock Watering

Water quality is an important consideration for livestock watering. Meeting limits for specific constituents is necessary to provide protection of livestock consuming produced water, and treatment is often necessary to meet requirements to sustain long-term health of the livestock. Although water requirements for livestock watering are relatively low, oil and gas wells drilled on property leased from farmers and ranchers represent a local source of water available for use. The use of produced water for livestock watering is convenient, given large ranching areas in areas producing large volumes of produced water. These overlapping areas include States such as Oklahoma, Wyoming, Texas, and California.

Volume of water necessary to meet livestock water requirements depends on the animal and is influenced by several other factors such as activity, feed intake and environmental temperature Table 2-1 is a summary of water volumes required for different species. Water requirements vary throughout the year; and the gender and size of an animal also impacts the estimated water consumption. To encompass these variations, an estimated range of daily water consumption for each livestock species is provided. For grazing species, such as cows and horses, water sources throughout grazing land are important in ranching regions.

| Livestock | Water Intake | Units |
|-----------|--------------|-----------------|
| Cattle | 3.5 to 23.0 | Gallons per day |
| Sheep | 1.5 to 3.0 | Gallons per day |
| Swine | 0.5 to 5.5 | Gallons per day |
| Horses | 6.0 to 18.0 | Gallons per day |

Table 2-1 Water intake volumes for livestock Source: After BLM²⁹

While livestock can tolerate and thrive on water of a lesser quality than humans, some important considerations must be evaluated when considering the use of produced water. High levels of specific ions and salinity can harm the animals. The National Academy of Sciences offers upper limits for toxic substances in water (Table 2-2). Additionally, sulfate and alkalinity not to exceed 2,000 mg/L and pH ranging between should be in the range 5.5–8.5 for livestock watering. The total dissolved solid (TDS) cutoff concentration listed in Table 2-2 of 10,000 mg/L is the maximum concentration, above which, it is not recommended for livestock watering use.

²⁹ Guerra, K., Dahm, K., and Dundorf, S., 2011, Science and Technology Program Report No. 157, Oil and Gas Produced Water Management and Beneficial Use in the Western United States, U.S. Department of the Interior, Bureau of Reclamation, 113 p. <http://www.usbr.gov/research/AWT/reportpdfs/report157.pdf>

| Constituent | Upper Limit (mg/L) |
|------------------------|---------------------------|
| Aluminum | 5 |
| Arsenic | 0.2 |
| Beryllium | No data available. |
| Boron | 5.0 |
| Cadmium | 0.05 |
| Chromium | 1.0 |
| Cobalt | 1.0 |
| Copper | 10.5 |
| Fluorine | 2.0 |
| Iron | No data available |
| Lead | 0.1 |
| Manganese | No data available |
| Mercury | 0.01 |
| Molybdenum | No data available |
| Nitrate + nitrite | 100 |
| Nitrite | 10 |
| Selenium | 0.05 |
| Vanadium | 0.10 |
| Zinc | 24 |
| Total dissolved solids | 10,000 |

Table 2-2 Recommended levels of specific constituents for livestock drinking water. Source: After BLM³⁰

Table 2-3 includes additional information on the effect of TDS levels on livestock. Specific TDS concentrations between different species vary because certain species are more susceptible to the impacts of saline water consumption than others. Also, the relative time duration for consumption of certain quality may be important and higher TDS water may be used during drought. It is important to consider not only the water quality but also the duration of consumption when predicting adverse effects.

| TDS Range¹ | Description |
|---|--|
| < 1,000 | Satisfactory |
| 1,000 to 2,999 | Satisfactory, slight temporary illness for some species |
| 3,000 to 4,999 | Satisfactory for livestock, increased poultry mortality |
| 5,000 to 6,999 | Reasonable for livestock, unsafe for poultry |
| 7,000 to 10,000 | Unfit for poultry and swine, acceptable short term for livestock |
| > 10,000 | Not recommended |
| ¹ < = less than; > = greater than. | |

² Table 2-3 TDS categories for livestock water Source: After BLM³¹

³⁰ ibid

³¹ ibid

Irrigation

In Oklahoma, agriculture and other irrigation uses over 700 million gallons of water per day, the largest use sector in the state in 2000 (USGS 2005). Irrigation not only requires large water volumes, but also has stringent water quality criteria. Specifically for produced water, parameters such as the sodium adsorption ratio are important criteria for ensuring that the water quality is sufficient to not damage crops. The sodium absorption ratio (SAR) is a calculation of the suitability for a water source for irrigation. The equation for the calculation is:

$$SAR = \frac{Na^+}{\sqrt{(Ca^{+2} + Mg^{+2})/2}}$$

The concentrations of sodium (Na⁺), calcium (Ca⁺²), and magnesium (Mg⁺²) are in milliequivalents per liter. When irrigation water has high SAR values, above three, then much more control of salt accumulation is needed. Water with high SAR can be used if enough water is applied to wash the salts down below the root zone of the crops.

The SAR and electrical conductivity (EC_w) of the water must be considered together to determine the probable effect of using the water for irrigation. When the source water has a higher conductivity, then there is a greater potential for salt damage at lower SAR levels. EC_w normally is expressed as decisiemens per meter (dS/m), which is the same as siemens per centimeter (S/cm). Given the saline nature of produced water with high sodium content the SAR and EC_w are both important parameters to consider before use.

Boron concentration also should be considered when using produced water for irrigation. The Food and Agriculture Organization publication, *Water Quality for Agriculture*, outlines boron concentration considerations for various types of crops (Ayers and Westcot 1994). Boron concentration limits are summarized in Table 2-4.

| Tolerance Level | Range of Boron Concentrations | Crops |
|------------------------|--------------------------------------|---|
| Very Sensitive | < 0.5 mg/L | Lemon, blackberry |
| Sensitive | 0.5–0.75 mg/L | Avocado, grapefruit, orange, apricot, peach, cherry, plum, persimmon, fig, grape, walnut, pecan, cowpea, onion |
| Sensitive | 0.75–1.0 mg/L | Garlic, sweet potato, wheat barley, sunflower, mung bean, sesame, lupine, strawberry, Jerusalem artichoke, kidney bean, lima bean, peanut |
| Sensitive | 1.0–2.0 mg/L | Red pepper, pea, carrot, radish, potato, cucumber |
| Moderately tolerant | 2.0–4.0 mg/L | Lettuce, cabbage, celery, turnip, Kentucky bluegrass, oats, maize, artichoke, tobacco, mustard, sweet clover, squash, muskmelon |
| Tolerant | 4.0–6.0 mg/L | Sorghum, tomato, alfalfa, purple vetch, parsley, red beet, sugar beet |
| Very tolerant | 6.0–15.0 mg/L | Cotton, asparagus |

Table 2-4 Example crop tolerances to boron in irrigation water Source: After BLM³²

³² ibid

Other constituents of concern and concentration limits are provided in Table 2-5. Concentration of minor constituents that occur in produced water may be prohibitive to plant growth used at concentrations above those listed for short- and long-term applications. In addition to these constituents, the following constituents and parameters also are identified as potentially detrimental at high concentrations to crops (Texas Cooperative Extension 2003):

- pH normal range 6.5–8.4
- Chloride < 70 parts per million (ppm) generally safe for all plants
- Nitrate < 10 ppm nitrate nitrogen (NO₃-N), 45 ppm nitrate (NO₃)

| Constituent | Long-term Use (mg/L) | Short-term Use (mg/L) |
|--------------------|---------------------------------|----------------------------------|
| Aluminum (Al) | 5 | 20 |
| Arsenic (As) | 0.1 | 2 |
| Beryllium (Be) | 0.1 | 0.5 |
| Boron (B) | 0.75 | 2 |
| Cadmium (Cd) | 0.01 | 0.05 |
| Chromium (Cr) | 0.1 | 1 |
| Cobalt (Co) | 0.05 | 5 |
| Copper (Cu) | 0.2 | 5 |
| Fluoride (F) | 1 | 15 |
| Iron (Fe) | 5 | 20 |
| Lead (Pb) | 5 | 10 |
| Lithium (Li) | 2.5 | 2.5 |
| Manganese (Mn) | 0.2 | 10 |
| Molybdenum (Mo) | 0.01 | 0.05 |
| Nickel (Ni) | 0.2 | 2 |
| Selenium (Se) | 0.02 | 0.02 |
| Vanadium (V) | 0.1 | 1 |
| Zinc (Zn) | 2 | 10 |

Table 2-5 Constituent limits for irrigation water Source: After BLM³³

In addition, Oklahoma has guidance for agricultural beneficial use of highly saline water that may provide guidance on surface water discharge requirements for agricultural irrigation runoff resulting from agricultural use of produce water.

Stream Flow Augmentation

The discharge of produced water into streams can provide more benefits than just the use of a surface water body as a conduit. Stream flow augmentation is the addition of waters to surface bodies to supplement low flows, thereby benefiting the surface body ecosystem. Additional instream flow can

³³ ibid

allow streams to meet total maximum daily loads and water quality standards required by the Oklahoma Pollution Discharge Elimination Program. When not provided by precipitation, runoff, or wastewater discharges, surface water base flow is primarily derived from ground water. Urbanization can change the hydrologic cycle and can result in streams shifting from perennial, biologically rich streams to ephemeral streams. Additionally, climate variations also affect surface water flows. Produced water may be used to sustain stream flow levels during low flow periods.

The quantity of water required to augment low stream flows is specific to the water body of application and the natural variations in water flow. For instance, creation of a perennial stream from a historically ephemeral stream using produced water flows may create an unsustainable ecosystem, because, as wells are abandoned, water sources will no longer be available. Over allocated water resources, where water taken from a surface body exceeds the flow or water sources where downstream users are in need of additional flow when available, are ideal situations for produced water augmentation. Produced water could be used to offset water use in surface bodies downstream from production, resulting in cheap transport of the water along a watershed and further dilution of the water through mixing with existing flow.

Important parameters to consider for this water quality and quantity management technique include impacts of elevated flows, which may include adverse effects such as erosion, total quantity losses due to evaporation, and impacts on the ecosystem based on water quality and physicochemical characteristics. Physical characteristics of the water that have potential to impact the ecosystem and aquatic life in a surface water body include temperature and dissolved oxygen (DO) levels resulting in high biological and chemical oxygen demand (BOD and COD). Depending on the species and application, water is expected to have DO levels from 3.0 to above 7.0 mg/L prior to discharge. Additionally, salinity and specific constituents also must be managed to protect the ecosystem. Table 2-6 outlines constituents for aquatic life requirements and includes values for both chronic and acute toxicity, which are commonly dictated by the water hardness (Colorado Department of Public Health and Environment 2010).

Table 10. Acute and chronic concentration levels by hardness

| | Mean Hardness in mg/L Calcium Carbonate | | | | | | | | | |
|------------------|---|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| | 25 | 50 | 75 | 100 | 150 | 200 | 250 | 300 | 350 | 400 |
| Aluminum | | | | | | | | | | |
| Acute | 512 | 1,324 | 2,307 | 3,421 | 5,960 | 8,838 | 10,071 | 10,071 | 10,071 | 10,071 |
| Chronic | 73 | 189 | 329 | 488 | 851 | 1,262 | 1,438 | 1,438 | 1,438 | 1,438 |
| Cadmium | | | | | | | | | | 5.7 |
| Acute | 0.8 | 1.5 | 2.1 | 2.7 | 3.9 | 5 | 6.1 | 7.1 | 8.1 | 9.2 |
| Chronic | 0.15 | 0.25 | 0.34 | 0.42 | 0.58 | 0.72 | 0.85 | 0.97 | 1.1 | 1.2 |
| Chromium | | | | | | | | | | |
| Acute | 183 | 323 | 450 | 570 | 794 | 1,005 | 1,207 | 1,401 | 1,590 | 1,773 |
| Chronic | 24 | 42 | 59 | 74 | 103 | 131 | 157 | 182 | 207 | 231 |
| Copper | | | | | | | | | | |
| Acute | 3.6 | 7 | 10 | 13 | 20 | 26 | 32 | 38 | 44 | 50 |
| Chronic | 2.7 | 5 | 7 | 9 | 13 | 16 | 20 | 23 | 26 | 29 |
| Lead | | | | | | | | | | |
| Acute | 14 | 30 | 47 | 65 | 100 | 136 | 172 | 209 | 245 | 281 |
| Chronic | 0.5 | 1.2 | 1.8 | 2.5 | 3.9 | 5.3 | 6.7 | 8.1 | 9.5 | 11 |
| Manganese | | | | | | | | | | |
| Acute | 1,881 | 2,370 | 2,713 | 2,986 | 3,417 | 3,761 | 4,051 | 4,305 | 4,532 | 4,738 |
| Chronic | 1,040 | 1,310 | 1,499 | 1,650 | 1,888 | 2,078 | 2,238 | 2,379 | 2,504 | 2,618 |

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| | | | | | | | | | | |
|----------------|------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| Nickel | | | | | | | | | | |
| Acute | 145 | 260 | 367 | 468 | 660 | 842 | 1,017 | 1,186 | 1,351 | 1,513 |
| Chronic | 16 | 29 | 41 | 52 | 72 | 94 | 113 | 132 | 150 | 168 |
| Silver | | | | | | | | | | |
| Acute | 0.19 | 0.62 | 1.2 | 2 | 4.1 | 6.7 | 9.8 | 13 | 18 | 22 |
| Chronic | 0.03 | 0.1 | 0.2 | 0.32 | 0.64 | 1 | 1.6 | 2.1 | 2.8 | 3.5 |
| Uranium | | | | | | | | | | |
| Acute | 521 | 1,119 | 1,750 | 2,402 | 3,756 | 5,157 | 6,595 | 8,062 | 9,555 | 11,070 |
| Chronic | 326 | 699 | 1,093 | 1,501 | 2,346 | 3,221 | 4,119 | 5,036 | 5,968 | 6,915 |
| Zinc | | | | | | | | | | |
| Acute | 45 | 85 | 123 | 160 | 231 | 301 | 368 | 435 | 500 | 565 |
| Chronic | 34 | 65 | 93 | 121 | 175 | 228 | 279 | 329 | 379 | 428 |

Source: Colorado Department of Public Health and Environment 2010.

Table 2-6. Acute and chronic toxicity levels for aquatic life Source: Colorado Department of Public Health and Environment, 2010, Table 10

Rangeland Restoration

Rangelands consist of shrubs and grasses and covers approximately 50% of the land surface in the United States. The most common use for rangelands is livestock grazing. Overstocking and drought are two of the causes of rangeland degradation. Degradation of rangeland also is caused by improper use of vehicles and other industrial activity and changing weather patterns resulting in drought.

Produced water can be applied to rangeland to help the natural biotic community to reestablish vegetation and to increase the response of the native species (Fox and Burnett 2002). SAR is an important criterion for using produced water for rangeland restoration. Similarly to irrigation water, high SAR values can further damage soils; therefore, treatment may be required for some produced water sources to be used for rangeland restoration.

Appendix 3: Oklahoma Water Quality Standards References

Repository of Documents: Oklahoma

http://water.USEPA.gov/scitech/swguidance/standards/wqslibrary/ok_index.cfm

Oklahoma Water Quality Standards Program

<http://www.owrb.ok.gov/quality/standards/standards.php>

Standards Fact sheet http://www.owrb.ok.gov/about/about_pdf/Fact-Standards.pdf

[Oklahoma's Water Quality Standards \(Chapter 45\) \(PDF\)](#) (133 pp, 1.9MB)

(Effective November 7, 2013) State regulation establishing water quality standards for surface waters of the State. Please note that not all parts of this document are effective for Clean Water Action purposes.

[Implementation of Oklahoma's Water Quality Standards \(Chapter 46\) \(PDF\)](#) (49 pp, 414K)

(State Effective Date of July 1, 2013) State regulation providing water quality standards implementation procedures.

<http://www.owrb.ok.gov/maps/index.php> Interactive Maps & GIS Data

Including



[Surface Water Data, Standards & Protection for Oklahoma](#)

[Surface Water GIS Data](#)

UNIFIED PROTOCOLS FOR BENEFICIAL USE ASSIGNMENT FOR OKLAHOMA WADABLE STREAMS (USE ATTAINABILITY ANALYSIS) OWRB TECHNICAL REPORT TRWQ2001-1, Oklahoma Water Resources Board

https://www.owrb.ok.gov/studies/reports/reports_pdf/TR2001_1_Protocols_Wadable.pdf

Fish and Wildlife Subcategories

There currently exists in the Oklahoma WQS four subcategories of beneficial uses under the Beneficial Use designation of Fish and Wildlife Propagation. All Oklahoma streams have been classified as capable of attaining one of these beneficial uses:

(1) Warm Water Aquatic Community (WWAC): - A subcategory of the beneficial use category "Fish and Wildlife Propagation" where the water quality and habitat are adequate to support intolerant climax fish communities (OAC785:45-1-2).

(2) Habitat Limited Aquatic Community (HLAC): - A subcategory of the beneficial use "Fish and Wildlife Propagation" where the water chemistry and habitat are not adequate to support a WWAC. Possible reasons for this inability are limited to (1) Naturally occurring water chemistry prevents the

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attainment of the use; or (2) Naturally occurring ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of a sufficient volume of effluent to enable uses to be met; or (3) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or (4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use; or (5) Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of the WWAC beneficial use (40 CFR 131.10).

(3) Cool Water Aquatic Community - A subcategory of the beneficial use category "Fish and Wildlife Propagation" where the water quality, water chemistry and habitat are adequate to support warm water intolerant climax fish communities and includes an environment suitable for the full range of cool water benthos. Typical species may include smallmouth bass, certain darters and stoneflies (OAC785:45-1-2).
(4) Trout Fishery - A water body that contains trout at least part of the year.

The Oklahoma Conservation Commission adopted an Oil & Gas Conservation Water Quality Standards Implementation Plan which was effective July 1, 2001. It addresses Statutory Authority, Definitions, Standards, Jurisdiction, and Beneficial Uses and Protocols http://www.occeweb.com/og/wqsip_05c.htm.

Appendix 4: Tribal Information

Tribal Standards

Current Tribal Jurisdiction Maps

<http://www.okladot.state.ok.us/hqdiv/p-r-div/maps/tribal/index.htm>

Indian Tribal Approvals

<http://water.USEPA.gov/scitech/swguidance/standards/wqslibrary/approvable.cfm>

The following chart lists USEPA approvals for tribes to administer a water quality standards (WQS) program, and USEPA’s approvals of those tribes’ WQS. A tribe may administer a WQS program if it applies and USEPA finds that it qualifies under Section 518(e) of the Clean Water Act to be treated in a manner similar to a state (“TAS”). Currently, **50** tribes have been found eligible to administer a WQS program, and USEPA has approved at least initial WQS for **40** of these tribes. USEPA has promulgated federal WQS for **1** tribe not included in these totals.

Indian Tribal Approvals for the Water Quality Standards Program

| Tribe | USEPA Region | Date Found Eligible to Administer a WQS Program | Date Initial WQS Approved by USEPA |
|--------------------|--------------|---|------------------------------------|
| Pawnee Nation (OK) | 6 | 04 Nov 2004 | |

Quick Links

Tribes <http://water.USEPA.gov/scitech/swguidance/standards/wqslibrary/tribes.cfm>

[Territories](#)

[Regional Coordinators](#)

[Water Quality Standards Repository \(WQS Repository\)](#)

In this repository, USEPA has compiled unofficial copies of state, territorial, and authorized tribal water quality standards that USEPA has approved or are otherwise in effect for Clean Water Act purposes. Please note the water quality standards may contain additional provisions outside the scope of the Clean Water Act, its implementing federal regulations, or USEPA’s authority. In some cases, these additional provisions have been included within this repository as supplementary information or for context.

USEPA is posting the water quality standards in this repository as a convenience to users and has made a reasonable effort to assure their accuracy. Additionally, USEPA has made a reasonable effort to identify parts of the standards that are not approved, disapproved, or are otherwise not in effect for Clean Water Act purposes. Please contact the appropriate Regional USEPA [Water Quality Standards coordinator](#) for questions about water quality standards for a particular state, tribe, or territory.

Regional Coordinators <http://water.USEPA.gov/scitech/swguidance/standards/comments.cfm#coor>

Region 6 Jurisdictions

Coordinator: [Russell Nelson](mailto:nelson.russell@USEPA.gov) (nelson.russell@USEPA.gov)

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Arkansas
Louisiana
New Mexico
Oklahoma
Texas
Pueblo of Acoma
Pueblo of Isleta
Pueblo of Nambe
Pueblo of Picuris
Pueblo of Pojoaque
Pueblo of Sandia
Pueblo of San Juan
Pueblo of Santa Clara
Pueblo of Taos
Pueblo of Tesuque

Repository of Documents for Tribes

[Region 6 Tribal Portal - Information and links to Tribal Environmental Offices](http://www.USEPA.gov/tribalportal/wherelive/region6.htm)
<http://www.USEPA.gov/tribalportal/wherelive/region6.htm>

Regional Tribal Programs

Region 6 Contacts

[USEPA's National Tribal Caucus Master List \(PDF\)](#) (5 pp, 466 K, [About PDF](#))

USEPA Region 6 Map



Regional Indian Program Managers and Coordinators

[Randy Gee](#) - Tribal Affairs Team Leader and Regional Indian Coordinator

Office of Environmental Justice and Tribal Affairs

USEPA Region 6

1445 Ross Ave. (6RA-DT)

Dallas, TX 75202

214-665-8355/Fax 214-665-6648

Email: gee.randy@USEPA.gov

Regional Website

The [USEPA Region 6 Tribal Program website](#) features:

A map showing tribal headquarters

Tribal contact information

A guide to the pronunciation of Region 6 tribal names

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List of Tribes in Oklahoma

The following is a partial list of Federally Recognized tribes in Oklahoma. (Note: all links are outside the USEPA server).

Oklahoma (OK)

[Absentee-Shawnee Tribe of Indians](#)

[Alabama-Quassarte Tribal Town](#)

Apache Tribe

[Caddo Nation](#)

(formerly the Caddo Indian Tribe of Oklahoma)

[Cherokee Nation](#)

[Cheyenne-Arapaho Tribes](#)

[Chickasaw Nation](#)

[Choctaw Nation](#)

[Citizen Band Potawatomi Tribe](#)

[Comanche Nation](#)

[Delaware Nation](#)

[Delaware Tribes of Indians](#)

[Eastern Shawnee Tribe](#)

[Fort Still Apache Tribe](#)

[Iowa Tribe of Oklahoma](#)

[Kaw Nation](#)

[Kialegee Tribal Town](#)

[Kickapoo Tribe](#)

[Kiowa Indian Tribe](#)

[Miami Tribe](#)

[Modoc Tribe](#)

[Muscogee \(Creek\) Nation](#)

[Osage Tribe](#)

[Ottawa Tribe](#)

[Otoe-Missouria Tribe of Indians](#)

[Pawnee Nation](#) <http://www.pawneenation.org/page/home/divisions/division-of-natural-resources-and-safety/dUSEPartment-of-environmental-conservation-and-safety-decs>

[Peoria Tribe of Indians](#)

[Ponca Tribe of Indians](#)

[Quapaw Tribe of Indians](#)

[Sac & Fox Nation](#)

[Seminole Nation](#)

[Seneca-Cayuga Tribe](#)

[Shawnee Tribe](#)

Thlopthlocco Tribal Town

[Tonkawa Tribe of Indians](#)

[United Keetoowah Band of Cherokee Indians](#)

[Wichita and Affiliated Tribes](#)

(Wichita, Keechi, Waco, and Tawakonie)

[Wyandotte Nation](#)

(formerly the Wyandotte Tribe of Oklahoma)

Tribal Affairs

<http://www.USEPA.gov/earth1r6/6dra/oejta/tribalaffairs/index.html>

Appendix 5: Surface Water Quality Data, Impaired Water Bodies, and NPDES.

<http://watersgeo.USEPA.gov/mwm/>

Welcome to the new MyWATERS Mapper!



[Click to launch MyWATERS Mapper](http://watersgeo.USEPA.gov/mwm/)

[MyWATERS Mapper](http://watersgeo.USEPA.gov/mwm/) dynamically displays snapshots of USEPA Office of Water program data. This version of MyWATERS Mapper depicts the status of NPDES permits for each State; summary information from the Clean Watershed Needs Survey; and water quality assessments. Future versions will include other Office of Water Program Snapshots. MyWATERS Mapper also contains water-related geographic themes such as 12-digit watersheds, the national stream network known as the National Hydrography Dataset, and other water-related map layers. MyWATERS Mapper enables you to create customized maps at national and local scales.

USEPA Issues Final Updated Human Health Ambient Water Quality Criteria

USEPA has published updated national recommended water quality criteria for the protection of human health for 94 chemical pollutants. These 2015 criteria reflect the latest scientific information and USEPA policies, including updated body weight, drinking water consumption rate, fish consumption rate, bioaccumulation factors, health toxicity values, and relative source contributions. The Agency accepted written scientific views from the public on the draft updated human health criteria from May to August 2014 and has published responses to those comments. USEPA water quality criteria serve as recommendations to states and tribes authorized to establish water quality standards for surface waters under the Clean Water Act. [Learn more here.](#)

[Implementation of Oklahoma's Water Quality Standards \(Chapter 46\) \(PDF\)](#) (49 pp, 414K)
 (State Effective Date of July 1, 2013) State regulation providing water quality standards
 implementation procedures.

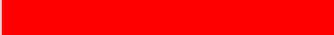
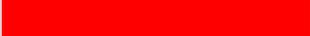
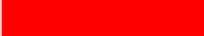
http://iaspub.USEPA.gov/waters10/attains_state.control?p_state=OK#causes

Causes of Impairment

Oklahoma Causes of Impairment for 303(d) Listed Waters

[Description of this table](#)

NOTE: Click on a cause of impairment (e.g. pathogens) to see the specific state-reported causes that are grouped to make up this category. Click on the "Number of Causes of Impairment Reported" to see a list of waters with that cause of impairment.

| Cause of Impairment Group Name | Number of Causes of Impairment Reported |
|--|---|
| Salinity/Total Dissolved Solids/Chlorides/Sulfates |  304 |
| Pathogens |  171 |
| Organic Enrichment/Oxygen Depletion |  158 |
| Cause Unknown - Impaired Biota |  129 |
| Turbidity |  108 |
| Metals (other than Mercury) |  107 |
| pH/Acidity/Caustic Conditions |  54 |
| Algal Growth |  22 |
| Mercury |  18 |
| Oil and Grease |  17 |
| Sediment |  14 |
| Nutrients |  14 |
| Pesticides |  12 |
| Ammonia |  4 |
| Radiation |  1 |

Total: 1,133 Causes of Impairment

Specific State Causes of Impairment That Make Up the National Salinity/Total Dissolved Solids/Chlorides/Sulfates Cause of Impairment Group

[Description of this table](#)

| | |
|---|---|
| Note: Click on the underlined "Cause of Impairment" to see a listing of those waters with the cause of impairment. | |
| <u>Cause of Impairment</u> | <u>Number of Causes of Impairment</u> |
| <u>Chloride</u> | 120 |
| <u>Sulfates</u> | 104 |
| <u>Total Dissolved Solids (TDS)</u> | 80 |
| - | |

Specific State Causes of Impairment That Make Up the National Oil and Grease Cause of Impairment Group

[Description of this table](#)

| | |
|---|---|
| Note: Click on the underlined "Cause of Impairment" to see a listing of those waters with the cause of impairment. | |
| <u>Cause of Impairment</u> | <u>Number of Causes of Impairment</u> |
| <u>Oil and Grease</u> | 17 |

<http://water.USEPA.gov/scitech/wastetech/guide/oilandgas/index.cfm>

Oil and Gas Extraction Effluent Guidelines



[Unconventional Oil and Gas Extraction](#) – Proposed Rule (April 7, 2015)

USEPA promulgated the Oil and Gas Extraction (O&G) effluent guidelines and standards ([40 CFR Part 435](#)) in 1979, and amended the regulation in 1993, 1996, and 2001. The regulation covers wastewater discharges from field exploration, drilling, production, well treatment and well completion activities. These activities take place on land, in coastal areas and offshore. The O&G effluent guidelines and standards are incorporated into [NPDES permits](#). The regulations apply to conventional and unconventional oil and gas extraction with the exception of coalbed methane.

[What is the Oil and Gas Extraction Industry?](#)

[Facilities Covered](#)

[Waste streams Covered](#)

[Subpart C Amendments: Unconventional Extraction](#)

[Coalbed Methane](#)

[Rulemaking History](#)

[Additional Information](#)

What is the Oil and Gas Extraction Industry?

Oil and Gas Extraction is the exploration and production of petroleum and natural gas from wells. The industry generates wastewater from the water extracted from the geological formations and from chemicals used during exploration, well drilling and production of oil and gas.

These activities are included within North American Industrial Classification System (NAICS) code 211111, Crude Petroleum and Natural Gas Extraction. (Note: the NAICS group listings are provided as a guide and do not define the coverage of the O&G rule. For precise definitions of coverage, see the applicability sections in [40 CFR Part 435](#).)

Facilities Covered

The O&G regulation applies to facilities organized into 5 subcategories:

Subpart A: Offshore

Subpart C: Onshore

Subpart D: Coastal

Subpart E: Agricultural and Wildlife Water Use

Subpart F: Stripper Wells

Waste streams Covered

| | |
|--|-------------------------|
| Produced water | Domestic* |
| Produced sand | Sanitary* |
| Drilling fluids | Deck drainage* |
| Drill cuttings | * Subparts A and D only |
| Well treatment, workover and completion fluids | |

Subpart C Amendments: Unconventional Extraction

USEPA has issued a proposed rule (FR Vol. 80, No. 66, p. 18557 – 18580) to address wastewater pollutant discharges from onshore unconventional oil and gas extraction facilities to municipal wastewater treatment plants.

Coalbed Methane

USEPA has not promulgated effluent limitations guidelines and standards for pollutant discharges from coalbed methane extraction facilities. USEPA had initiated a coalbed methane rulemaking, but announced its decision to discontinue this effort in fall 2014.

Rulemaking History

2001 Amendment

Added requirements for the discharge of synthetic-based drilling fluids (SBFs) and other non-aqueous drilling fluids.

[Clarification Memo: Standards for Controlling SBF Discharges \(PDF\)](#) (16 pp, 271K) (10/10/2003)

Final Rule: [66 FR 6850 \(PDF\)](#) (70 pp, 1.1MB) 1/22/2001

Technical correction: [66 FR 30807 \(PDF\)](#) (5 pp, 177K) 6/8/2001

[Development Document](#) (518 pp, 1.2MB) (USEPA-821-B-00-013; December 2000)

Proposed Rule: [67 FR 5488 \(PDF\)](#) (67 pp, 629K) 2/3/1999

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1996 Amendment

Added BAT, BCT, NSPS, PSES and PSNS, and revised BPT limitations for coastal facilities.

Final Rule: [61 FR 66086 \(PDF\)](#) (45 pp, 463K) 12/16/1996

[Development Document \(PDF\)](#) (640 pp, 29MB) (USEPA-821-R-96-023, October 1996)

Proposed Rule: [60 FR 9428 \(PDF\)](#) (54 pp, 505K) 2/17/1995

1993 Amendment

Added BAT, BCT and NSPS requirements for offshore facilities.

Final Rule: [58 FR 12454 \(PDF\)](#) (59 pp, 8MB) 3/4/1993

[Development Document \(PDF\)](#) (407 pp, 21MB) (USEPA-821-R-93-003, January 1993)

Proposed Rules:

[56 FR 10664 \(PDF\)](#) (52 pp, 6.3MB) 3/13/1991

[55 FR 49094 \(PDF\)](#) (3 pp, 397K) 11/26/1990

[53 FR 41356 \(PDF\)](#) (35 pp, 4.2MB) 10/21/1988 (Notice of Data Availability)

[50 FR 34592 \(PDF\)](#) (45 pp, 5.5MB) 8/26/1985

1979 Initial Rulemaking

BPT limitations for Offshore; Onshore; Coastal; and Agricultural and Wildlife Water Use subcategories.

Final Rule: [44 FR 22069 \(PDF\)](#) (10 pp, 1.2MB) 4/13/1979

Interim Final Rules:

[41 FR 44942 \(PDF\)](#) (7 pp, 1.3MB) 10/13/1976 (Subparts C through F)

[40 FR 42543 \(PDF\)](#) (9 pp, 1.4MB) 9/15/1975 (Subparts A and B)

[Development Document \(PDF\)](#) (156 pp, 5.7MB) (USEPA-440/1-76/055a, September 1976)

Additional Information

For additional information on existing Oil and Gas Extraction subcategories, please contact [Ron Jordan](#) (jordan.ronald@USEPA.gov) or 202-566-1003. For additional information on Unconventional Extraction, please contact [Lisa Biddle](#) (biddle.lisa@USEPA.gov) or 202-566-0350.

NPDES Home Overview

Water pollution degrades surface waters making them unsafe for drinking, fishing, swimming, and other activities. As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. In most cases, the NPDES permit program is administered by [authorized states](#). Since its introduction in 1972, the NPDES permit program is responsible for significant improvements to our Nation's water quality.

What can I find on this website

The site contains technical and regulatory information about the NPDES permit program. The NPDES Permits Program consists of a number of programs and initiatives. Links to each of these programs and initiatives are located on the right navigational bar.

For information on specific facilities with NPDES permits, there are several USEPA public search tools that may be helpful:

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[Enforcement and Compliance History Online \(ECHO\)](#) - The public access website to data stored in USEPA's compliance and enforcement data systems, including ICIS-NPDES for facilities regulated under the CWA NPDES program. ECHO allows users to find and download information on permit data, inspections, violations, enforcement actions, and penalties. The ECHO website was recently modernized and redesigned to make it easier to use and maintain. The modernized search for Clean Water Act facility search, effluent charts, and water quality data.

[Envirofacts](#) - A single point of access to select U.S. USEPA environmental data. This website provides access to several USEPA databases to provide you with information about environmental activities, including those that affect water. Under "System Data Searches", a user can retrieve facility data from ICIS-NPDES.

Specify the facilities by using any combination of facility name, permit number, location, industrial classification, and chemicals.

[Clean Water Act DMR Pollutant Loading Tool](#) - This tool helps users determine who is discharging, what pollutants they are discharging and how much, and where they are discharging. Provides and calculates water discharge information from the USEPA system for water enforcement and compliance data and from the Toxics Release Inventory (2007-2011). Search by location, watershed, pollutant, or industry and compare the two USEPA datasets.

[My WATERS Mapper](#) - Displays snapshots of USEPA Office of Water program data and enables you to create customized maps at national and local scales. The "Other USEPA Water Data" section allows the user to display all NPDES facilities on a map, along with several other features, such as impaired waters and waters with TMDLs.

Treatment and Disposal of Wastewater from Shale Gas Extraction

<http://water.USEPA.gov/polwaste/npdes/Treatment-and-Disposal-of-Wastewater-from-Shale-Gas-Extraction.cfm>

To assist State and Federal permitting authorities in addressing treatment and disposal of wastewater from shale gas extraction, USEPA issued a March 17, 2011 memo from James Hanlon, Director of USEPA's Office of Wastewater Management to the USEPA Regions titled, "[Natural Gas Drilling in the Marcellus Shale under the NPDES Program Frequently Asked Questions](#) (1 pg, 312K, [About PDF](#))", and [shale gas extraction FAQs](#) (18 pp, 648K, [About PDF](#)). Shale gas extraction produces large volumes of wastewater from hydraulic fracturing in addition to relatively small volumes of produced water from the formation. That wastewater can contain high concentrations of dissolved solids (salts), naturally occurring radionuclides, and metals, as well as other pollutants used in drilling and completion of wells. See discussion in Appendix 1.

National Pollutant Discharge Elimination System (NPDES) Permits Program

<http://www.USEPA.gov/region6/water/npdes/index.htm>

Overview

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) Permit Program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches.

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Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. Since its introduction in 1972, the NPDES permit program is responsible for significant improvements to our Nation's water quality.

Resources

[Region 6 NPDES Public Notices and General Permits Regional Program Contacts \(PDF\)](#) (23KB)
[National NPDES Program](#)
[NPDES Application Forms](#)
[State Program Information](#)

| | | |
|--|--|---|
| For further information on NPDES Permits and TMDLs, please contact any of the following: | | |
| Claudia Hosch Associate Director, NPDES Permits & TMDL Branch 214-665-6464 | | |
| Brent Larsen Permits & Technical Section 214-665-7523 | Paul Kaspar Oversight Section 214-665-7459 | Richard Wooster TMDL Section 214-665-6473 |

The Oversight and TMDL Section reviews wastewater permits in [authorized states](#), establishes and approves [TMDLs](#) in Region 6.

Region 6 NPDES Programs:

[CAFO's](#) - Concentrated Animal Feeding Operations
[NPDES Oil & Gas Permits](#) - Discharges from oil and gas facilities are generally authorized under general permits.
[Final Individual Permits](#)
[Industrialized Pretreatment Program](#)
[Sewage Sludge \(Biosolids\)](#)
[Storm Water Program](#)
[Green Infrastructure](#)
[TMDL Program](#) - Total Maximum Daily Loads and §303(d) Lists
[Wastewater Security](#)
[Whole Effluent Toxicity](#)
[316\(b\) Rule](#) - Thermal Discharges
[Illinois River Watershed](#)
[New Mexico NPDES Coordination](#)
[ODAFF Program Authorization Website](#)

Industrial and Commercial Facilities Regional Contacts

<http://water.USEPA.gov/polwaste/npdes/Industrial-and-Commercial-Facilities-Regional-Contacts.cfm>

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Region 6 Contacts

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Onshore Oil and Gas
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Dallas, TX 75202-2733
Phone: (214) 665-7364
Fax: (214) 665-2191

Reading Materials

Recycling and Reuse of Produced Water to Reduce Freshwater Use in Hydraulic Fracturing Operations
<http://www2.USEPA.gov/hfstudy/recycling-and-reuse-produced-water-reduce-freshwater-use-hydraulic-fracturing-operations>

Matthew Mantell, Chesapeake Energy Corporation

[Recycling and Reuse of Produced Water to Reduce Freshwater Use in Hydraulic Fracturing Operations \(PDF\)](#) (17 pp, 2 MB)

Sources Contributing Inorganic Species to Drinking Water Intakes During Low Flow Conditions on the Allegheny River in Western Pennsylvania

<http://www2.USEPA.gov/hfstudy/sources-contributing-inorganic-species-drinking-water-intakes-during-low-flow-conditions>

Norris et al. *USEPA Report*. May 2015.

Summary

USEPA scientists evaluated sources of bromide and other inorganic pollutants impacting drinking water intakes on the Allegheny River in Pennsylvania to examine the potential impacts related to the treatment and disposal of oil and gas well produced wastewater. Study results demonstrate that multiple sources contributed bromide concentrations to public drinking water intakes on the Allegheny River in Pennsylvania, with the major sources being centralized oil and gas wastewater treatment facilities that

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treat wastewater from hydraulic fractured wells, and coal-fired power plants that use flu-gas desulfurization. This research study is also significant in demonstrating the application of source apportionment techniques to evaluate a complex array of source impacts on public drinking water system intakes. This work was done as part of USEPA's Study of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources.

Case Study Analysis of the Impacts of Water Acquisition for Hydraulic Fracturing on Local Water Availability

<http://www2.USEPA.gov/hfstudy/case-study-analysis-impacts-water-acquisition-hydraulic-fracturing-local-water-availability>

Sullivan et al. *USEPA Report*. May 2015.

Summary

USEPA scientists examined the balance between water supply and demand associated with hydraulic fracturing operations in the Susquehanna River basin in the eastern U.S., and the upper Colorado River basin in the western U.S. Researchers found that neither the Susquehanna River basin in Pennsylvania, nor the upper Colorado River basin are currently experiencing imbalance from water withdrawals directly from hydraulic fracturing operations. These reasons relate to different water user demands, water management practices, geologic conditions, and hydraulic fracturing operations in the two areas. This work was done as Part of USEPA's Study of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources.

[Case Study Analysis of the Impacts of Water Acquisition for Hydraulic Fracturing on Local Water Availability \(PDF\)](#)(215 pp, 26 MB)

Appendix 6 List of Acronyms

| Acronym | Meaning |
|---------|---|
| AR | Aquifer Recharge |
| ASR | Aquifer Storage and Recovery |
| BLM | Bureau of Land Management |
| BOD | Biological Oxygen Demand |
| CEC | Cation Exchange Capacity |
| CFR | Code of Federal Regulation |
| COD | Chemical Oxygen Demand |
| CWA | Clean Water Act |
| CWT | Centralized Waste Treatment |
| DBP | Disinfection By-product |
| dS/m | Decisiemens per meter |
| E&P | Exploration and Production |
| ECw | Electrical conductivity of Water |
| ELG | Effluent Limitation Guideline |
| ESP | Exchangeable Sodium Percentage |
| FR | Federal Register |
| GWPC | Ground Water Protection Council |
| HF | Hydraulic Fracturing |
| mg/L | Milligrams per liter |
| NETL | National Energy Technology Laboratory |
| NPDES | National Pollutant discharge Elimination System |
| O&G | Oil & Gas |
| OCC | Oklahoma Corporation Commission |
| OCWP | Oklahoma Comprehensive Water Plan |
| ODEQ | Oklahoma Department of Environmental Quality |
| OOGO | Onshore Oil & Gas Order |
| OPDES | Oklahoma Pollutant Discharge Elimination System |
| OWQS | Oklahoma Water Quality Standards |
| OWRB | Oklahoma Water Resources Board |
| POTW | Publicly Owned Treatment works |
| PPWS | Public and Private Water Supply |
| Primacy | Primary Enforcement Authority |
| RCRA | Resource Conservation Recovery Act |
| SDWA | Safe Drinking Water Act |
| TDS | Total Dissolved Solids |
| TMDL | Total Maximum Daily Load |
| TOC | Total Organic Carbon |
| UIC | Underground Injection Control |
| UOG | Unconventional Oil and Gas |
| USDOE | U.S. Department of energy |
| USDW | Underground Source of Drinking Water |
| USEPA | U.S. Environmental Protection Agency |
| USGS | U.S. Geological Survey |

Addendum A: List of Attachments

- Attachment 1 Oklahoma Comprehensive Water Plan, 2012
- Attachment 2 Injection Wells: An Introduction to Their Use, Operation & Regulation, 2013
- Attachment 3 Federal Register 18558 CWA Effluent Limitations for the Oil and Gas Extraction Point Source Category
- Attachment 4 Produced Water Resources for use in Thermoelectric Power Generation- EPRI
- Attachment 5 Produced Water: Asset or Waste
- Attachment 6 Use of Produced Water in Recirculating Cooling Systems at Power Generating Facilities
- Attachment 7 Environmental Aspects of Produced-water Salt Releases in Onshore and Coastal Petroleum-producing Areas of the Conterminous U.S. – A Bibliography
- Attachment 8 Oil and Gas Produced Water Management and Beneficial Use in the Western United States
- Attachment 9 USEPA Letter on Acceptance of Oil and Gas Waste by POTW's
- Attachment 10 USEPA discharge paper and memo hydrofracturing faq
- Attachment 11 Energy-Positive Water Resource Recovery Workshop Report
- Attachment 12 OWRB Fact Standards
- Attachment 13 State NPDES Delegation Map
- Attachment 14 Map of tribal jurisdictions in Oklahoma
- Attachment 15 USEPA-ASR letter to Florida DEP dated September 13, 2013
- Attachment 16 USEPA Technical Development Document for Proposed Effluent Limitations
- Attachment 17 USEPA Aquifer Recharge and Aquifer Storage and Recovery Wells, Volume 21
- Attachment 18 USEPA Revisions to the Unregulated Contaminant Monitoring Rule (UCMR 4) for Public Water Systems

Addendum B: Produced Water Analyses

Spreadsheets of produced water analyses in Oklahoma from USGS and select oil and gas companies (Previously submitted to GE)

Disclaimers

1. The documents listed as Attachments in Addendum A are for reference purposes only. They may be protected by Copyright and you should verify their status with the author or publisher prior to copying or distributing these documents.
2. All hyperlinks in this report were valid at the time of insertion. However, USEPA is currently revising its websites and links may be temporarily unavailable during this process.
3. Opinions and recommendations in this report are those of the authors and do not represent the opinions or recommendations of the GWPC or any of its member states.

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