Legal and Regulatory Permitting for Re-Use of Purified Produced Water in Colorado

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Abstract

Altela, Inc. has developed a fundamentally new produced water treatment product, the AltelaRain[SM] System that creates pure water from highly salinated and contaminated water sources. Since the treated water stream is distilled water, the quality of water from the AltelaRain[SM] System is extremely high and can be used at the well site for frac/well completion water, irrigation, stock watering, or other clean water uses following applicable legal and regulatory permitting.

Prior to placing treated, purified produced water to re-use, certain regulatory and permitting requirements must be addressed. This paper provides a brief overview of the legal framework associated with produced water and its re-use. A brief survey and related summary of Rocky Mountain States' regulation of produced water follows. Finally, a summary of an exciting Colorado-based produced water treatment and re-use project located in the fast-growing Piceance Basin of northwestern Colorado is included that demonstrates how oil and gas regulations can be successfully dovetailed with vital, long-standing water rights law and related code to create positive environmental stewardship and sustainability.

In support of treating and re-using produced water in the Piceance Basin of northwestern Colorado, Altela has received approval from the Colorado Department of Public Health and Environment, Water Quality Control Division to place the treated, clean water into the Colorado River drainage for valuable in-stream flow. In addition, the Colorado Division of Water Resources, State Engineer Office, has approved and issued precedent-setting permits to place the treated, clean water to beneficial use for industrial, commercial, the irrigation of 40 acres of irrigated pastureland, the watering of livestock, road spreading, dust suppression, recovery, recycling drilling and mitigation for oil and gas production and exploration, and in-stream flows. Such re-use of treated, clean produced water directly supports the 'energy/water/environment' partnership outlined in the *More Water, More Energy, Less Waste Act of 2007* which was signed into law by President Bush on May 8, 2008.

Legal Framework of Produced Water

In order to identify potential projects where produced water can be successfully re-used, a basic understanding of the legal and regulatory framework associated with produced water is required. The legal framework related to produced water is broadly summarized in three major federal laws, coupled with a compliment of attendant state laws and regulations.

Resource Conservation and Recovery Act (RCRA)

Congress enacted the Resource Conservation and Recovery Act of 1976 (RCRA) as "a comprehensive environmental statute that empowers the Environmental Protection Agency to regulate hazardous wastes from cradle to grave, in accordance with rigorous safeguards and waste management procedures of Subtitle C."[1] In 1980, Congress conditionally exempted oil and gas industry waste, including drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of crude oil or natural gas or geothermal energy, from the hazardous waste management requirements of Subtitle C of RCRA (Section 3001(b)(2)(A) of RCRA and Section 8002(m) of RCRA)[2]. In addition to directing the EPA to study these wastes and submit a report to Congress on the status of their management, Congress required the Agency either to promulgate regulations under Subtitle C of RCRA or make a determination that such regulations were unwarranted.

On July 6, 1988, the EPA published its Regulatory Determination for Oil and Gas and Geothermal Exploration, Development, and Production Wastes in the Federal Register (FR) at 53 FR 25447. EPA continued to exempt oilfield wastes from regulation stating that regulation of oil and gas exploration and development wastes under RCRA Subtitle C was "unwarranted because of the relatively low risk of these wastes and the presence of generally effective state and federal

[1] City of Chicago v. EDF, 511 U.S. 328, 331 (1194) (citing RCRA tit. II, subtit. C, 42 U.S.C. §§ 6921-6934).

[2] Act of Oct. 21, 1980, 42 U.S.C. § 6921(b)(2)(A).

regulatory programs."[3] In order to define the exact scope of the continued oilfield waste exemption under RCRA, EPA outlined the materials that it considered within the initial exemption including tank bottoms, pit sludges, produced water, drilling fluids and other wastes associated with oil and gas drilling and production.[4] Produced water ranks first on the list of exempt wastes and the EPA states that produced wastewater is considered "solid wastes which are not hazardous wastes".[5]

In 1993, the EPA published the Clarification of the Regulatory Determination for Wastes from the Exploration, Development and Production of Crude Oil, Natural Gas, and Geothermal Energy in the Federal Register (FR) at 58 FR 15284 (March 22, 1993). The Clarification states that "[F]or a waste to be exempt from regulation as hazardous waste under RCRA Subtitle C, it must be associated with operations to locate or remove oil or gas from the ground or to remove impurities from such substances and it must be intrinsic to and uniquely associated with oil and gas exploration, development or production operations ... [and] must not be generated by transportation or manufacturing operations.[6] EPA further notes that the off-site transport of exempt waste from a primary field site for treatment, reclamation, or disposal does not negate the exemption. ... Thus, the off-site transport and/or sale of exempt oil-field wastes to crude oil reclaimers for treatment does not terminate the exempt status either of the wastes or the residuals from a reclamation process applied to these wastes.[7]

In 2002, the EPA published an information booklet entitled Exemption of Oil and Gas Exploration and Production Wastes from Federal Hazardous Waste Regulations. The federal E&P RCRA Subtitle C exemption, however, does not preclude these wastes from control under other federal regulations and state regulations (including oil and gas conservation programs and some hazardous waste programs).

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Section 101(14) of CERCLA sets forth the petroleum exclusion.[8] That provision states, "[t]he term [hazardous substance] does not include petroleum,

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[3] See EPA Regulatory Determination for Oil & Gas and Geothermal Exploration, Development and Production Wastes, 53 Fed. Reg. 25,446 (July 6, 1988) at 25,459.

[4] Id at 25,453-54.

[5] 40 C.F.R. §261.4(b)(5)).

[6] EPA Clarification of the Regulatory Determination for Wastes From the Exploration, Development and Production of Crude Oil, Natural Gas and Geothermal Energy, 58 Fed. Reg. 15,284, (Mar. 22, 1993) at 15,284.

[7] Id. at 15,285.

[8] See CERCLA, 42 U.S.C. § 9601(14) (excluding petroleum from definition of "hazardous substance").

including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance."[9]

Historically, onshore produced water disposal has fallen within two general categories (1) surface impoundment and/or surface discharge, or (2) ground reinjection. Surface discharge of produced water is regulated largely by the Clean Water Act. Ground reinjection is largely regulated by Underground Injection Control (UIC) regulation provided under the Safe Drinking Water Act.

Clean Water Act (CWA)

Produced water which is not re-injected into the ground may be alternatively surface discharged pursuant to regulatory oversight. Surface discharge of produced water is governed by the United States Clean Water Act (CWA), also known as the Federal Water Pollution Control Act. In 1972, Congress enacted the CWA, "to restore and maintain the chemical, physical and biological integrity of the Nation's waters."[10] The CWA created both state and federal roles for the attainment of these goals. The EPA Administrator must "establish and enforce technology-based limitations on individual discharges into the country's navigable waters from point sources," while each state must establish water quality standards with accompanying goals for all intrastate waters."[11] Section 401 of the CWA requires oil and gas companies to apply for a National Pollution Discharge Elimination System (NPDES) permit if they are discharging produced water into surface waters of the state. Clean water regulations provide that there will be no discharge of water pollutants into navigable waters from any source associated with production, field exploration, drilling, well completion, or well treatment (i.e. produced water) without an NPDES permit.[12]

National Pollution Discharge Elimination System (NPDES)

The EPA 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. Currently, the EPA has authorized thirty-seven states to implement and monitor the NPDES program. NPDES permits set specific requirements regulating the characteristics of the discharged water based on national technology-based effluent limitations and applicable water quality standards. The permits establish the level of performance the discharger must maintain and specify monitoring, inspection, and reporting requirements and other actions necessary to achieve compliance. However, the EPA retains the opportunity to review the permits issued by the state, and formally object to elements deemed in conflict with federal requirements. NPDES permits are specifically tailored to individual facilities. General NPDES permits cover multiple facilities within a certain

[9] Id.

[10] 33 U.S.C. §§ 1251-1376; 33 U.S.C. § 1251(a).

[11] PUD No. 1 of Jefferson County v. Wash. Dept. of Ecology, 511 U.S. 700, 704.

[12] 40 C.F.R. § 435.32.

category located in a specific geographical area. The applicant must submit a complete application for a permit, which includes the application form and any supplemental information completed to the satisfaction of the Regional Administrator (NM – Region 6, South Central), who may seek further information by issuing a notice of deficiency.[13]

The primary mechanism for regulating discharges of pollutants to receiving waters is through numerical effluent limits. The effluent limits describe the pollutants subject to monitoring as well as quantity (concentration) of pollutants. For oil and gas operations, the EPA has codified the ELGs in the Code of Federal Regulations (CFR) at 40 CFR Part 435—Oil and Gas Extraction Point Source Category.

Effluent Limitation Guidelines (ELG) Exceptions

Subpart C of 40 CFR Part 35 states that oil and gas companies located onshore may not discharge produced water into navigable waters of the United States. However, two exceptions exist:

1. Subpart E – Allows for onshore discharge for those facilities located in the continental United States located west of the 98th meridian. Produced water with a maximum oil and grease limit of 35 mg/L may be discharged provided that the produced water is of sufficient quality to be re-used for wildlife or livestock watering or other agricultural uses. In addition, the produced water has to be put to use during actual discharge.

2, Subpart F – Allows for onshore discharge for facilities that produce 10 barrels per day or less of crude oil (stripper well exception). The EPA published no discharge standards for this subcategory - rather leaving oversight to the states or regional EPA offices.

In addition, Coal Bed Methane (CBM) production was not considered when the EPA established the above ELGs. CBM is a form of natural gas that is trapped within coal seams. Methane attaches to the surface areas of coal and is held in place by water pressure. To date, the EPA has not yet revised the ELGs to include CBM discharges. Therefore, states have been able to issue NPDES permits allowing discharges of CBM water using each state's "best professional judgment". Each state authorized to issue NPDES permits adopts its own discharge standards and permitting procedures. The EPA is currently reviewing these CBM discharge standards with respect to applicable updates.

Federal Safe Drinking Water Act (SDWA)

Regulatory control of the injection of produced water into injection wells is governed by the Federal Safe Drinking Water Act, Underground Injection Control (UIC) Program. The charter of this federal act is to ensure high quality of drinking water by limiting the injection of produced water to injection zones that geologically will never serve as an Underground Source of Drinking Water (USDW). A USDW is an aquifer or portion of an aquifer that supplies any public water

[13] 40 CFR § 122.21(e).

system or contains sufficient quantity of groundwater to supply a public water system; and currently supplies drinking water for human consumption or contains fewer than 10,000 milligrams/liter total dissolved solids; and is not an aquifer exempted from UIC regulations.[14] Class I wells are used for the injection of hazardous and non-hazardous fluids (industrial and municipal wastes). Class II wells inject brines and other fluids associated with oil and gas production. Class III wells inject mining fluids. Class IV wells deal with the injection of hazardous or radioactive wastes. Class V wells govern injection not covered above.

The EPA's regulations establish minimum standards for state programs to receive primacy for the UIC program under Section 1422 of the SDWA. In 1981, the federal government added Section 1425 to the SDWA to relieve oil and gas re-injection well programs in the states of having to meet the technical requirements of the federal UIC program. The New Mexico Oil Conservation Division (OCD) regulates Class II wells, as well as Class I, III, and V wells related to oil and gas development activities, geothermal activities, and brine solution mining.

Additional Regulatory Jurisdiction of Produced Water

As noted above, the EPA can delegate jurisdiction to the states thereby creating a regulatory environment of interwoven federal, state and local laws and regulations. The following serves as a brief summary of additional agencies retaining jurisdiction(s) over the regulation of produced water.

1. *Bureau of Land Management (BLM)*: The BLM approves disposal of produced water on BLM-managed land and evaluates environmental impacts of proposed action (National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.); Mineral Leasing Act of 1920 (30 U.S.C. 181 et seq.); 43 CFR 3164; Onshore Oil and Gas Order No. 7; CWA 401 certification by state under 33 U.S.C. 1341). BLM is also required to protect/preserve wetlands and floodplains (Exec. Order 11990 (May 24, 1977), BLM Manual Section 1737, rel. 1-1611 (12/10/92); Exec. Order 11988 of 1977.

2. *U.S. Fish and Wildlife Service (USFWS)*: The USFWS retains jurisdiction over the coordination, consultation and impact review for federally listed threatened and endangered species. The USFWS also deals with migratory bird impact coordination. (Fish and Wildlife Coordination Act (16 U.S.C. 661-666c), Section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1536); enforcement of other ESA provisions and other specialty wildlife protection acts including Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703, 1918 as amended). The USFWS administers and enforces regulations promulgated under the MBTA (see 50 C.F.R. Subchapter B). The MBTA provides that it is unlawful, among other things, "to take, capture, [or] kill…by any means or in any manner" any migratory bird. Produced water disposal operators must be cognizant of this law and USFWS regulations when disposing of produced water in an

[14] 40 C.F.R § 144.3.

evaporation pit and must take measures to ensure that such disposal does not endanger migratory birds.

3. *Bureau of Indian Affairs (BIA)*: The BIA is responsible for the efficient and timely development and production of tribal oil and gas leases and is also responsible for handling consultations for impacts to tribal lands or resources from off-reservation activities (Indian Minerals Leasing Act of May 11, 1938, 25 U.S.C. 396a-396q, 25 CFR, Part 211. Act of March 3, 1909, 25 U.S.C. 396, 25 C.F.R. Part 212. Indian Mineral Development Act of December 22, 1982, 25 U.S.C. 21-02-2108, 25 CFR, Part 225.)

4. *U.S. Army Corps of Engineers (COE)*: The COE oversees Section 404 permits and coordination regarding dams and dikes or placement of dredged or fill material in jurisdictional waters and adjacent wetlands (Section 404 of the Clean Water Act of 1972, as amended (33 U.S.C. 1344).

Rocky Mountain States Survey

A brief survey and related summary of other Rocky Mountain States' regulation of produced water follows. Emphasis is placed on the ever increasing coal bed methane (CBM) produced water production. The legal framework surrounding the production, handling and use of CBM produced water is not well developed. Produced water from CBM wells has recently received much attention due to the exploding demand for natural gas, coupled with the increasing lawsuits surrounding the adequacy of environmental protections, the regulation of development by local governments, and conflicts between surface owners and gas production companies. There has been great disagreement over what impacts CBM regulation is having on water quality, local ecosystems, and water supplies. There is also much debate over what are the best uses for the produced water.

All western states have adopted the 'prior appropriation' doctrine. Under 'prior appropriation', ownership of land does not translate into ownership of the appurtenant water rights. Rather, water rights are created when water is diverted and placed (or appropriated) to "beneficial use."[15] There are no limits to the quantity used but state statutes typically require that they will not be wasted in support of the principal tenant that water is a scarce, precious resource.

[15] In New Mexico, "[b]eneficial use shall be the basis, the measure and the limit of the right to the use. 'N.M. Cost. Art. XVI, § 1. See also Frank J. Trelease, Law, Water and People: The Role of Water Law in Conserving and Developing Natural Resources in the West, 18 Wyo. L.J. 3, 4-5 (1963) (water to be put to beneficial use); George W. Pring & Karen A. Tomb, License to Waste: Legal Barriers to Conservation and Efficient Use of Water in the West, 25 Rocky Mtn. Min. L. Inst. 25-1, 25-17, 25-18 (1979) ("There exists ... a duty to use water beneficially.").

New Mexico

The New Mexico Constitution provides that "[a]ll existing rights to the use of any waters in this state for any useful or beneficial purpose are hereby recognized and confirmed."[16] There is no specific constitutional provision applying to ground water, although for all water "[b]eneficial use shall be the basis, the measure and the limit of the right to the use."[17] In New Mexico, underground water is "declared to be public water and to belong to the public and to be subject to appropriation for beneficial use."[18] Anyone wishing to appropriate ground water must submit a permit application to the New Mexico State Engineer stating the beneficial purpose, the amount to be used, and other particulars. The State Engineer will issue a finding that the proposed diversion is not contrary to the public's interest in the conservation of water within the state and that the diversion is not detrimental to the public welfare prior to issuance of a permit.[19] It is unlawful for any person, including a corporation, to begin drilling a well for reasonably ascertainable water from an underground source without a valid existing permit from the State Engineer.[20]

In New Mexico, when drilling for oil and gas occurs below 2,500 feet and the byproduct water is non-potable, i.e., a TDS of 1,000 ppm or higher, the water is, by law, non-ascertainable and not subject to permit requirements.[21] In addition, New Mexico grants regulatory jurisdiction of "the disposition of water produced . . . with the drilling . . . of oil or gas" to the state Oil Conservation Division (NMOCD).[22]

New Mexico's Mine Dewatering Act states that the diversion of water to permit mineral production is in the public interest and that the "existing principles of prior appropriation, beneficial use and impairment of water rights, when applied to the diversion of water to permit mineral production, may cause severe economic hardship and impact to persons engaged in mineral production."[23] While mine dewatering, is defined to include "the diversion and discharge of ground water developed by mining activities by means of depressurizing wells," no reported legal case has explicitly held the Mine Dewatering Act applicable to oil and gas production.

Utah

The Utah Constitution states "[a]ll existing rights to the use of any of the waters in this State for any useful or beneficial purpose, are hereby recognized and confirmed."[24] Utah's statutes

[16] N.M. Const. art. XVI, § 1.

[17] Id. § 3.

[18] N.M.S.A. 1978 § 72-12-1.

[19] N.M.S.A. 1978 § 72-12-3(E).

[20] N.M.S.A. 1978 § 72-12-12.

[21] N.M.S.A. 1978 Id. § 72-12-25.

[22] N.M.S.A. § 70-2-12(B)(15) .

[23] N.M.S.A. 1978 § 72-12A-2(A)(2), (3).

[24] Utah Const. of 1896, art. XVII, § 1.

provides "[a]ll waters in this state, whether above or under the ground, are hereby declared to be the property of the public" and "[b]eneficial use shall be the basis, the measure and the limit of all rights to the use of water. . . ."[25] The Utah State Engineer has authority over all ground and surface water appropriations and each appropriation must be for a beneficial use.[26] However, akin to New Mexico, produced water does not fall under the jurisdiction of the State Engineer. Rather, "the disposal of salt water and oil field wastes," including water associated with natural gas development, is under the jurisdiction of the Utah Board and Division of Oil, Gas, and Mining (DOGM).[27] Byproduct water is managed according to rules designed to "regulate . . . the disposal of these wastes in a manner which protects the environment, limits liability to producers, and minimizes the volume of waste."[28] Methods of handling the water are lined pits; unlined pits (surface reservoirs) if the disposed water's TDS are not higher than any ground water that could be affected, or if all or a substantial portion of the water is being used for a beneficial purpose such as irrigation or livestock watering, or if the produced water is less than five barrels per day.[29] Safe Drinking Water Act Class II injection wells are also permitted provided that the disposal aquifers do not contain suitable drinking water.[30] No requirement for beneficial use is required for produced water. The water is treated as a waste stream.

Montana

Montana's Constitution regarding water rights states that "[a]ll surface, underground, flood, and atmospheric waters within the boundaries of the state are the property of the state for the use of its people and are subject to appropriation for beneficial uses as provided by law."[31] Similar to the water codes of Utah, New Mexico, Colorado and Wyoming, Montana's water code contains an oil and gas byproduct exception to its ground water appropriation requirements.[32] Up until 2001, Montana's water code prohibited waste of this precious resource: "Waste and contamination of ground water prohibited. . . . No ground water may be wasted."[33] In 2001 this waste-preventing provision was amended to address CBM byproduct water quantity issues. As the Montana water code now reads, "the management, discharge, or re-injection of ground water produced in association with a coal bed methane well in accordance with 82-11-175(2)(b) through (2)(d)" may not be construed as waste.[34] Four disposal alternatives are available for handling produced water

[25] Utah Code Ann. §§ 73-1-1, 73-1-3.

[26] Utah Code Ann. § 73-2-1(3)(a)(b).

[27] Utah Code Ann § 40-6-5(3)(d).

[28] Utah Admin. Code R649-9-1.1.

[29] Id. § R649-9-3 et al.

[30] Id § R649-5-2.1.

[31] Mont. Const. art. IX, § 3(3).

[32] Mont. Code Ann. § 82-11-111(2)(a).

[33] Mont. Code Ann. § 85-2-505(1).

[34] Id. § 85-2-505(1)(e).

(1) use the water for irrigation or stock water or for other beneficial uses; (2) inject the water into an acceptable subsurface strata or aquifer pursuant to applicable law; (3) discharge it to the surface or surface waters, or (4) managed through other methods allowed by law.[35] Recent Montana court decisions, while not negating the 2001 law, have affirmed that CBM related produced water is no different from any other ground water.

Wyoming

The Wyoming Constitution states "Control of Water: Water being essential to industrial prosperity, of limited amount, and easy of diversion from its natural channels, its control must be in the state, which, in providing for its use, shall equally guard all the various interests involved."[36] In addition "Priority of appropriation for beneficial uses shall give the better right. No appropriation shall be denied except when such denial is demanded by the public interests."[37] As such the regulation of produced water in Wyoming is significantly different than that of other western states. Produced water falls under the primary jurisdiction of the state engineer instead of the Wyoming Oil and Gas Conservation Commission. Produced water receives the same treatment as all other groundwater in Wyoming instead of being considered a waste byproduct of oil and gas production. Byproduct water is defined as, "water which has not been put to prior beneficial use, and which is a by-product of some non water-related economic activity. . . . By-product water includes, but is not limited to, water resulting from the operation of oil well separator systems or mining activities such as dewatering of mines."[38] In Wyoming, traditional deep oil and gas byproduct water is treated in this fashion, with no beneficial use permit required by the state engineer.[39] However, state officials have not applied the byproduct provision to CBM water and have required a beneficial use permit in order to monitor groundwater depletion rates in protecting water rights. In addition to the regulations of the State Engineer requiring an appropriation permit for all water produced from CBM wells, other regulations apply depending on the disposal of the produced water. Surface discharges into waters of the state are allowed pursuant to a WPDES permit issued by the Wyoming Department of Environmental Quality (WDEQ).[40] In addition, a Class II injection well permit issued by the Wyoming Oil & Gas Conservation Commission (WOGCC) is required for underground injection of produced water and WOGCC permits are required for disposal of produced water in an evaporation pit or percolation pit.

[35] Mont. Code Ann. § 85-11-175..1

[36] Wyo. Const. art. I, § 31.

[37] Id. art. 8, § 3.

[38] Wyo. Stat. Ann. § 41-3-903.

[39] Id.

[40] Wyo. Stat. Ann. § 35-11-301.

Colorado

The Colorado Constitution only outlines water appropriation, beneficial use, and priority provisions in relation to "natural streams."[41] Ground water is outlined within the 1965 Ground Water Management Act.[42] Under the Act, a critical initial determination is whether the ground water diversion comes from a designated ground water basin and whether the diversion is from a tributary or non-tributary source. If the diversion derives from a designated ground water basin, a person seeking to appropriate water must put it to a beneficial use and obtain approval from the Ground Water Commission.[43] If the diversion is outside a designated ground water basin, and is non-tributary, a permit from the State Engineer is required; non-tributary ground water is not considered part of the natural stream that brings Colorado's constitution into play for natural streams or surface waters.[44] Colorado also exempts oil and gas byproduct water from State Engineer regulation in the case of dewatering of geologic formations by removing non-tributary ground water to facilitate or permit mining of minerals:

> (a) No well permit shall be required unless the non-tributary ground water being removed will be beneficially used; and
>
> (b) [T]he state engineer shall allow the rate of withdrawal stated by the applicant to be necessary to dewater the mine; except that, if the state engineer finds that the proposed dewatering will cause material injury to the vested water rights of others, the applicant may propose, and the permit shall contain, terms and conditions which will prevent such injury. The reduction of hydrostatic pressure level or water level alone does not constitute material injury.[45]

Produced water must be treated prior to placement in a pit (lined or unlined) to prevent crude oil and condensate contamination. The rules allow five types of byproduct water handling: (1) injection into a Class II Safe Drinking Water Act disposal well; (2) evaporation/percolation in a properly lined or unlined pit; (3) disposal at permitted commercial facilities; (4) road-spreading on leased roads (to control fugitive dust) when less than 5000 ppm TDS (with approval by the surface owner); and (5) discharge into state waters pursuant to a Clean Water Act section 402 permit. Colorado aligns with both New Mexico and Utah in treating produced water as a waste stream

Piceance Basin Project

In support of treating and re-using produced water in the Piceance Basin of northwestern Colorado, Altela, Inc., has received approval from the Colorado Department of Public Health and Environment, Water Quality Control Division to place the treated, clean water into the Colorado River drainage for valuable in-stream flow. A Colorado Pollution Discharge Elimination System-

[41] Colo. Const. art. XVI, §§ 5, 6.

[42] Colo. Rev. Stat. Ann. §§ 37-90-101 to -143.

[43] Colo. Rev. Stat. Ann. § 37-90-107(1).

[44] Id. § 37-90-137(4)(a).

[45] Colo. Rev. Stat. Ann. § 37-90-137(7)(a)-(b).

[46] Colo. Oil & Gas Conservation Comm'n, Rules and Regulations . § 907(c)(2)(A)-(E)

based permit was applied for and approved for the project. The permit established the level of performance the project's treated water must maintain and specified monitoring, inspection, and reporting requirements.

In addition, the Colorado Division of Water Resources, State Engineer Office, has approved and issued precedent-setting permits to place the treated, clean water to beneficial use for industrial, commercial, the irrigation of 40 acres of irrigated pastureland, the watering of livestock, road spreading, dust suppression, recovery, recycling drilling and mitigation for oil and gas production and exploration, and in-stream flows. These State Engineer well-permits designate the water as non-tributary.

The statutory definition of non-tributary groundwater is quantitative per Colorado Revised Statute § 37-90-103(10.5) as follows:

"Non-tributary ground water" means that ground water, located outside the boundaries of any designated ground water basins in existence on January 1, 1985, the withdrawal of which will not, within one hundred years, deplete the flow of a natural stream, including a natural stream as defined in sections §*37-82-101 (2) and* §*37-92-102 (1) (b),* at an annual rate greater than one-tenth of one percent of the annual rate of withdrawal."

In order to demonstrate the produced water being treated from the producing wells was non-tributary, a Glover Balmer-based stream depletion model was employed. The model is briefly outlined below.

Glover-Balmer Equation:

$$q/Q = erfc\left[\sqrt{\frac{\alpha^2 S}{4tT}}\right]$$

where:

q/Q =	ratio of the quantity of stream depletions to pumping rate for time (t)
$erfc$ =	probability function that returns a proportion (between 0 and 1)
α =	distance from pumping well to the point of stream depletion
S =	aquifer storativity
t =	time
T =	aquifer transmissivity

The model was used to assess whether produced water from the project's natural gas development area was located at a sufficient distance from the nearest perennial stream crossing outcrop (in this case the Williams Fork Formation) to meet the statutory definition for non-tributary groundwater in Colorado.

In order to substantiate a basis for claiming that the proposed water from the project's area is non-tributary, the following information was obtained and developed for use in the Glover-Balmer Method as a means to assess the quantitative depletive effect on a stream system: (1) well distance from perennial stream crossing at the top of the Williams Fork outcrop and the midpoint of Williams Fork outcrop, (2) saturated thickness of the aquifer, (3) hydraulic conductivity of the aquifer, (4) transmissivity, and (5) specific storage and storativity of the aquifer.

Following completion and running of the depletion model, it was concluded that produced water generated from the natural gas development area would not have a depletive effect on the nearest perennial stream system which flowed across the same formation from which the produced groundwater was developed in an amount greater than one tenth of one percent after 100 years. As a result, the produced water pumped with respect to the project met the statutory definition of non-tributary groundwater.

Conclusion

Continuing growth in demand for fully appropriated water supplies worldwide (coupled with recent severe drought conditions) has increased the need for the development and adoption of novel water supply technologies to enhance and augment the world's water supply. Nowhere is there both a greater need and opportunity for the application of new water supply-enhancing technologies than in the field of produced water. Produced water is by far the largest volume of waste generated in oil and gas extraction operations. Typically, in the United States 7 to 10 barrels of produced water are pumped for each barrel of oil produced. It is estimated that the United States oil and gas industry alone generates 20 to 30 billion barrels of produced water every year. This is equivalent to one-fifth of the entire flow of the Colorado River. Traditional disposal methods simply treat this produced water as a waste that is either injected back into the ground never to be used again or 'stored' in large pits that pose environmental and regulatory challenges.

By recognizing that produced water can be a valuable asset that can be treated for re-use, new environmental opportunities develop between the environment and the oil and gas industry. Re-use of treated, clean produced water directly supports the 'energy/water environment' partnership outlined in the *More Water, More Energy, Less Waste Act of 2007* which was signed into law by President Bush on May 8, 2008. This recent legislation and related efforts to re-use produced water to expand scarce and overdrawn water supplies will assist in the development of new synergies. The Piceance permitting example above demonstrates that oil and gas regulations can be successfully dovetailed with vital, long-standing water rights laws and related codes to create positive environmental stewardship and sustainability.