

# [***ARTICLE: WATER: THE FUEL FOR COLORADO ENERGY***](https://advance.lexis.com/api/document?collection=analytical-materials&id=urn:contentItem:56C0-52M0-00SW-5033-00000-00&context=1516831)

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**Text**

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[*I*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8T9R-T2X2-D6RV-H374-00000-00&context=1516831). INTRODUCTION

"We used to think that energy and water would be the critical issues for the next century. Now we think water will be the critical issue." [[1]](#footnote-2)1 This observation by Dr. Mostafa Tolba of Egypt, former head of the U.N. Environmental Program, may also prove a fitting perspective for ***Colorado***. Since before statehood, water has played a fundamental role in ***Colorado***'s economy. It was a critical resource to the miners who flooded into the state in the 1850s and 1860s to search for gold and silver; it was the driving force behind the agricultural settlement of the state, from the peach orchards in Mesa County to the cantaloupe fields in Rocky Ford; and it was brought over and through the Continental Divide to support the a growing population in the state's economic hub - Denver and the Front Range.

Although producing energy in ***Colorado*** has historically created a relatively minor water demand compared to agriculture, which still accounts for approximately ninety percent of the water used in ***Colorado***, [[2]](#footnote-3)2 **[\*277]** acquiring a reliable water supply has long gone hand-in-hand with the development of various energy resources - from coal to hydropower - as well as the hydroelectric generation stations needed to convert the energy resource to electricity and supply it to the power grid. In the 21st century, water's historic role in supporting western agricultural, municipal, and industrial development is being challenged by a growing population, a changing climate, and escalating demands - not only for traditional water uses, but also for relatively new uses such as recreation, environmental preservation, and new methods of energy production.

The U.S. Department of Energy Information Administration ("EIA") projects that electricity demand will grow by thirty-one percent between 2009 and 2035 (an average of one percent per year, from 3,745 billion hours in 2009 to 4,908 billion in 2035). [[3]](#footnote-4)3 While the U.S. and world demand for energy will only increase, in ***Colorado*** our ability to develop our state's own substantial energy resources is hurtling head-on toward water supplies that are more and more limited by other demands, as well as anticipated reductions in certainty of supply due to climate change. [[4]](#footnote-5)4 ***Colorado*** will need an additional 600,000 to one million acre-feet of water per year by 2050 for municipal and industrial needs, including energy industry development. [[5]](#footnote-6)5 More specifically, a ***Colorado*** oil shale industry yielding 1,500,000 barrels of oil per day could require from zero to 120,000 acre-feet of water per year. [[6]](#footnote-7)6

Other ***Colorado***-specific cases illustrate some of the challenges of limited water supplies impacting energy development. The San Luis Valley receives the most intense sunshine in ***Colorado***, and as such this region is considered optimal for commercial-level solar development. [[7]](#footnote-8)7 Despite this abundance of sunshine, the water needed to cool-down a solar powered turbine is a scarce resource in the San Luis Valley. [[8]](#footnote-9)8 In 2011, community **[\*278]** outcry prompted a solar company to withdraw its application for a utility scale solar plant it planned to locate there. [[9]](#footnote-10)9

***Colorado*** may contain approximately 500 million to 1.5 billion barrels of recoverable unconventional oil in the rapidly developing Niobrara formation centered in the northeastern portion of the state. [[10]](#footnote-11)10 In order to recover that oil trapped in the shale, the process of hydraulic fracturing ("fracking") is employed. [[11]](#footnote-12)11 Fracking shale for unconventional oil uses large amounts of water: the ***Colorado*** Oil and Gas Commission recently estimated that developing the Niobrara in ***Colorado*** may requireabout 6.5 billion gallons, or 20,000 acre-feet, of water. [[12]](#footnote-13)12 The demand for fracking water to develop the Niobrara, and other unconventional oil and gas resources, must compete with a plethora of other demands, such as agricultural, municipal, industrial, recreational, and environmental interests. Although small in terms of overall demand, development of the Niobrara is anticipated to occur in an area that has seen significant transfers from agricultural to municipal use, and irrigators who were reliant on wells shut down due to inadequate water supplies. [[13]](#footnote-14)13 Moreover, state water officials predict that ***Colorado*** could fall short of the water needed to sustain population and agriculture by 600,000 to one million acre feet. [[14]](#footnote-15)14

This paper focuses on water quantity issues impacting the various energy resources that are developed to generate ***Colorado***'s electrical power: the energy that powers ***Colorado*** homes, businesses, and industries, as well as energy demands in other states that use ***Colorado***-generated energy. Throughout the paper the authors highlight ***Colorado***'s unique water market, and how, in ***Colorado***, private transactions and water courts play a major role in the development of energy. Section II begins by providing a brief introduction to the legal basics governing ***Colorado***'s administration of water rights and protection of water quality. Section III addresses the important relationship between water and the generation of electricity, and how new energy technologies affect that relationship. Finally, Section IV addresses the several energy resources found in ***Colorado*** - coal, oil & gas, coalbed methane, oil shale, solar, **[\*279]** hydropower, and geothermal - and the water requirements associated with producing those resources.

[*II*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8T9R-T352-D6RV-H379-00000-00&context=1516831). BACKGROUND PRINCIPLES OF ***COLORADO*** WATER LAW

Water in ***Colorado*** is allocated pursuant to the prior appropriation doctrine. [[15]](#footnote-16)15 The first person to put water to a beneficial use establishes a priority right to use a certain quantity of water over every other person who subsequently puts water to a beneficial use. [[16]](#footnote-17)16 This first-in-time, first-in-right system was necessary to ensure that water in the arid West was allocated to economically important activities, rather than only to those few people fortunate enough to own riparian land. [[17]](#footnote-18)17 In ***Colorado***, the priority system of water allocation is established through the adjudication of water rights in water courts, which confirm when each water right is appropriated for use. [[18]](#footnote-19)18 ***Colorado*** statutes also give water judges the authority to attach conditions and terms to a water right; [[19]](#footnote-20)19 such terms and conditions typically include a limitation on the quantity of water attributable to the water right, either in terms of a rate of flow limit (cubic feet per second) used to quantify flowing water, or a volumetric limit (acre-feet) used to quantify storage rights. Water court decrees also typically specify what the water can be used for (irrigation, industrial, municipal, and so forth), where the water can be diverted from the ***river*** and/or stored, [[20]](#footnote-21)20 and where the water can be used.

The ***Colorado*** Division of Water Resources, Office of the State Engineer, maintains a list of all adjudicated water rights, in order of priority, [[21]](#footnote-22)21 for each of the seven major ***river*** basins. [[22]](#footnote-23)22 The State and Division Engineers are also responsible for administering water rights in accordance with their relative priority, as well as other terms and conditions contained within the water court's decree. [[23]](#footnote-24)23

**[\*280]** Virtually all of the major ***rivers*** in ***Colorado***, and their smaller tributaries, are over-appropriated. [[24]](#footnote-25)24 This means that under typical circumstances, there are more water rights decreed on paper, and more demands for water, than there is a physical supply of water to meet those demands. Accordingly, when new or increased demands arise for water, one can rarely depend upon appropriating a new, junior water right to reliably meet that demand. [[25]](#footnote-26)25 Water will simply not be available under a junior priority often enough to provide a reliable water supply. Instead, people typically obtain water for new uses by purchasing existing, senior, water rights, and then applying to the water court to change the water right to the new use. [[26]](#footnote-27)26

The good news for latecomers to the water scene, such as energy producers, is that ***Colorado*** has a developed water rights market, which distinguishes it from most other prior appropriation states. Water rights in ***Colorado*** are considered to be real property rights, which can be severed from the land, and bought and sold. [[27]](#footnote-28)27 The bad news is that determining whether or not there are sufficient existing water rights available for transfer to new uses is often a highly localized inquiry. When transferrable water rights are available, the transactions costs of purchasing the rights, changing them through a water court application process, and frequently dealing with local regulatory and political concerns can be quite high. [[28]](#footnote-29)28 When existing, reliable, and transferrable water rights are not readily available, acquiring sufficient water rights for a new project frequently involves complex, multi-phased transactions, which both increases the costs and the timetable required to secure the necessary water supply. [[29]](#footnote-30)29

Water rights transactions are often very slow moving. It takes time to find water - and the more permanent and reliable the needed water supply, the longer it can take to identify water rights that will provide a dependable, long-term source of water. The energy industry may be better equipped than most water users to absorb the potentially high costs of water rights transactions. [[30]](#footnote-31)30 However, for fast-moving developments in energy production, such as the discovery of a new oil or gas field, the **[\*281]** time it takes to secure a water supply can be a significant limitation. For these reasons, and as the remainder of this article demonstrates, it is critical for those in the energy industry to:

(1) understand their water demands, including:

. the amount of water needed,

. the amount of water consumed in the process,

. whether water can be reused,

. whether there are process-related spikes in demand for water,

. whether water storage is needed for a project,

. whether water treatment is needed to meet the demand, and

.how long water will be needed for the project; and

(2) integrate water acquisition into project planning at the earliest stage possible, and on an ongoing basis in order to ensure that water is available for project demands when needed.

[*III*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8T9R-T372-8T6X-731R-00000-00&context=1516831). WATER AND ELECTRICITY DO MIX

The generation of electrical power is the end-product of most of the energy development in ***Colorado***. The state has a number of long-established electric generation stations, including the historic Ames Hydropower Station above Telluride, the Shoshone Hydropower Station on the ***Colorado*** ***River*** above Glenwood Springs, as well as many gas and coal-fired steam turbine generation stations. [[31]](#footnote-32)31 However, as the demand for power increases in ***Colorado*** and the West due to population demands, the use of electrically-powered devices surges, and the need to replace aging power generation infrastructure accelerates, new capacity for generating electricity requires utility companies to plan for and consider the water requirements necessary to continue to meet electric generation demands.

A. Demand

One cannot address the generation of electricity without also considering water supply. [[32]](#footnote-33)32 Most electricity-generation technologies use both steam to power a turbine to create electricity and water to cool-down that generation equipment. Thus, a large and reliable water supply is required to maintain utility-scale generation. [[33]](#footnote-34)33 Modern electric power plants use about two hundred billion gallons of water per day, five times what **[\*282]** they used in 1950. [[34]](#footnote-35)34 In 2009, the average power plant in the United States used approximately twenty-five gallons of water for every kilowatt-hour (kWh) produced. [[35]](#footnote-36)35 According to the U.S. Department of Energy, cooling water for thermoelectric generation ranks just behind irrigation/agriculture in total freshwater withdrawals. [[36]](#footnote-37)36 While ***Colorado*** withdraws significantly less water for use in thermoelectric power generation than most states, water is also more scarce in ***Colorado*** than in many other states - indeed, it is estimated that the Denver metropolitan area will have a summer water deficit by the summer of 2025, and with this shortage, ***Colorado*** is the eighth most vulnerable state for water deficits due to thermoelectric power generation. [[37]](#footnote-38)37

B. Producing Thermoelectric Power: The Technology

Understanding thermoelectric technology is also important for understanding its demand for water. Thermoelectric power production relies on a fuel source (gas, coal, biomass, nuclear, geothermal or solar) to heat a fluid (usually water) to drive a turbine, which converts the thermal energy into electricity. [[38]](#footnote-39)38 Water is also necessary to cool the steam after it goes through the turbine, and most of the demand for water in thermoelectric plants is cooling water for condensing steam. [[39]](#footnote-40)39 There are three types of cooling system designs used in thermoelectric power stations: open-loop systems (or "once-through" cooling systems), closed-loop systems (or "recirculating" systems), and dry or air-cooling systems. [[40]](#footnote-41)40 The water demand for the generating station depends on the type of cooling system.

Open-Cooling System. In once-through systems, the cooling water is withdrawn from a nearby water body, such as lake or reservoir, and subsequently discharged back to the same water body after it passes through **[\*283]** the condenser to cool the steam. [[41]](#footnote-42)41 The once-through process therefore results in relatively high water withdrawal but low water consumption. [[42]](#footnote-43)42

Closed-Loop Systems. Closed loop or recirculating systems use wet cooling towers or ponds to dissipate heat from the cooling water to the atmosphere. [[43]](#footnote-44)43 Most of the cooled water is then recycled back to the generating plant to be used again. [[44]](#footnote-45)44 However, because clean water is evaporated leaving behind salts and minerals, a portion of the cooling water needs to be discharged to prevent a buildup of minerals and sediment in the water that could impact cooling ability and electric generating efficiencies. [[45]](#footnote-46)45 New water is added into the cooling water supply as water is evaporated and discharged. [[46]](#footnote-47)46 As a result, plants equipped with closed-loop systems have relatively low water demands for water withdrawal, but these plants consume a relatively high portion of what they do withdraw (as compared to open-loop systems). [[47]](#footnote-48)47

Dry-Cooling Systems. Dry-cooling systems use air or air combined with cooling water to cool steam in power generation stations. [[48]](#footnote-49)48 In either case, water withdrawal and consumption in dry cooling systems are minimal. [[49]](#footnote-50)49 Because they depend on the ambient air for cooling, dry-cooling systems are most often used in wetter, colder climates. [[50]](#footnote-51)50 Even though the water demands for dry-cooling systems are significantly reduced, less than one percent of the generating capacity in the United States uses a dry-cooling system, [[51]](#footnote-52)51 because it is significantly less efficient from an energy production standpoint. [[52]](#footnote-53)52

C. Water Rights and Competing Resources

Not only does cooling for thermoelectric generation compete with other energy resources for water, it competes directly with municipal, agricultural, and other industrial water users. [[53]](#footnote-54)53 When Xcel Energy, Inc. **[\*284]** was planning for a new generating unit at its Comanche Station near Pueblo, ***Colorado***, water supply was a major consideration. [[54]](#footnote-55)54 Water requirements for the new unit using a traditional closed-loop system would have been significant, and likely would have required Xcel to acquire and change existing agricultural rights for industrial purposes. However, Xcel designed the new 750-megawatt unit with a low-water use system (air-cooled condenser). [[55]](#footnote-56)55 This system reduced the unit's water use by about half. [[56]](#footnote-57)56 As a result, Xcel was able to contract with the Pueblo Board of Water Works to meet the water demand of the new unit, rather than having to buy and convert agricultural water rights from local farmers. [[57]](#footnote-58)57

Utility companies generally must make these types of decisions - weighing capital costs and efficiencies versus water supply costs - each time new generating capacity is brought online in ***Colorado***. As competition for water increases, utility companies will likely have to look toward technological solutions to reduce their water demand in order to produce energy economically and meet the political demands of customers who value water for other uses.

[*IV*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8T9R-T3H2-D6RV-H37G-00000-00&context=1516831). WATER FOR FUEL SOURCES

In order to generate electricity, all generating plants require a fuel source such as coal, gas, geothermal water (in the case of hydroelectric generation), or solar. [[58]](#footnote-59)58 In addition to the water used for the production of electricity, there are varying demands for water in the development of the fuel sources used in the electric generation plants. [[59]](#footnote-60)59 Water use varies by fuel source, but includes uses such as fracking unconventional oil and gas wells, cleaning sulfur from coal, and washing dusty solar panels. But, in virtually every case, water is required to develop fuel, further demonstrating **[\*285]** the close connection between energy development and water. Below is a discussion of several fuel sources produced in ***Colorado*** and the water required for development.

A. Coal

In the United States, coal is still "king" - coal mining operations extract one billion short tons of coal annually, and the energy content of that coal in the United States is comparable to the energy available from worldwide oil reserves. [[60]](#footnote-61)60 The amount of water used in coal mining varies greatly depending on the method of mining, the equipment used, and the availability of water. [[61]](#footnote-62)61 In the western United States, most coal is found in seams of sedimentary layers that lie near the surface; as a result, surface mining is the dominant method of coal extraction in ***Colorado***. [[62]](#footnote-63)62 Coal production in ***Colorado*** averaged approximately 32.6 million tons per year between 2001 and 2007. [[63]](#footnote-64)63 In 2008, approximately thirty-two million tons of ***Colorado*** coal was produced for a total value of production at $ 887.7 million based on production data provided by the ***Colorado*** Mining Association. [[64]](#footnote-65)64 Coal is used to generate sixty-five percent of ***Colorado***'s electricity supply. [[65]](#footnote-66)65

Coal is a solid, brittle carbonaceous sedimentary rock, made up of carbon, hydrogen, oxygen, nitrogen, and lesser amounts of sulfur and other trace elements. [[66]](#footnote-67)66 There are several different types of coal: [[67]](#footnote-68)67 1) lignite, 2) subbituminous, 3) bituminous, and 4) anthracite. [[68]](#footnote-69)68 ***Colorado*** coal is generally of a higher quality compared to coal in the East, with low ash, sulfur, and mercury levels and high heat value. [[69]](#footnote-70)69 The sulfur content in ***Colorado*** coal is approximately four times lower than the bituminous coal present in the eastern United States. [[70]](#footnote-71)70

**[\*286]**

1. Water Demands

Surface mining requires significantly less water than underground mining, and U.S. Department of Energy estimates put water quantity needs for coal mining at about ten to 150 gallons per ton of coal produced. [[71]](#footnote-72)71 In ***Colorado*** surface coal mining, water is mostly used for three activities: 1) mining (and air quality) demands associated with dust suppression via spraying along conveyer belts, at railway and truck docks, and along access roads; 2) preparation and washing demands from coal by placing coal in pools of high-density water; [[72]](#footnote-73)72 3) reclamation and grading associated with disturbed areas resulting from mining, though this last use is a one-time (or few times) water demand that occurs once the producer closes portions of the mine that are no longer producing coal and reclaims the surface with plantings. [[73]](#footnote-74)73 But water demands associated with coal mining typically are not significant; many coal mines actually produce more water through dewatering activities than they consume to support mining operations. [[74]](#footnote-75)74 However, water needs increase dramatically where unconventional coal production activities, like liquefaction or gasification, occur. [[75]](#footnote-76)75

2. Regulatory Framework

The federal Surface Mining Control and Reclamation Act of 1977 ("SMCRA") is, as its name implies, focused on surface coal mining. [[76]](#footnote-77)76 It was enacted by Congress in 1977 to regulate surface mining in a manner to reduce impacts to land, air, and water resources. [[77]](#footnote-78)77 In ***Colorado***, the use of water for mining coal is regulated both at the federal and state levels. [[78]](#footnote-79)78 One of the SMCRA's distinguishing features is the underlying premise that coal mining should constitute a temporary land use and that mined lands should be reclaimed and returned to the "approximate original contours" that existed prior to mining operations. [[79]](#footnote-80)79

**[\*287]** The U.S. Department of the Interior, Office of Surface Mining ("OSM") administers the SMCRA programs and delegates regulatory authority to states with properly designed programs for administering the substantive standards and procedural aspects of the Act. [[80]](#footnote-81)80 ***Colorado*** adopted the ***Colorado*** Surface Coal Mining Reclamation Act ("CSCMRA") in 1979. [[81]](#footnote-82)81 The CSCMRA tracks the SMCRA closely, with a few changes unrelated to issues of water quantity or water availability. [[82]](#footnote-83)82 Under both regulatory regimes, water quantity concerns arise particularly as it pertains to reclamation activities.

Under the CSCMRA, each operator is required to adhere to certain environmental protection performance standards, and must create "permanent impoundments of water on mining sites as part of reclamation activities only when it is adequately demonstrated that … such water impoundments will not result in the diminution of water or the quantity of water available to water rights holders for agricultural, industrial, recreational, or domestic uses." [[83]](#footnote-84)83 In addition, the CSCMRA also addresses the surface effects of underground coal mining, requiring coal mining operators to "minimize the disturbances of the prevailing hydrologic balance at the mine site and in associated off-site areas and to the quantity of surface water and groundwater systems both during and after underground coal and during reclamation." [[84]](#footnote-85)84 Finally, the CSCMRA requires that coal operators give a detailed description of the measures taken during coal mining and reclamation operations to assure the protection of "the quantity of water in surface and groundwater systems. Protection measures may include providing water by exchange, substitution, replacement, or augmentation, as appropriate under state law." [[85]](#footnote-86)85

As in SMCRA ( § 510 (b)(5)), one of the most significant water-related provisions in the ***Colorado*** coal mining regulations is one designed to protect alluvial valley floors - where most western farms and ranches are located. The ***Colorado*** Code of Regulations section requires certain performance standards for surface mining operations around alluvial floors. [[86]](#footnote-87)86 Section 407-2:4.24 "establishes minimum environmental protection performance, reclamation, and design standards for surface coal mining operations on or which affect alluvial valley floors in arid or semi-arid regions." [[87]](#footnote-88)87 Surface mining operations must preserve the essential hydrologic functions of alluvial valley floors not within a surface mine operation's permit area, and most relevantly, "shall not cause material damage to the quality or quantity of water in surface or underground water systems **[\*288]** that supply alluvial floors." [[88]](#footnote-89)88 The surface coal mining operation must also include an environmental monitoring system to ensure that the quantity or quality of water in the surface or groundwater systems that supply alluvial floors is protected. [[89]](#footnote-90)89

3. Clean Coal

"Clean coal" does not refer to a special type of coal that burns cleaner than other types. Instead, it refers to advances in technology that have developed cleaner coal-burning systems that can dramatically reduce air pollution including carbon dioxide emissions. [[90]](#footnote-91)90 Some of those technologies include innovations in scrubbing to remove sulfur compounds from coal before burning, [[91]](#footnote-92)91 using combustion chambers to remove nitrogen oxide (NOX) from coal before burning to generate electricity, [[92]](#footnote-93)92 and using fluidized bed boilers that burn cooler than standard coal boilers to remove ninety percent of sulfur and nitrogen oxide components. [[93]](#footnote-94)93 Addressing carbon emissions requires the development and use of carbon capture and storage for coal-fired power plants - a continuing economic and technologic challenge. [[94]](#footnote-95)94 Clean coal is promoted as a way to utilize abundant domestic coal resources, while addressing the environmental downsides of burning coal to produce electricity. [[95]](#footnote-96)95 However, many clean coal technologies require much more water than conventional coal technologies. [[96]](#footnote-97)96

Many clean coal technologies contemplate inclusion of some type of carbon sequestration addition to reduce or prevent the release of sulfides and nitrogen oxide into the air. [[97]](#footnote-98)97 This is often a multi-stage process, and a significant amount of water can be used at the capture stage as the ***CO***<2> **[\*289]** is separated and stored. [[98]](#footnote-99)98 In order to sequester the ***CO***<2>, the ***CO***<2> has to be impounded by something, and possible mediums include saline water, depleted oil and gas reservoirs, and unmineable coal seams. [[99]](#footnote-100)99 Groundwater contamination can occur if the sequestered ***CO***<2> migrates or leaks, potentially impacting the availability of safe or clean water. [[100]](#footnote-101)100

B. Oil and Gas

1. Hydraulic Fracturing Technology

Technological advancements in hydraulic fracturing or "fracking" and horizontal drilling are opening up reserves and formations where oil and gas were not previously retrievable. [[101]](#footnote-102)101 In ***Colorado***, over ninety percent of gas wells are fracked. [[102]](#footnote-103)102 Fracking is incredibly effective at producing unconventional gas in the Piceance Basin in western ***Colorado***, and energy companies are also ramping up unconventional oil development in the Niobrara formation, mainly in northeastern ***Colorado***. [[103]](#footnote-104)103 Fracking is controversial in terms of its possible effects on water quality, and there is a growing concern about the amount of water necessary to fully develop the Niobrara play, if it proves to be as extensive as predicted. [[104]](#footnote-105)104 Essentially, water is a primary component of this technology, which uses up to five **[\*290]** million gallons of water for each well that is fracked, depending on the type of well. [[105]](#footnote-106)105

It is important, here, to highlight the distinctions among unconventional oil and gas resources - e.g. shale gas, shale oil, and coalbed methane. Oil shale - an immature kerogen oil that must be heat-treated either before or after extraction - is discussed in Section IV(4).

Shale Gas. Approximately 400 million years ago, thick shale was deposited as fine silt and clay at the bottom of relatively enclosed bodies of water. [[106]](#footnote-107)106 Methane - formed from organic matter existing at that time - was buried with the sediment and escaped into sandy rock layers adjacent to the shale, thus forming the conventional accumulations of natural gas. [[107]](#footnote-108)107 Some of that methane remained locked in the low permeability shale layers. [[108]](#footnote-109)108 At present, "the [Energy Information Administration] projects that there are 827 trillion cubic feet (TcF) of natural gas recoverable from U.S. shales using the currently available technology." [[109]](#footnote-110)109

Shale Oil. Similar to shale gas, shale oil is produced directly from shale oil reservoirs. [[110]](#footnote-111)110 (Oil shale, discussed infra, is different and is either mined, or the reservoir is heated in order to remove the oil shale). Oil hydrocarbons are trapped in the shale rock, and recent technology developments, such as fracking and horizontal drilling, now allow developers to recover them. [[111]](#footnote-112)111 Major shale oil plays include the Bakken, in Montana and North Dakota, [[112]](#footnote-113)112 and the Niobrara, in ***Colorado***. [[113]](#footnote-114)113

Coalbed Methane. Discussed at greater length below, coalbed methane is an unconventional source of natural gas, in that the methane is adsorbed to coal cleats or fractures in coal seams. Coalbed methane is held in place by the pressure of the coal seam aquifer, [[114]](#footnote-115)114 and the gas is released once the water is pumped out. [[115]](#footnote-116)115

**[\*291]**

2. Water is Major Component in Hydraulic Fracturing Technology

The process of fracking is a well stimulation process used to maximize the extraction of oil, natural gas, and even geothermal energy. [[116]](#footnote-117)116 The process involves the pressurized injection of fluids (comprised mostly of water), propping agents (such as sand), and various chemical additives into a geologic formation. [[117]](#footnote-118)117 The resulting pressure will exceed the strength of the rock, and the fluid opens or enlarges pre-existing fractures in the rock. [[118]](#footnote-119)118 As the formation is fractured, a propping agent, such as sand or ceramic beads, is pumped into those fractures to keep them from closing as the pumping pressure is released. [[119]](#footnote-120)119 The fracturing fluids - the water and chemical additives - are returned back to the surface, and the natural gas or oil will flow from pores and fractures in the rock into the well for later extraction. [[120]](#footnote-121)120

The amount of water required for fracking varies by site and by type of formation. [[121]](#footnote-122)121 According to the ***Colorado*** Oil & Gas Commission, two to five million gallons of water may be necessary to fracture one horizontal well in a shale formation. [[122]](#footnote-123)122 In some cases, operators can use the fluids returned from the wellbore to frack more than one well in order to conserve water, money, and perhaps time. [[123]](#footnote-124)123

3. Meeting Water Demands for Hydraulic Fracturing

While the overall water demand for fracking in ***Colorado*** is small in comparison to other kinds of water demands, such as agricultural irrigation, it can still present a stumbling block for oil and gas companies because the ability to obtain water varies greatly from place to place, and also over hydrologic conditions. [[124]](#footnote-125)124 For these reasons, it is an element of resource development worthy of advanced planning. For example, recent news articles have focused on water supplies used to develop the Niobrara shale in areas along ***Colorado***'s Front Range. [[125]](#footnote-126)125 Contract water haulers are leasing excess municipal water from various cities and towns and hauling that water to the drill sites. [[126]](#footnote-127)126 Short-term municipal contracts may not always be an option, though, particularly if municipal customers are subject to water restrictions due to drought or other planning purposes. [[127]](#footnote-128)127 **[\*292]** Therefore, assuming the Niobrara develops into a significant hydrocarbon field, it is likely that oil and gas companies will have to acquire water supplies other than short-term purchases from cities and towns. [[128]](#footnote-129)128

Longer-term water supplies can be difficult to obtain along the South Platte ***River*** downstream of the Denver metropolitan area. [[129]](#footnote-130)129 This is a region of the state that has seen substantial water battles in recent years. [[130]](#footnote-131)130 Farmers who irrigate with wells have had to adjudicate augmentation plans to cover their out-of-priority depletions. [[131]](#footnote-132)131 The two largest plans, decreed by the Division 1 Water Court in Case Nos. 02CW335 and 03CW99, are managed by subdistricts of the Central ***Colorado*** Water Conservancy District, and together augment over 800 wells. [[132]](#footnote-133)132 The 02CW335 plan has provided its members with a marginally increased ability to pump water. [[133]](#footnote-134)133 The 03CW99 augmentation plan has not allowed pumping by its member wells since the water court's initial entry of the decree approving the plan for augmentation in 2008 due to a lack of replacement supplies. [[134]](#footnote-135)134

In addition to unmet demand for water supplies for agriculture, there have are several large municipal projects that have been, or are in the process of being, completed in the same area. For example, Aurora's Prairie Waters Project captures the city's water using riverside wells, treats the water, and pumps it upstream for use by Aurora customers. [[135]](#footnote-136)135 East Cherry Creek Valley Water and Sanitation District and Arapahoe County Water and Wastewater Authority, in conjunction with Farmers Reservoir and Irrigation Company and the United Water and Sanitation District, have acquired large amounts of senior South Platte ***River*** irrigation rights and changed those rights for municipal use in the south metro area. [[136]](#footnote-137)136 Between the shortage of water for existing irrigation demands, and **[\*293]** the increase in demands from municipalities, the Lower South Platte ***River*** Basin is the focus of intensified competition for reliable water supplies.

How will water demands for energy development fit into the competitive water market on the Lower South Platte ***River***? One factor that sets the oil and gas industry apart from most other South Platte water users is that their demand for fracking water is relatively temporary. [[137]](#footnote-138)137 The water needed to frack each well is very short term - it occurs over the course of days or a couple of weeks. [[138]](#footnote-139)138 The current water demand for development of the Niobrara shale is likely to continue for a decade or two, but does not represent a permanent demand. [[139]](#footnote-140)139 Accordingly, ***Colorado***'s water rights market may provide the oil and gas industry with the opportunity to pursue creative options in order to acquire the water necessary for developing the Niobrara and other hydrocarbon reserves, while at the same time preserving the ability to use water rights for longer-term demands.

One example of such a solution comes out of the Arkansas ***River*** basin. The Lower Arkansas Valley Water Conservancy District ("LAVWCD") is working on a plan that uses rotational fallowing to enable irrigators to lease water for temporary use by thirsty cities, water districts, and other water users, while retaining water ownership and irrigation in the Valley. [[140]](#footnote-141)140 The LAVWCD implemented this plan using the "super ditch company" model that has found success in California's Imperial Valley. [[141]](#footnote-142)141 Instead of one farmer selling his water and drying up his land permanently, LAVWCD's strategy draws from a relatively large group of irrigators. [[142]](#footnote-143)142 Individual irrigators can elect to dry up a small portion of their total irrigated acres, but the aggregate of all these smaller contributions creates a substantial amount of fully consumable water available for other uses. [[143]](#footnote-144)143 This is not to say that such plans come without transactional costs. This plan still requires that water users go to water court in order to quantify their irrigation rights and implement augmentation **[\*294]** plans and/or exchanges as necessary. [[144]](#footnote-145)144 However, such solutions can create incentives for senior water rights owners, particularly farmers, to enter into water deals that senior water users may otherwise be unwilling to consider. Such deals can be structured with a lot of flexibility, thereby enabling energy developers to meet short-term demand, while preserving long-term water supplies for agriculture.

Another option for obtaining temporary water supplies for fracking is through a statutorily created Interruptible Water Supply Agreement as provided in ***Colorado*** Revised Statute [*§ 37-92-309*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3G8-00000-00&context=1516831). [[145]](#footnote-146)145 This provision allows for administrative approval for the use of interruptible water supply agreements without the need for adjudicating an application in water court. [[146]](#footnote-147)146 It allows a water rights owner to loan a water right to another user for a specified length of time, provided that it is not exercised more than three years in a ten-year period. [[147]](#footnote-148)147 The parties to the interruptible water supply agreement submit a written application to the State Engineer, which includes a detailed engineering report containing information such as the historical consumptive use, return flows, terms and conditions to prevent injury to other water rights users, and a plan to prevent erosion, blowing soils and noxious weeds. [[148]](#footnote-149)148 The application is published in the appropriate water court resume, and interested parties have thirty days to provide comments to the state engineer. [[149]](#footnote-150)149 The state engineer may deny the application or approve it with any terms and conditions he determines are necessary to prevent injury to other water users. [[150]](#footnote-151)150

4. Hydraulic Fracturing, Water Quality, and the Impact on Water Demand

No present-day discussion of hydraulic fracturing is complete without discussing the water quality issues at the forefront of the recent fracking controversy. Such water quality issues can also have an impact on water demand. Although fracking has been used since the 1940's, the recent escalation of its use to develop unconventional oil and gas fields across the country has led to growing concern about the potential threats to water contamination, particularly groundwater contamination, from "produced water." [[151]](#footnote-152)151 There are two phases of the fracking process where **[\*295]** groundwater contamination could theoretically occur. First, during the actual fracking process, fracking fluid could escape into groundwater if the integrity of the well casing is insufficient. [[152]](#footnote-153)152 Second, because some of the fracking fluid returns out of the well (flow back), it must either be reused or disposed of. [[153]](#footnote-154)153 One technique to manage produced water is to store it in lined pits on the surface, and let the water evaporate. [[154]](#footnote-155)154 If the pits leak or overflow, contamination of surface or groundwater could result. [[155]](#footnote-156)155 A second technique for disposing of produced water is to reinject it into very deep formations through an injection well. [[156]](#footnote-157)156 Again, if the integrity of the injection well casing is insufficient, groundwater contamination could occur through leaking of the produced water. Third, produced water may be treated to meet state water quality standards and discharged to surface water with a permit. [[157]](#footnote-158)157 Mishandling of the components (salts) that are removed during treatment could result in groundwater contamination.

One way to minimize the risks of produced water is to reuse it to the extent possible in the fracking process. In ***Colorado***, produced water is regulated by the ***Colorado*** Oil and Gas Conservation Commission ("COGCC"). [[158]](#footnote-159)158 Produced water may be reused for future operations; where there is a high demand for water in other operations, nearly all produced water is reused for servicing new wells. [[159]](#footnote-160)159 However, reuse and recycling rates vary due to field conditions, and, regardless of the formation, current hydraulic fracturing technologies require the use of relatively low salinity water. [[160]](#footnote-161)160 High salt content makes pumping the injection fluid **[\*296]** difficult and can make the fracturing fluid ineffective. [[161]](#footnote-162)161 In some cases, use of recycled water can increase the power requirements and result in higher volumes of chemicals needed to reduce friction. [[162]](#footnote-163)162 ***Colorado***'s recent STRONGER Report - which evaluated the effectiveness of COGCC regulations governing hydraulic fracturing (prior to the new rules released in December 2011) - recommended that the COGCC work with the Division of Water Resources to evaluate water use in ***Colorado*** and also to administer programs that maximize water reuse. [[163]](#footnote-164)163 Accordingly, there is also an incentive on the water quality side of the hydraulic fracturing process to look for ways to maximize the reuse of produced water and minimize the need for fresh water supplies.

Energy companies are just now starting to explore the water options available for developing the Niobrara formation in ***Colorado***. Not only does it appear that developing the Niobrara shale will likely be more water intensive than developing gas in the Piceance Basin on the West Slope, [[164]](#footnote-165)164 but the competition for water in the South Platte Basin has escalated in the past several years due to increased municipal demand on the Front Range. [[165]](#footnote-166)165 These factors may provide additional cost incentive to energy production companies to treat and reuse produced water, rather than simply dispose of it as a waste stream. [[166]](#footnote-167)166 On the West Slope, treating produced water for reuse in fracking is far more expensive than simply disposing of it through reinjection. [[167]](#footnote-168)167 However, due to a more competitive water market on the Front Range, treating produced water for reuse in fracking may end up being a more viable alternative when developing the Niobrara shale if the price of fresh water supplies, and the cost of transporting fresh water to the drilling site, become excessive.

**[\*297]**

C. Coalbed Methane

1. The Technology: Producing Coalbed Methane

Coalbed methane ("CBM") is natural gas that is trapped within coal seams. [[168]](#footnote-169)168 It is created either by thermo-chemical reaction or by microbiological action [[169]](#footnote-170)169 The methane is absorbed into the coal cleats (surface area of the coal) and held by water pressure. [[170]](#footnote-171)170 Coalbed methane is produced by reducing the water pressure by pumping it out of the formation so that the gas may flow out. [[171]](#footnote-172)171 The gas separates from the water and flows up a separate pipe. [[172]](#footnote-173)172 Once CBM is extracted, the gas and water are divided. The gas is transported via pipeline, while the water is either injected back into the ground, treated, or discharged on the surface. [[173]](#footnote-174)173

CBM accounts for seven percent of natural gas production and eight percent in United States reserves, with eighty percent of that production coming from the Rocky Mountain West. [[174]](#footnote-175)174 Regional sources for CBM include: the Piceance Basin (northwestern ***Colorado***), the San Juan Basin (southwest ***Colorado***/New Mexico), the Powder ***River*** Basin (Wyoming), the Uintah Basin (Utah), and the Raton Basin (south-central ***Colorado***). [[175]](#footnote-176)175 To complete production, companies must pump about 12,000 gallons of water per day, per well, in order to separate the methane. [[176]](#footnote-177)176 Pumping water during CBM development in basins with deep methane-bearing coals such as the San Juan, Raton, and Piceance basins is unlikely to lower the water table of shallow alluvial aquifers, because of the distance of separation between the two formations. For this reason, ***Colorado*** has taken a unique approach with regard to the potential impact of dewatering CBM formations on existing water rights. [[177]](#footnote-178)177

2. Regulatory and Common Law Framework

i. ***Colorado***'s Legal Perspective on CBM Produced Water

Absent a showing to the contrary, groundwater in ***Colorado*** is presumed to be "tributary," or hydraulically connected to surface water so as to require administration within the prior appropriation system. [[178]](#footnote-179)178 Pursuant to the Water Right Determination and Administration Act of 1969, **[\*298]** [*§§37-92-101*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3FM-00000-00&context=1516831) through -602, ***Colorado*** Revised Statute ("C.R.S.") ("1969 Act"), the State Engineer must protect existing rights from injury by curtailing out-of-priority diversions of groundwater that may cause injury to vested water rights. [[179]](#footnote-180)179 In addition, the ***Colorado*** Groundwater Management Act requires that all water users obtain a permit from the State Engineer for any "well," which is defined as "any structure or device used for the purpose or with the effect of obtaining groundwater for beneficial use from an aquifer." [[180]](#footnote-181)180 However, based on their conclusion that produced water was under the exclusive jurisdiction of the COGCC, the State Engineer's office never regulated groundwater produced in the course of oil and gas operations. [[181]](#footnote-182)181 This position was challenged by a group of water users, and the case ultimately went to the ***Colorado*** Supreme Court. [[182]](#footnote-183)182

As it pertained to CBM production, ***Colorado*** water law (as of 2009) was similar to Wyoming water law, in that produced water from CBM production constituted a beneficial use of that water, though the water was not the object of production. [[183]](#footnote-184)183 In 2009, the ***Colorado*** Supreme Court, affirming a water court ruling, held in Vance v. Wolfe that produced water from CBM development constitutes "beneficial use" and further, operators of CBM wells must obtain well permits pursuant to the Ground Water Management Act. [[184]](#footnote-185)184 In addition, the Vance decision held that produced water is not only subject to regulation by COGCC, but is also subject to the 1969 Act and the Ground Water Management Act. [[185]](#footnote-186)185 Accordingly, the Vance decision necessitated that the State Engineer permit all of the five thousand or so existing CBM wells in ***Colorado***. [[186]](#footnote-187)186

ii. Changing the State Regulatory Framework: Produced Nontributary Groundwater Rules ([*2 CCR 402-17*](https://advance.lexis.com/api/document?collection=administrative-codes&id=urn:contentItem:5XSH-9F01-DXHD-G2DM-00009-00&context=1516831))

In light of the Vance v. Wolfe decision, the ***Colorado*** General Assembly passed HB 09-1303, [[187]](#footnote-188)187 codified in title 37, article 90, sections 137, **[\*299]** 138(2), and 308(11) of the C.R.S., [[188]](#footnote-189)188 the intent of which was to assist the State Engineer to "efficiently and expeditiously identify those oil and gas wells that withdraw nontributary groundwater" and administer CBM well permits accordingly. [[189]](#footnote-190)189 The State Engineer's office promulgated new rules that: (1) delineated certain areas or geologic formations as nontributary for the purposes of the State Engineer's administration of produced water; and (2) established an adjudicatory procedure for the State Engineer to make individual nontributary determinations for the administration of produced water. [[190]](#footnote-191)190

The first purpose of the rules - to establish certain areas or formations as "nontributary" - was of critical importance to both the State of ***Colorado*** and energy companies conducting CBM operations within ***Colorado*** borders. [[191]](#footnote-192)191 Nontributary groundwater is statutorily defined as "that groundwater, located outside the boundaries of any designated groundwater basins in existence on January 1, 1985, the withdrawal of which will not, within one hundred years, deplete the flow of a natural stream." [[192]](#footnote-193)192 Unlike tributary water, nontributary groundwater is not administered within the priority system. [[193]](#footnote-194)193 Therefore, CBM wells extracting nontributary groundwater do not have to meet the regular requirements of 1) proving no injury to vested rights and 2) submitting augmentation plans to replace any out-of-priority diversions. [[194]](#footnote-195)194

Without a categorical determination that certain areas are nontributary, the energy companies would have to quantify the impacts of the produced water on surface flows, and even more importantly, find existing water rights that could be used to augment the depletions caused by pumping produced water from the coal bed methane formations. [[195]](#footnote-196)195 Because the formations tapped for CBM production are often thousands of feet deep, [[196]](#footnote-197)196 it is technically very difficult to quantify the amount, timing **[\*300]** and location of depletions attributable to the produced water. Moreover, because of the deep formations, the lagging impact of developing produced water extends out over many, many years. [[197]](#footnote-198)197 This means that any requirement to augment such depletions would also extend out decades or even hundreds of years into the future. In other words, for CBM production to continue to be economically viable in ***Colorado***, it is important that most of the CBM wells are considered nontributary.

Prior to these rules, there was no procedure in place for the State Engineer to determine whether waters produced during CBM extraction were or were not nontributary. [[198]](#footnote-199)198 The purpose of the new rules is to create an efficient means for the State Engineer to determine which of the current wells that withdraw produced groundwater are nontributary, thereby requiring permitting under C.R.S. [*§ 37-90-137(7)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:689F-SN93-GXF6-81VM-00000-00&context=1516831), and which are tributary - thereby requiring water court adjudication, and that any out-of-priority depletions caused by the production of water during coalbed methane development be augmented. [[199]](#footnote-200)199

The State Engineer made the following determinations about which areas of ***Colorado*** are considered nontributary for the purposes of the well permitting scheme required under C.R.S. [*§ 37-90-137(7)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:689F-SN93-GXF6-81VM-00000-00&context=1516831). [[200]](#footnote-201)200

**[\*301]**

|  |  |  |  |
| --- | --- | --- | --- |
| Basin/Field | Formation (Name) | Rule Dictating | Area Designated As |
| (Name) |  | Nontributary | Nontributary |
|  |  | Designation |  |
| Piceance | Mesaverde Formation | Rule 17.7.D.1 | Cameo and South |
| Basin |  |  | Canyon Coal Groups |
|  |  |  | (in the Muddy Creek |
|  |  |  | Drainage North of |
|  |  |  | Paonia Reservoir in |
|  |  |  | Delta and Gunnison |
|  |  |  | Counties) |
|  | Neslen Formation |  | All Neslen Formation |
|  |  |  | within Piceance Basin |
|  |  |  | in Garfield and Rio |
|  |  |  | Blanco Counties |
|  | Shallow Formations |  | Undifferentiated |
|  |  |  | Wasatch Formation, |
|  |  |  | middle and lower |
|  |  |  | Wasatch Formation, |
|  |  |  | Iles Formation of the |
|  |  |  | Mesaverde Group, |
|  |  |  | Williams Fork |
|  |  |  | Formation of the |
|  |  |  | Mesaverde Group, and |
|  |  |  | undifferentiated |
|  |  |  | Mesaverde Group, |
|  |  |  | within certain |
|  |  |  | delineated areas in |
|  |  |  | Rio Blanco, Garfield, |
|  |  |  | Mesa, Delta, and |
|  |  |  | Pitkin Counties. |
|  | Weber Formation |  | Rangely Oil Field in |
|  |  |  | Rio Blanco County |
|  | Morrison and Entrada |  | Wilson Creek Oil |
|  | Sundance Formations |  | Field in Rio Blanco |
|  |  |  | County |
| Northern San | Fruitland Formation | Rule 17.7.D.2 | All Fruitland |
| Juan Basin |  |  | Formation |
|  | A Pictured Cliff, |  | Within delineated |
|  | Cliff House, Menefee, |  | areas in Southwestern |
|  | Point Lookout, and |  | ***Colorado*** |
|  | Dakota Formations |  |  |
| Paradox Basin | Paradox Formation |  | Hovenweep Shale, |
|  |  |  | Gothic Shale, and |
|  |  |  | Desert Creek Members |
|  |  |  | within Mesa, |
|  |  |  | Montrose, San Miguel, |
|  |  |  | Dolores, and |
|  |  |  | Montezuma Counties |
| Basin/Field | Formation (Name) | Rule Dictating | Area Designated As |
| (Name) |  | Nontributary | Nontributary |
|  |  | Designation |  |
| Sand Wash | From Fort Union |  | Mowry Shale, Dakota |
| Basin | Formation, Lance |  | Sandstone, Nugget |
|  | Formation, Lewis |  | Sandstone, and |
|  | Shale, Meseverde |  | Hiawatha Member of |
|  | Group, Baxter Shale, |  | the main body of the |
|  | Frontier Formation |  | Wasatch Formation in |
|  |  |  | Moffat County. |
|  | Wasatch Formation |  | Hiawatha and West |
|  |  |  | Hiawatha Gas Fields |
| Denver--Julesburg | Pierre Shale |  | Parkman, Sussex, and |
| Basin | Formation, Lower |  | Shannon Members of |
|  | Pierre Shall |  | Pierre Shale |
|  | Formation, the |  | Formation; within |
|  | Niobrara Formation, |  | certain delineated |
|  | the Carlile |  | areas in northeastern |
|  | Formation, the |  | ***Colorado***. |
|  | Greenhorn Formation, |  |  |
|  | the Graneros |  |  |
|  | Formation, the Dakota |  |  |
|  | Group, and the Lyons |  |  |
|  | Formation |  |  |

As a result of these findings, the producers of wells within these areas, although required to obtain a well permit from the State Engineer's office, do not have to attempt to quantify the out-of-priority depletions associated with produced water, nor find alternative water supplies to replace those depletions on a virtually permanent basis.[[201]](#footnote-202)201 Under the new State Engineer rules, wells outside of these formations may also seek a nontributary designation pursuant to the adjudicatory process established therein.[[202]](#footnote-203)202 The new State Engineer rules appear to have balanced the concerns of water rights users, who have been provided with a forum to demonstrate injury to their rights by the production water in the CBM process, and energy producers, who can continue to produce CBM efficiently at least in nontributary-designated formations.

D.

Oil Shale

Commentators have again suggested that an oil shale boom is coming to ***Colorado*** in the next decade. [[203]](#footnote-204)203 Oil shale is attractive due to its abundance **[\*303]** and potential as a domestic source of oil - it is a sedimentary rock that contains solid bituminous materials (known as kerogen) that are released as petroleum-like liquids when the rock is heated. [[204]](#footnote-205)204 The biggest known resource for oil shale lies in the Green ***River*** Formation, located at the intersection of Utah, Wyoming, and ***Colorado*** (known as the Piceance Basin), which may contain as much as 800 billion to 1.8 trillion barrels of oil resources. [[205]](#footnote-206)205 Over seventy percent of those oil shale deposits are lie within federal lands and fall under the regulatory authority of the U.S. Department of the Interior, Bureau of Land Management ("BLM"). [[206]](#footnote-207)206 Reserve estimates in the area of ***Colorado*** surrounding Grand Junction indicate there are 1.5 to 1.8 billion barrels (bbl) of retrievable oil. [[207]](#footnote-208)207

1. History of Oil Shale Development in ***Colorado***

Coloradans have known about significant oil shale reserves since the late 19th century, [[208]](#footnote-209)208 and have attempted to take advantage of this resource since that time. For as long as the energy industry can remember, oil shale development has been "around the corner." However, until recent technological developments, oil shale was difficult to develop. [[209]](#footnote-210)209 Energy companies have attempted to harness the oil shale resources in ***Colorado*** for over a century; many of those companies hold at least somewhat senior water rights, and this fact may have major implications for the West Slope in particular. [[210]](#footnote-211)210

Shell, a subsidiary of Royal Dutch Shell, has slowly acquired water rights and cropland in the Piceance Basin [[211]](#footnote-212)211 for the purposes of oil shale research and development - indeed, Shell states that it believes oil shale development will become commercially viable "in the next decade." [[212]](#footnote-213)212

**[\*304]** Oil shale development has been susceptible to crude oil boom-and-bust cycles and development of oil shale has begun only to be halted a number of times. [[213]](#footnote-214)213 One of the more recent cycles began in 2005 when Congress declared, in the Energy Policy Act of 2005 ("EPACT"), that oil shale development should take priority as a "strategically important resource." [[214]](#footnote-215)214 This statutory provision tasked BLM with oil shale leasing to promote rapid commercial development. [[215]](#footnote-216)215 Early in 2006, BLM, by rulemaking, granted research and development leases in ***Colorado***. [[216]](#footnote-217)216 But EPACT directed an accelerated move to commercial oil shale development, and to facilitate oil shale leasing BLM began an environmental analysis of a leasing program. [[217]](#footnote-218)217 In 2007 a Draft Programmatic Environmental Impact Statement ("PEIS") was issued for public comment and completed in 2008. [[218]](#footnote-219)218 The Record of Decision identified areas open for leasing and amended eight Resource Management Plans to allow for leasing of oil shale. [[219]](#footnote-220)219 In addition, commercial oil shale rules were promulgated. [[220]](#footnote-221)220 However, when Secretary of the Interior Ken Salazar arrived in 2009, he pulled back on the reins of commercial oil shale. Instead of expediting the development process of oil shale, as the EPACT 2005 directed, Secretary Salazar slowed the process, [[221]](#footnote-222)221 explaining that he would take a "judicious approach to oil shale development [that] will help Western Slope communities avoid any unfortunate bust that comes from an unchecked boom on commercial leasing." [[222]](#footnote-223)222

In February 2011, Secretary Salazar directed that the Department of Interior take a "fresh look" at oil shale and review the commercial rules **[\*305]** for oil shale development [[223]](#footnote-224)223 and BLM began a new planning process for oil shale. [[224]](#footnote-225)224 One of Secretary Salazar's noted concerns was the "protection of water supplies in the arid West" and the Rule's low royalty rate. [[225]](#footnote-226)225 On February 3, 2012, the BLM issued a new Draft Programmatic Environmental Impact Statement for oil shale and Tar Sands with a comment period closing on May 4, 2012. [[226]](#footnote-227)226 How this story will unfold is anybody's guess, but so long as oil and gas companies remain interested in developing technologies making oil shale commercially viable, [[227]](#footnote-228)227 oil shale development will remain a potentially significant future water demand in ***Colorado***.

2. Oil Shale Production Techniques

The two methods generally under discussion for extracting oil from shale rock are surface retort and in situ underground retort. [[228]](#footnote-229)228 Surface retort - the older of the two technologies - involves mining the shale out of the earth first and then extracting or retorting the oil from the shale above ground. [[229]](#footnote-230)229 Above ground oil shale retort is plagued by environmental concerns. In particular, it requires access to significant amounts of water. [[230]](#footnote-231)230 In situ underground retort uses heat to extract oil from the shale while the rock is in place underground. [[231]](#footnote-232)231 Currently, oil companies are using BLM research and development leases to test in situ technology to extract oil from the shale. In some cases, the heating process, which itself can require significant power, can take years before the oil is adequately heated and extracted from the shale so that it can be pumped to the surface. [[232]](#footnote-233)232 However, until the regulatory environment is more settled and the long-term economics are viable - the cost of producing oil from **[\*306]** oil shale is currently greater than sixty dollars per barrel [[233]](#footnote-234)233 and oil shale becomes economically viable when oil prices are higher and stay high, it is likely that oil shale remains in the more distant future.

3. Water Demand for Oil Shale Production

Even if the lower water use estimates of three to four barrels of water per barrel of oil shale [[234]](#footnote-235)234 are correct, [[235]](#footnote-236)235 oil shale development requires large quantities of water. To develop ***Colorado***'s estimated oil shale reserve, the direct demand (1.55 million bbl) will require approximately 100,000 acre-feet per year, according to a February 2011 ***Colorado*** ***River*** Water Conservation District ("CRWCD") Study. [[236]](#footnote-237)236 This number was cut drastically from an earlier study (the CRWCD's Phase I Study), where the estimate suggested approximately 400,000 acre feet per year to produce ***Colorado***'s recoverable oil shale. [[237]](#footnote-238)237 The CRWCD notes, however, that the study is not predictive, and that the water needs for oil shale development will vary depending on technological improvements, economic viability, future demand, and other limitations such as environmental permitting requirements. [[238]](#footnote-239)238

In anticipation of oil shale development, oil companies have established conditional water rights associated with more than 200 separate proposed structures, including reservoirs and pipelines in the ***Colorado*** ***River*** and White ***River*** Basins. [[239]](#footnote-240)239 Collectively, these rights would enable the direct diversion of more than 10,000 cubic feet per second and the storage of more than 1.7 million acre-feet. [[240]](#footnote-241)240 If energy companies were to exercise their decreed water rights, Western Resource Advocates ("WRA"), a ***Colorado*** conservation organization, argues there would be four major impacts on traditional water use in ***Colorado***: 1) impacts on agriculture; [[241]](#footnote-242)241 2) impacts on junior users; [[242]](#footnote-243)242 3) restrictions on the 1922 ***Colorado*** ***River*** Compact; [[243]](#footnote-244)243 and 4) impacts on endangered fish. [[244]](#footnote-245)244

**[\*307]** The water rights associated with oil shale development have, from time to time, come under legal challenges from other water rights users. In 1999 and 2000, there were a series of cases challenging oil companies' conditional water rights appropriated for oil shale development on the basis that (1) the companies had failed to diligently develop the water rights; (2) the companies could not meet the statutory requirement (C.R.S. [*§ 37-92-305(9)(b)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3G3-00000-00&context=1516831)) that they "can and will" develop the water rights and put them to beneficial use within a reasonable time, and; (3) that the water rights were speculative because it was unlikely that commercial scale oil shale development would occur. [[245]](#footnote-246)245

The ***Colorado*** Supreme Court determined that, in addition to the reasonable diligence requirement, [[246]](#footnote-247)246 the "can and will" standard and the anti-speculation doctrine would be applied in the context of an application for diligence for conditional water rights. [[247]](#footnote-248)247 However, the ***Colorado*** Supreme Court also held that the current economic infeasibility of oil shale extraction due to low oil prices could be taken into account, and thus determined that OXY USA, Inc. had met its burden of proof demonstrating that it had diligently developed its conditional water rights. [[248]](#footnote-249)248

More recently, in July of 2011 the water court in Water Division No. 6 nullified 140,000 acre-feet of White ***River*** Basin conditional water rights, some of which were intended for use in potential oil shale development, on the basis that the Yellow Jacket Water Conservancy District did not have the requisite quorum of directors necessary to authorize the filing of diligence applications when the same were filed by the District's secretary and general counsel in 2009. [[249]](#footnote-250)249 The District has appealed the water court ruling to the ***Colorado*** Supreme Court. [[250]](#footnote-251)250 If unsuccessful on **[\*308]** appeal, the District could apply for new conditional water rights, though, if granted, it would have lost its priority date of the voided rights. [[251]](#footnote-252)251 Some observers believe that the water court decision is one which shows disfavor for oil shale development. [[252]](#footnote-253)252 Whether that is true or not, if upheld, this decision, and other inevitable future challenges to the water rights appropriated for oil shale development, could have significant impact on energy development because of the potential impact on actual water availability.

4. Protecting Water Quality

In addition to refining the extraction process, companies with oil shale interests are attempting to reduce water demands associated with oil shale production and develop techniques to protect water quality in the nearby alluvial aquifers. Shell engaged in testing the viability of an underground freeze wall - one that is designed to create an impermeable frozen barrier that will surround the heat zone - in order to protect nearby groundwater from contamination. [[253]](#footnote-254)253 American Shale Oil is working on a similar project to protect groundwater, but intends to drill into deeper layers of the oil shale below the Piceance Basin's aquifers. [[254]](#footnote-255)254 Chevron plans to target shale beds capped by impermeable geological formations, in an effort to prevent groundwater from seeping into the contaminated rubble left behind from the extraction process. [[255]](#footnote-256)255 A successful technology to prevent groundwater contamination will be a key factor for commercial scale oil shale production to become a reality in ***Colorado***.

E. Solar

1. The Technology: Producing Solar

Production of photovoltaic solar energy ("PV") is the world's fastest growing technology, and because demand is increasing and technology improvements for producing solar panels are improving, costs for installing direct-use PV systems have dropped. [[256]](#footnote-257)256 Considering the rapidly decreasing **[\*309]** cost of PV, implementation of renewable energy portfolio standards (mandated by state governments such as California, ***Colorado***, and Washington), state and federal subsidies, [[257]](#footnote-258)257 a less arduous permitting process, and the heightened water concerns surrounding other forms of utility grade solar power, PV, which does not require cooling water, is playing a growing role in the solar technology development game. [[258]](#footnote-259)258

Another type of utility-grade solar - Concentrating Solar Power ("CSP") - has raised concerns regarding water availability. CSP is a utility-scale technology, and because it can include storage capabilities, CSP with storage can avoid the intermittency problems found in typical solar energy sources. [[259]](#footnote-260)259 CSP technologies come in four different forms: solar trough, linear Fresnel, power tower, and dish/engine. [[260]](#footnote-261)260 The first three utilize a steam cycle similar to that used in coal and gas-fired electric power plants: the energy harnessed from the sun boils water, creating exhaust steam, and spins a turbine that generates electricity. [[261]](#footnote-262)261 Though the boiled water is usually recycled, it is the cooling process that uses large volumes of water. Closed-loop CSP withdraws approximately 750 -920 gal/mWh, depending on whether the system utilizes trough or tower technology. [[262]](#footnote-263)262 Some CSP projects, like Ivanpah Solar Electric Generating System in California (power tower), have elected to air-cool the turbine - there is a significant loss of efficiency, but the issue of using scarce Mohave Desert water is addressed. [[263]](#footnote-264)263 Others, like Crescent Dunes (power **[\*310]** tower) in Tonopah, Nevada have elected to use a hybrid system - part air, part water - to reduce the impact on efficiency and water consumption. [[264]](#footnote-265)264

2. Concentrating Solar Power (CSP) v. Photovoltaic Solar (PV)

Some commentators believe that CSP, particularly with storage, is more competitive dollar for dollar than PV; however, when one considers the long-term costs of CSP's potential heavy water consumption, along with the greater construction and permitting costs of CSP, and the rapidly decreasing cost of PV panels, PV might actually be more economically competitive. [[265]](#footnote-266)265 Indeed, three major solar companies have switched from CSP to PV. [[266]](#footnote-267)266 Switching from CSP to PV projects can make it easier and less expensive to obtain permits and construct and, thus, easier to obtain financing particularly when water consumption and the effects on water resources in arid climates is a concern. [[267]](#footnote-268)267 Still, PV is at a disadvantage without storage capability, and until that issue can be addressed, interest in CSP technologies will continue. [[268]](#footnote-269)268

3. Reconciling Federal and State Objectives: Solar Development in the San Luis Valley

In the Draft Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States, the BLM identifies the proposed Antonito Southeast solar energy zone ("SEZ") in Conejos County, ***Colorado*** as one of the major SEZ opportunities in the United States. [[269]](#footnote-270)269 Conejos County is located in the San Luis Valley, a high elevation **[\*311]** (approximately 8,000 feet) basin between two mountain ranges, [[270]](#footnote-271)270 and is in the Rio Grande Headwaters sub-basin of the Rio Grande hydrologic region. [[271]](#footnote-272)271 The climate is arid and evaporation rates generally exceed precipitation rates, with average annual precipitation and snowfall amounts in the southern San Luis Valley measuring seven and twenty-five inches respectively. [[272]](#footnote-273)272 According to the BLM, "aquifers in the San Luis Valley are predominantly recharged by snowmelt runoff from higher elevations of the surrounding mountain ranges along the valley rim … as well as by irrigation return flows, subsurface inflow, and seepage from streams." [[273]](#footnote-274)273 The surface and groundwater rights in the Rio Grande Headwaters sub-basin, where the Antonito Southeast SEZ is located, are already over appropriated, meaning that solar companies would have to purchase an augmentation certificate or existing water rights in order to use water. [[274]](#footnote-275)274

As the BLM notes in the solar environmental analysis, it would be very difficult for any project seeking an amount of water more than approximately 1,000 acre-feet per year (1.2 million m3/yr) to be successful in obtaining needed water rights, because any use of water in the SLV area must be augmented (or taken from other areas) and this directly affects other water rights and rights of other states under inter-state treaties. [[275]](#footnote-276)275 In addition, there would be a significant amount of produced wastewater - normal operations would produce up to 22 acre-feet per year (27,100 m3/yr) of sanitary wastewater requiring treatment on-site or sent to an off-site facility [[276]](#footnote-277)276 - and the quantity of water discharged would range from 246 to 422 acre feet per year (303,000 to 521,000 m3/yr). [[277]](#footnote-278)277

SLV residents, who host three PV solar facilities have also fought the plans for construction of some utility-scale solar projects in the SLV. [[278]](#footnote-279)278 Residents have noted the wastewater problem, but on March 26, 2012 the Saguache County Commissioners decided (2-1) to issue a permit for a 6,200 acre CSP solar with storage project capable of producing up to 200 mw. [[279]](#footnote-280)279 Although it would appear that the citizens of the SLV do not oppose utility-scale solar projects wholesale, in addition to aesthetic and **[\*312]** land use objections, local groups express concern over the availability of water and of pitting solar in competition with traditional water uses, such as irrigating crops. [[280]](#footnote-281)280 In addition to these citizen objections, recent changes to local water district regulations in response to Rio Grande ***River*** compact issues will likely make finding adequate, reliable water supplies more challenging. [[281]](#footnote-282)281

4. Water Availability Issues: Meeting the Rio Grande Compact

The BLM's Solar DPEIS identifies the Rio Grande Compact of 1938, an interstate treaty that obligates ***Colorado*** to deliver a certain amount of water to the ***Colorado***-New Mexico border, as a potential restriction on water availability for solar projects in the San Luis Valley. [[282]](#footnote-283)282 This is a result of irrigators in the San Luis Valley using more than ***Colorado***'s share of Rio Grande water for a number of years. [[283]](#footnote-284)283 In an effort to reduce overall water use in the Valley, while still maintaining the viability of the agricultural community, local organizations have implemented new management plans. [[284]](#footnote-285)284 These plans will ultimately result in the retirement of tens of thousands of acres of irrigated agricultural land in the San Luis Valley in order to reduce overall water depletions and enable the State of ***Colorado*** to meet its Rio Grande ***River*** compact obligations. [[285]](#footnote-286)285

C.R.S. [*§ 37-48-126*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J2WF-00000-00&context=1516831) authorizes the Rio Grande Water Conservation District ("RGWCD") to create sub-districts for the administration of a water management plan in each sub-district. [[286]](#footnote-287)286 In June 2009, the RGWCD's Board of Directors adopted the Water Management Plan for Special District #1 (Sub-district #1). [[287]](#footnote-288)287 As such, the sub-district is responsible **[\*313]** for imposing "limits on groundwater withdrawals in order to reduce groundwater extractions to a sustainable level and help sustain [Rio Grande ***River*** Compact] obligations." [[288]](#footnote-289)288 The sub-district plan involves using fees imposed upon well users within the sub-district to purchase and retire groundwater rights from irrigators. [[289]](#footnote-290)289 The operation of the Plan complies with the applicable ***Colorado*** statutory requirements. [[290]](#footnote-291)290 Sub-district #1, alone, anticipates retiring 40,000 acres of irrigated land. [[291]](#footnote-292)291

Because water demands are already so oversubscribed in the Rio Grande basin that the local water users must implement such drastic reduction of existing water use, finding sufficient water supplies for solar companies to develop utility-scale solar projects that use CSP wet-cooling will likely prove exceedingly difficult. [[292]](#footnote-293)292 Therefore, unless CSP developers adequately address water consumption, uncertainty of water availability in the San Luis Valley draws into question whether there is a realistic chance that the Antonito Southeast Solar Energy Zone will develop into one of the country's main solar resources.

F. Hydropower

The connection between energy and water demand associated with hydropower is fairly obvious - power is generated from the flow of water. [[293]](#footnote-294)293 "Hydropower was one of the oldest forms of energy harnessed before the industrial revolution" and is by far the most significant renewable energy resource in the country. [[294]](#footnote-295)294 Hydropower accounts for seventy percent of renewable energy, half of which is produced in Washington, California, and Oregon, [[295]](#footnote-296)295 and provides for approximately seven percent of United States electricity needs. [[296]](#footnote-297)296 However, ***Colorado*** is not a very big hydropower state - hydropower only accounts for 3.7 percent [[297]](#footnote-298)297 of the total electricity produced in ***Colorado*** as of 2009. [[298]](#footnote-299)298

**[\*314]** Hydropower is a very efficient renewable resource and can operate on utility scale at an average of ninety percent efficiency. [[299]](#footnote-300)299 That being said, hydropower can have significant environmental consequences, [[300]](#footnote-301)300 though in most cases - such as in ***Colorado*** - large hydropower projects are entirely nonconsumptive, and one hundred percent of the water is released back into the ***river***. [[301]](#footnote-302)301

1. The Technology: Producing Hydropower

To generate hydroelectric power, the water must be in motion - the flowing water turns blades in a turbine, and the form of energy is changed from kinetic to mechanical energy. [[302]](#footnote-303)302 The turbine then turns the generator rotor, which converts the mechanical energy into electrical energy. [[303]](#footnote-304)303 Most hydroelectric power plants are located on ***rivers*** and streams in order to guarantee a stable water supply, and dams are utilized to guarantee that supply. [[304]](#footnote-305)304 The dam creates a height from which water flows (called "head"), while a pipe called a penstock carries the water from the reservoir to the turbines. [[305]](#footnote-306)305 Then, the water's force on the turbine blades turns the rotor (the moving part of the electric generator), so that electricity is produced when coils of wire on the rotor move past the generator's stationary coil (or stator). [[306]](#footnote-307)306 The output of energy from a dam is determined by the volume of water released (discharge) and the vertical distance the water falls (head) - the discharge and head determine what type of turbine must be used (the stronger the head, the more pressure available to drive those turbines). [[307]](#footnote-308)307 The water flows unchanged back into the ***river*** or stream. [[308]](#footnote-309)308 From there, the electricity generated is transmitted through transmission lines and facilities. [[309]](#footnote-310)309

**[\*315]**

2. Federal Permitting Regulation v. State Determined Water Rights

The Federal Energy Regulatory Commission ("FERC"), an independent federal agency, is responsible for the hydropower licensing process under the Federal Power Act ("Power Act"). [[310]](#footnote-311)310 Fifty-percent of the nation's installed hydroelectric capacity was due for licensing renewals in 2010. [[311]](#footnote-312)311 Section 4(e) of the Power Act authorizes FERC to "issue licenses … for the purpose of constructing, operating and maintaining dams, water conduits, reservoirs, power houses, transmission lines, or other project works necessary or convenient for the … development, transmission, and utilization of power" on bodies of water within Congress's Commerce Clause jurisdiction or

upon any part of the public lands and reservations of the United States … : Provided, That licenses shall be issued within any reservation only after a finding by the Commission that the license will not interfere or be inconsistent with the purpose for which such reservation was created or acquired, and shall be subject to and contain such conditions as the Secretary of the department under whose supervision such reservation falls shall deem necessary for the adequate protection and utilization of such reservations. [[312]](#footnote-313)312

Thus, pursuant to Section 4(e), FERC must consult with the department that manages the subject federal land regarding conditions to include in the license. [[313]](#footnote-314)313 Under section 15 of the Power Act, the Commission may "issue a new license to the existing licensee upon such terms and conditions as may be authorized or required under the then existing laws and regulations, or … issue a new license under said terms and conditions to a new licensee." [[314]](#footnote-315)314

In some cases, FERC-conditioned approval of a renewed license for a hydropower project can come into conflict with state-issued water rights. [[315]](#footnote-316)315 One of the common conditions placed upon a hydropower license, especially in water-short stream systems, is a bypass flow requirement to protect fish and wildlife. [[316]](#footnote-317)316 This means that the hydropower project is required to forego diverting a portion of its decreed water right in order to maintain certain flows for the benefit of fish and wildlife. [[317]](#footnote-318)317 In a similar **[\*316]** context, the Forest Service imposed a bypass flow on a reservoir located on federal land above Ft. Collins pursuant to the Federal Land Policy Management Act ("FLPMA") [*43 U.S.C.§§1701*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8SDD-0HD2-8T6X-74JK-00000-00&context=1516831)-1782. [[318]](#footnote-319)318 Water user interveners in the case challenged the authority of the Forest Service to impose the bypass flow requirement on the basis that "Congress has not granted to the Forest Service the authority to impose bypass flow conditions in order to reallocate water from existing uses to unmet National Forest needs." [[319]](#footnote-320)319

The water user interveners asserted: (1) that the exercise of this authority by the Forest Service would contradict the repeated and explicit decisions by Congress to defer to and respect state authority over water allocation and use; (2) that the imposition of bypass flow requirements on existing water uses would be contrary to Congressional intent to authorize the National Forest system principally to enhance the quantity of water that would be available for nonfederal water users; (3) that the applicable statutes explicitly and broadly disclaim any agency authority to affect existing nonfederal uses of water or to interfere with state control over the allocation and use of water; (4) that the applicable statutes also limit the exercise of Forest Service authority by making it subject to valid existing rights such as existing water rights and facilities; and (5) that the use of bypass flow requirements by federal agencies to obtain water for federal purposes is inconsistent with the McCarran Amendment, [*43 U.S.C. § 666,*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8SDD-0HD2-8T6X-73VR-00000-00&context=1516831) by which Congress established a unified and all-inclusive method to allocate the use of water between federal and non-federal water uses, including the riparian uses which Plaintiffs seek to protect in this case. [[320]](#footnote-321)320 The court rejected all of these arguments and held that the Forest Service's exercise of its regulatory authority to impose bypass flows as a condition on the use of National Forest land does not constitute the assertion of a water right. [[321]](#footnote-322)321

There have been recent instances where FERC relicensing has imposed bypass flows on ***Colorado*** hydropower projects. Public Service Company of ***Colorado***'s ("PSCo") Salida Hydropower Station on the South Fork of the Arkansas ***River*** was relicensed in the late 1990s. [[322]](#footnote-323)322 The license was issued May 7, 1997 and required PSCo to implement a staged bypass flow regime at two locations, with bypass flow amounts increasing at ten, fifteen, and twenty years after issuance of the license in order to support fishery values on the ***river***. [[323]](#footnote-324)323 This was a negotiated condition, which attempted to balance the demands of state and federal wildlife **[\*317]** agencies with the economics of the project. [[324]](#footnote-325)324 More recently, FERC issued the Tacoma Hydropower Station a license on January 29, 2010. [[325]](#footnote-326)325 The license requires PSCo to bypass water it would otherwise be entitled to divert under its water rights to provide continuous flows in Cascade and Elbert Creeks to enhance habitat for trout and other aquatic resources. [[326]](#footnote-327)326 PSCo had opposed the imposition of bypass conditions for a number of reasons, including the concern that these conditions would make winter operations difficult under certain conditions, and would make the project non-economical. [[327]](#footnote-328)327

These two examples demonstrate that even though hydropower is a critical piece of the renewable energy portfolio in ***Colorado*** - in that it provides clean, reliable, low-cost energy - even the most established hydropower projects can be threatened at each new FERC license renewal because of stringent bypass flow conditions which not only diminish state-granted water rights, but also make continued economic operation of the projects more difficult.

3. The Shoshone Hydro Plant: A Critical Link in West Slope Water Administration

The Shoshone Hydropower Plant, which has been in operation for over a century, provides a unique example of the links that bind water and energy in ***Colorado***. Unlike most hydropower stations, which rely upon releases of stored water to produce energy, the Shoshone project diverts water directly from the ***Colorado*** ***River***. [[328]](#footnote-329)328 A diversion dam across the ***river*** backs up water and diverts it at a rate of 1,250 cubic feet per second ("cfs") into a tunnel constructed at the top Shoshone Falls. [[329]](#footnote-330)329 The water falls down 287 feet to the generation station housing the turbines and provides the mechanical energy required by the generators to create electrical energy. [[330]](#footnote-331)330 The water right powering the entire project is a 1902 direct flow right for 1,250 cfs. [[331]](#footnote-332)331 This senior water right has become the most powerful water right on the ***Colorado*** ***River***, preserving flows in the ***river*** for the benefit of other West Slope water users. [[332]](#footnote-333)332 During times of **[\*318]** low flow, the Shoshone Hydro Plant may divert the entire flow of the ***river*** into its turbines, which dries up several miles of the ***Colorado*** ***River*** between the Shoshone diversion dam and the tailrace, where virtually all of the water diverted returns to the ***river***. [[333]](#footnote-334)333 Because the Shoshone senior water right calls water downstream to its diversion dam in Glenwood Canyon year round, Eric Kuhn, general manager of the ***Colorado*** ***River*** Water Conservation District, credits the Shoshone call as the key factor that "makes the ***river*** run." [[334]](#footnote-335)334 By calling the water downstream, Shoshone Hydro's water rights prevent upstream, transbasin diversions, such as Denver's Roberts Tunnel system, from taking water out of the ***Colorado*** ***River***. [[335]](#footnote-336)335 Other water users all along the ***Colorado*** ***River***, including municipalities, irrigators, and rafters, rely on the Shoshone water right to keep water in the ***river***. [[336]](#footnote-337)336

It should come as no surprise then that the Shoshone water right has been in the cross-hairs between Front Range and West Slope water interests for years. In response to severe drought in 2003, Denver Water, Xcel Energy, and several West Slope water users reached a cooperative agreement that provided for the partial shutdown of the Shoshone Hydro plant during times of low flow. [[337]](#footnote-338)337 Denver Water compensated Xcel for lost revenue due to inefficient power generation and earmarked ten percent of the water gained from the call to be returned to the West Slope. [[338]](#footnote-339)338

Denver Water and Xcel, with input from Western Slope water interests, renewed the agreement in 2006. [[339]](#footnote-340)339 Because Xcel must maintain a franchise agreement with Denver Water in order to use the city's rights of ways for its distribution facilities, Denver Water has significant leverage over Xcel at the negotiating table. [[340]](#footnote-341)340 West Slope interests are wary that Denver Water will demand more concessions from Xcel on the Shoshone call in future franchise agreement negotiations. [[341]](#footnote-342)341 Accordingly, the Shoshone call was important to recent negotiations for a comprehensive East Slope-West Slope water agreement. [[342]](#footnote-343)342

**[\*319]** Denver Water, the ***Colorado*** Water ***River*** Conservation District, and many West Slope counties, towns, water providers, recreational interests, and other water users are parties to this draft ***Colorado*** ***River*** Cooperative Agreement (Xcel is not among them). [[343]](#footnote-344)343 This agreement has the potential to create a new era of cooperation between Denver Water and water users in the ***Colorado*** ***River*** Basin by creating significant benefits for both Denver Water and West Slope water interests. According to Denver Water, the ***Colorado*** Cooperative Agreement will provide:

For Cities, Counties and Other Entities in the ***Colorado*** ***River*** basin [[344]](#footnote-345)344

. Additional water for towns, districts, and ski areas in Grand and Summit counties to serve the needs of their residents and to improve the health of our ***rivers*** and streams;

. An agreement to operate key Denver Water facilities, such as Dillon Reservoir in Summit County, and Williams Fork Reservoir, and the Moffat Collection System in Grand County, in a way that better addresses the needs and concerns of neighboring communities and enhances the ***river*** environment;

. Enhanced recreational opportunities by providing additional water to certain ski areas;

. Greater certainty in the continued availability of water in the middle and lower ***Colorado*** ***River*** by ensuring that when the Shoshone Power Plant in Glenwood Canyon is not operating, the parties will operate their facilities as if the plant was operational to help maintain the historic flows in the ***Colorado*** ***River***;

For Denver Water [[345]](#footnote-346)345

. Greater certainty in developing a secure water future for its customers by resolving long-standing disputes over its service territory, its ability to use West Slope water, its ability to develop future water supplies in the ***Colorado*** ***River*** Basin, and other legal issues;

. Additional water and enhanced system reliability for customers of Denver Water, representing nearly twenty-five percent of the state's population, by moving forward the Moffat Collection System Project;

. Agreement by all partners to not oppose Denver's storage of its Blue ***River*** and Moffat Project water on the Front Range;

**[\*320]** . Clarification of the conditions under which Denver Water will be able to provide water outside its service territory - thus paving the way for the cooperative WISE Project;

The ***Colorado*** Cooperative Agreement is not yet final as it is currently pending final approval by the thirty-five participating entities. [[346]](#footnote-347)346

4. Small Hydropower

While ***Colorado*** is not a big hydropower state compared to its other Western counterparts, there is a small but growing movement for the implementation of small hydro. [[347]](#footnote-348)347 Small hydro is not utility-scale, and exists to serve and generate electricity for specific project areas. [[348]](#footnote-349)348 Some cities in ***Colorado*** - such as Boulder and Aspen - have either built, or intend to build, small hydropower facilities for municipal-scale use. In the City of Boulder, eight small hydroelectric generators are enough to support eleven percent of the city's electricity needs for 96,000 residents. [[349]](#footnote-350)349 Aspen recently applied for preliminary licensing to build hydropower plants that would produce approximately eight percent of the town's needed energy. The project, however, is not without controversy. Critics claim the power generated by the facility is not worth the potential harm caused by reduced stream flows. [[350]](#footnote-351)350

The future of hydropower in ***Colorado*** is somewhat uncertain. Because many older hydropower projects were the first large scale electrical generating plants to supply significant power to the state, they benefit from relatively senior water rights - unlike many more current energy development projects in ***Colorado***. A project owner's ability to generate power economically through state-derived water rights, however, is in question because federally imposed bypass conditions are now standard practice for FERC relicensing.

**[\*321]**

G. Geothermal

For hundreds of years, people have enjoyed geothermal energy mostly through hot springs. [[351]](#footnote-352)351 In the twentieth century, however, technologies to exploit the earth's natural heat to generate electricity became more available. [[352]](#footnote-353)352 While geothermal energy might be "effectively unlimited," [[353]](#footnote-354)353 its "most significant environmental and economic impact … [is] the effect on water, the material transfer medium for all geothermal systems." [[354]](#footnote-355)354 Those seeking to develop geothermal resource must seek standard water rights to take advantage of the earth's heat. A myriad of water issues affect the development of geothermal energy, in both a technological and legal sense.

1. The Technology: Producing Geothermal

There are a number of geothermal technologies and a number of applications. Four generate electricity - 1) dry steam systems; 2) hot water systems; 3) hybrid geothermal brine systems; and 4) hot dry rock systems - and the fifth application uses low temperature geothermal waters to heat buildings (also known as "direct use"). [[355]](#footnote-356)355 In addition, there is Geothermal Heat Pump (GHP) technology, which takes advantage of the difference in temperature between above and below ground, and thus differs from other types of geothermal resources. [[356]](#footnote-357)356

Dry Steam Systems. Where a well is drilled to access the geothermal dry steam in a reservoir, the steam rises through the drilled well to the surface and then expands to drive a steam turbine. [[357]](#footnote-358)357 Steam then discharges through a condenser and mixes with cool water, and this heated water is pumped to a cooling tower where most of the condensation evaporates. [[358]](#footnote-359)358 Any unevaporated water is then eventually re-injected into the reservoir. [[359]](#footnote-360)359

**[\*322]** Hot Water Systems. Where the underground water's temperature is higher than its boiling point, and remains in liquid form because of extreme underground pressure, electricity can be generated through either flash steam or binary processes. [[360]](#footnote-361)360 A binary power plant uses cooler geothermal reservoirs than a power dry steam or flash steam power plant [[361]](#footnote-362)361 Binary plants pump hot water through a heat exchanger, and the cooled water is then returned to the geothermal reservoirs. [[362]](#footnote-363)362 In the heat exchanger, the hot water heats and vaporizes the lower boiling "binary" fluid, whose vapors then power the steam turbine. [[363]](#footnote-364)363

Hot Dry Rock Systems. To exploit hot rock, typically located at depths of eight thousand to twenty thousand feet, high pressure pumps inject water into the formation, fracturing the rock and thereby creating a reservoir. [[364]](#footnote-365)364 Water, when heated in this hot rock reservoir and extracted from secondary wells, can then generate electricity. [[365]](#footnote-366)365

Warm-Water Systems: Direct Use. Before high-temperature drilling and well-completion technology, geothermal energy was utilized to heat homes through direct use applications. [[366]](#footnote-367)366 While thermal water can cool or heat homes and businesses, it cannot be transported without thermal loss and this limits its application. [[367]](#footnote-368)367

Geothermal Heat Pumps. GHPs cause thermal energy to flow up temperature, opposite the direction that it would naturally flow. [[368]](#footnote-369)368 A heat pump works best when the outdoor air is too hot or cold, and this technology substantially increases the efficiency of traditional heating and cooling systems by significantly decreasing the lift - the extra work necessary to get heat or cool air to flow upstream. [[369]](#footnote-370)369

While numerous geothermal energy technologies exist, they all have one component in common - they all need a lot of water (with the exception of GHP technology). A utility-scale geothermal power plant consumes 1400 gal/mWh of water to cool equipment and generate electricity. [[370]](#footnote-371)370 Even an area rich in geothermal resources, such as The Geysers in California, requires large volumes of cooling water. [[371]](#footnote-372)371

**[\*323]**

2. Demand for Geothermal (and GHP technology in particular) in ***Colorado***

GHP technology is among the most efficient cooling and heating technologies available, transferring heat between buildings and the earth three to five times more efficiently than other HVAC systems. [[372]](#footnote-373)372 Currently, buildings contribute 48 percent of U.S. energy consumption and greenhouse gas emissions: [[373]](#footnote-374)373 "GHPs could avoid the need to build 91 to 105 [gigawatts] of electricity generation capacity, or 42 to 48 percent of the … net new capacity additions projected to be needed nationwide by 2030." [[374]](#footnote-375)374 However, only about 1.54 percent of heating, ventilating, and cooling in North America comes from GHP technology. [[375]](#footnote-376)375

***Colorado*** is not among the top states taking advantage of geothermal resources, either on a utility-scale or for direct use, despite its fifty-nine hot springs. [[376]](#footnote-377)376 In fact, in the Mount Princeton and Waunita Hot Springs areas, five hot springs produce temperatures at or above 165 degrees Fahrenheit, an optimum temperature for binary power plant development. [[377]](#footnote-378)377 ***Colorado*** also holds a number of low to moderate temperature sites that make direct use with GHP technology possible; [[378]](#footnote-379)378 and ***Colorado*** ranks fifth among states in total geothermal resource potential. [[379]](#footnote-380)379 According to the ***Colorado*** Geothermal Strategic Plan, the following characteristics make ***Colorado*** an optimum place for geothermal development: (1) **[\*324]** high heat flow; [[380]](#footnote-381)380 (2) volcanism; (3) recent faulting, and (4) continental rifting. [[381]](#footnote-382)381

Presently, geoexchange resources, including GHPs, heat and cool a number of ***Colorado*** State government buildings. [[382]](#footnote-383)382 ***Colorado*** offers financial incentives promoting demand side management technologies, including GHPs. [[383]](#footnote-384)383

3. Federal Geothermal Law and the Geothermal Steam Act

In 1970, Congress passed the Geothermal Steam Act, authorizing the Secretary of the Interior to issue leases and establish royalties for geothermal resources. [[384]](#footnote-385)384 In 1977, the Ninth Circuit Court resolved a fundamental resource ownership issue. [[385]](#footnote-386)385 The Ninth Circuit determined that although the federal government did not reserve geo-resources expressly, the United States had reserved the minerals when it conveyed the surface under the Stock-Homestead Raising Act of 1916, and determined that reservation would include subsurface fuel resources like geothermal. [[386]](#footnote-387)386

In 2005, the Energy Policy Act ("EPACT") amended the Geothermal Steam Act to streamline the process of leasing and development of federal geothermal resources by eliminating the previous two-tiered leasing system and implementing a competitive leasing system, including leasing for "direct use" systems for purposes other than commercial electricity generation. [[387]](#footnote-388)387 EPACT also sought to address a twenty year backlog in U.S. Forest Service geothermal leasing. [[388]](#footnote-389)388

In 2008, in response to the direction of EPACT, the BLM and the U.S. Forest Service issued a Programmatic Environmental Impact Statement regarding geothermal leasing on federal public lands. [[389]](#footnote-390)389 In addition to the monitoring activities that the BLM and the U.S. Forest Service must engage in while permitting geothermal development, the BLM and **[\*325]** U.S. Forest Service must apply stipulations to the leases in order to protect the integrity of the leased lands, particularly where geothermal operations are likely to cause significant adverse environmental effects pertaining to water quality and quantity. [[390]](#footnote-391)390 While federal protections for geothermal development operations and water quantity affect federal lands, the state also plays a major role in geothermal regulation. [[391]](#footnote-392)391

4. State Water Law and Geothermal Development

As discussed above (supra at Section IV(3)), in 2009, the ***Colorado*** Supreme Court declared that CBM produced water constituted a "beneficial use" under ***Colorado*** water law. [[392]](#footnote-393)392 Decades before the Vance v. Wolfe decision, the use of water as a material medium for geothermal production was codified as a beneficial use of water in ***Colorado***. [[393]](#footnote-394)393 Accordingly, geothermal resources, like CBM produced water, are subject to water court jurisdiction and are under the jurisdiction of the State Engineer. [[394]](#footnote-395)394 In order to develop geothermal resources from a well, at a minimum, a permit must be obtained from the State Engineer; [[395]](#footnote-396)395 and if the geothermal resource is determined to be tributary water, a water right must be obtained through the water court. [[396]](#footnote-397)396

5. Conflicts over BLM Leasing of Geothermal in ***Colorado***

The BLM offered geothermal leases in ***Colorado*** in 2009, [[397]](#footnote-398)397 but there was significant pushback in Salida and Mt. Princeton, ***Colorado***. [[398]](#footnote-399)398 In December of 2010, 3E Geothermal LLC of ***Colorado*** Springs successfully bid for a 30-year lease on a parcel of federal land near the Mt. Princeton Hot Springs. [[399]](#footnote-400)399 3E Geothermal has 10 years to develop the **[\*326]** geothermal resource, and the lease will continue beyond its primary term as long as3E Geothermal makes a beneficial use of that resource under ***Colorado*** water laws. [[400]](#footnote-401)400 Because 3E Geothermal, LLC is a subsidiary of the Christian ministry group Young Life, one of 60 private landowners in the Mt. Princeton area, there is speculation that 3E Geothermal purchased the geothermal lease in order to protect the area from geothermal development. [[401]](#footnote-402)401 Although BLM addressed and put stipulations in place to protect water resources in the area in the 2010 leases, the community opposed the lease based largely on concerns over the aesthetic effects of geothermal development and the placement of a geothermal power plant in the Chalk Creek Valley. [[402]](#footnote-403)402 On February 9, 2012 the BLM offered and sold two geothermal lease parcels, totaling 8,353.26 acres in Gunnison County. [[403]](#footnote-404)403 As before, the geothermal leases were purchased by a resort company, Double Heart Lodge, LLC whose owner is opposed to geothermal development adjacent to his property. [[404]](#footnote-405)404

Despite its environmental benefits relative to fossil-fuel power plants, and its constant energy availability in contrast to intermittent wind and solar resources, large-scale geothermal development is likely to continue to hit significant bumps and obstacles in ***Colorado***. This is due in part to the aesthetic effects on the resort communities in ***Colorado*** where the geothermal resource is most available, and in part to over-appropriated water resources.

[*V*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8T9R-T3X2-8T6X-731X-00000-00&context=1516831). CONCLUSION

From fossil fuels to renewable resources, all forms of energy development (with a few exceptions, such as wind energy) require water resources. As ***Colorado***'s population continues to increase, constraints on water resources will become more pronounced. As concerns over gaining control of domestic energy supplies and creating national energy security continue to increase, energy developers will continue to flock to **[\*327]** ***Colorado*** where a variety of energy resources are abundant. But where will the water come from? Some commentators have discussed the option of re-drafting some of the more constraining Compacts with other states, since ***Colorado***'s population growth is the highest in the Rocky Mountain West. Others simply suggest that Coloradans avoid jumping into development before a particular energy source is economically viable. However, such arguments fail to address development of resources that are currently economically viable, such as solar, geothermal, hydropower, coal, shale oil, and shale gas, and those arguments do not acknowledge the long-term and critical need of energy developers to plan for water supplies.

As the authors have illustrated, ***Colorado*** is fortunate in that it has a well-established mechanism for moving scarce water resources to new demands through market transactions. As water supplies have become more limited, water users have developed more innovative and cooperative ways to meet multiple water demands. The ***Colorado*** legislature has also assisted by creating statutory mechanisms, such as temporary water leasing, that enable water users to structure creative deals. The keys to integrating energy development into ***Colorado*** water demands include market-based solutions, as well as ongoing efforts to protect existing water rights decreed for energy development from loss or attrition due to federal or state regulatory action.

University of Denver Water Law Review

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82. 82 See id. [*§§34-33-101*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WXJ1-DYDC-J33D-00000-00&context=1516831) to -137. [↑](#footnote-ref-83)
83. 83 Id. at [*§ 34-33-120*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WXJ1-DYDC-J343-00000-00&context=1516831). [↑](#footnote-ref-84)
84. 84 Id. at [*§ 34-33-121(2)(a)(III)(i)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WXJ1-DYDC-J344-00000-00&context=1516831). [↑](#footnote-ref-85)
85. 85 Id. at [*§ 34-33-111(1)(m)(III)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WXJ1-DYDC-J33S-00000-00&context=1516831). [↑](#footnote-ref-86)
86. 86 ***Colo.*** Code Regs. § 407-2:4.24.1 (2007). [↑](#footnote-ref-87)
87. 87 Id. § 407-2:4.24.1. [↑](#footnote-ref-88)
88. 88 Id. § 407-2:4.24.3. [↑](#footnote-ref-89)
89. 89 Id. § 407-2:4.24.4(1)(c). [↑](#footnote-ref-90)
90. 90 C. Lowell Miller, U.S. Dep't of Energy, Clean Coal Technologies, Clear Air Legislation, and National Energy Strategy 1358-59, available at [*http://www.anl.gov/PCS/acsfuel/preprint%20archive/Files/Merge/V*](http://www.anl.gov/PCS/acsfuel/preprint%20archive/Files/Merge/V) ol-35\_4-0003.pdf. [↑](#footnote-ref-91)
91. 91 Cleaning Up Coal: The Clean Coal Technology, U.S. Dep't of Energy (last updated Mar. 29, 2011), [*http://www.fe.doe.gov/education/energylessons/coal/coal*](http://www.fe.doe.gov/education/energylessons/coal/coal) \_cct2.html. [↑](#footnote-ref-92)
92. 92 Cleaning Up Coal: Knocking the NOx out of Coal, U.S. Dep't of Energy (last updated Mar. 29, 2011), [*http://www.fe.doe.gov/education/energylessons/coal/coal*](http://www.fe.doe.gov/education/energylessons/coal/coal) \_cct3.html. [↑](#footnote-ref-93)
93. 93 Cleaning Up Coal: A "Bed" for Burning Coal?, U.S. Dep't of Energy, [*http://www.fossil.energy.gov/education/energylessons/coal/*](http://www.fossil.energy.gov/education/energylessons/coal/) coal\_cct4.html (Mar. 29, 2011). [↑](#footnote-ref-94)
94. 94 See Clean Coal Technology & The Clean Coal Power Initiative, U.S. Dep't of Energy [*http://www.fossil.energy.gov/programs/powersystems/cleancoal/*](http://www.fossil.energy.gov/programs/powersystems/cleancoal/) (last updated Oct. 04, 2011). [↑](#footnote-ref-95)
95. 95 Id., Cleaning Up Coal: Introduction to Coal Technology, U.S. Dep't of Energy, [*http://www.fossil.energy.gov/education/energylessons/coal/index.html*](http://www.fossil.energy.gov/education/energylessons/coal/index.html) (last updated Oct. 09, 2008). [↑](#footnote-ref-96)
96. 96 Water Needs Assessment, supra note 4, at 3-13. [↑](#footnote-ref-97)
97. 97 See World Nuclear Association, "Clean Coal" Technologies, Carbon Capture & Sequestration, [*http://world-nuclear.org/info/inf83.html*](http://world-nuclear.org/info/inf83.html) (last updated Dec. 2011). [↑](#footnote-ref-98)
98. 98 Preventing National Electricity-Water Crisis, supra note 37, at 376; see also Jeffrey Logan et. al., Opportunities and Challenges for Carbon Capture and Sequestration, WRI Issue Brief: Carbon Capture and Sequestration, Oct. 2007, at 2, available at http:// pdf.wri.org/opportunities-challenges-carbon-capture-sequestration.pdf (describing four different possible approaches to capturing ***CO***<2>). [↑](#footnote-ref-99)
99. 99 National Energy Technology Laboratory, U.S. Department of Energy, Carbon Sequestration FAQ Information Portal: Carbon Storage, [*http://www.netl.doe.gov/technologies/carbon\_seq/FAQs*](http://www.netl.doe.gov/technologies/carbon_seq/FAQs) /carbonstorage2.html (last visited Feb. 6, 2012). [↑](#footnote-ref-100)
100. 100 Preventing National Electricity-Water Crisis, supra note 37, at 377. [↑](#footnote-ref-101)
101. 101 See, e.g., Ground Water Prot. Council & ALL Consulting, U.S. Dep't of Energy, Modern Shale Gas Development in the United States: A Primer ES-3 (2009), available at [*http://www.netl.doe.gov/technologies/oilgas/publications/*](http://www.netl.doe.gov/technologies/oilgas/publications/) epreports/shale\_gas\_primer\_2009.pdf. [↑](#footnote-ref-102)
102. 102 Hydraulic Fracturing, ***Colo.*** Oil & Gas Ass'n., [*http://www.coga.org/index.php/Hydraulic%20Fracturing*](http://www.coga.org/index.php/Hydraulic%20Fracturing) (last visited Feb. 4, 2012). [↑](#footnote-ref-103)
103. 103 Fast Facts: The Niobrara, ***Colorado*** Oil & Gas Ass'n., [*http://www.coga.org/index.php/Hydraulic%20Fracturing*](http://www.coga.org/index.php/Hydraulic%20Fracturing) (follow "Niobrara" hyperlink) (last updated June 14, 2011); Piceance Basin - Green ***River*** Formation - ***Colorado*** Oil & Natural Gas Field, OilShaleGas.com, [*http://oilshalegas.com/piceancebasin.html*](http://oilshalegas.com/piceancebasin.html) (last visited Feb. 7, 2012). [↑](#footnote-ref-104)
104. 104 In 2011, there were 3,000 oil and gas well completions, accounting for 0.9 percent of the state's water use. Because the COGCC's focus on fracking has primarily dealt with water quality issues, at present, the only reason the Commission knows about water quantity - how much water a company uses is as a result of companies voluntarily sharing the information - the COGCC does not track the amount of water used separately. See Chris Woodka, State Bores Into Water Data for Oil Drilling, The Pueblo Chieftain (Dec. 13, 2011), [*http://www.chieftain.com/news/local/state-bores-into-water-data-for-oil-drilling/article\_91cd38ea-1274-11e1-*](http://www.chieftain.com/news/local/state-bores-into-water-data-for-oil-drilling/article_91cd38ea-1274-11e1-) 9802-001cc4c03286.html. [↑](#footnote-ref-105)
105. 105 ***Colorado*** Oil & Gas Association, Water Use Fast Facts, [*http://www.coga.org/index.php/Hydraulic%20Fracturing*](http://www.coga.org/index.php/Hydraulic%20Fracturing) (follow "Water Use" hyperlink) (last visited Feb. 7, 2012). [↑](#footnote-ref-106)
106. 106 Nat'l Energy Tech. Lab., U.S. Dept. of Energy, Shale Gas: Applying Technology to Solve America's Energy Challenges 3 (2011), available at [*http://www.netl.doe.gov/technologies/oilgas/publications/br*](http://www.netl.doe.gov/technologies/oilgas/publications/br) ochures/Shale\_Gas\_March\_2011.pdf. [↑](#footnote-ref-107)
107. 107 Id. [↑](#footnote-ref-108)
108. 108 Id. [↑](#footnote-ref-109)
109. 109 Id. at 4. [↑](#footnote-ref-110)
110. 110 Shale Oil, Halliburton, [*http://www.halliburton.com/ps/default.aspx?navid=1413&p*](http://www.halliburton.com/ps/default.aspx?navid=1413&p) ageid=4787 (last visited Feb. 5, 2012). [↑](#footnote-ref-111)
111. 111 Id. [↑](#footnote-ref-112)
112. 112 Id. [↑](#footnote-ref-113)
113. 113 Niobrara Play, Halliburton, [*http://www.halliburton.com/ps/default.aspx?navid=2280&pagei*](http://www.halliburton.com/ps/default.aspx?navid=2280&pagei) d=5180 (last visited Feb. 5, 2012). [↑](#footnote-ref-114)
114. 114 See Wyoming Geology: Coalbed Methane Information, Wyo. State Geological Survey, [*http://www.wsgs.uwyo.edu/GeologyBySubject/coalbed\_me*](http://www.wsgs.uwyo.edu/GeologyBySubject/coalbed_me) thane.aspx (last visited Feb. 5, 2012) [hereinafter Wyoming Geology]. [↑](#footnote-ref-115)
115. 115 See id. [↑](#footnote-ref-116)
116. 116 Environmental Protection Agency, Hydraulic Fracturing Research Study 1, 2 (2010), available at [*http://epa.gov/tp/pdf/hydraulic-fracturing-fact-sheet.pdf*](http://epa.gov/tp/pdf/hydraulic-fracturing-fact-sheet.pdf) [hereinafter EPA Fracking Study]. [↑](#footnote-ref-117)
117. 117 Id. at 1. [↑](#footnote-ref-118)
118. 118 Id. [↑](#footnote-ref-119)
119. 119 Id. [↑](#footnote-ref-120)
120. 120 Id. at 2. [↑](#footnote-ref-121)
121. 121 Id. [↑](#footnote-ref-122)
122. 122 Water Use Fast Facts, supra note 105, at 1. [↑](#footnote-ref-123)
123. 123 Id., at 3-4; EPA Fracking Study, supra note 116, at 2. [↑](#footnote-ref-124)
124. 124 See Bruce Finley, Fracking of wells puts big demand on ***Colorado*** water, Denver Post Nov. 23, 2011, available at [*http://www.denverpost.com/news/ci\_19395984*](http://www.denverpost.com/news/ci_19395984). [↑](#footnote-ref-125)
125. 125 See, e.g., id. [↑](#footnote-ref-126)
126. 126 Id. [↑](#footnote-ref-127)
127. 127 Id. [↑](#footnote-ref-128)
128. 128 Id. [↑](#footnote-ref-129)
129. 129 See Jeremy P. Meyer, S. Platte Water Rift Idles Land, Denver Post (June 29, 2007), [*http://www.denverpost.com/headlines/ci\_6256517*](http://www.denverpost.com/headlines/ci_6256517). [↑](#footnote-ref-130)
130. 130 See Jerd Smith, Platte ***River*** Use Studied, Rocky Mountain News (June 30, 2007), [*http://m.rockymountainnews.com/news/2007/jun/30/platte-****river****-use-studied*](http://m.rockymountainnews.com/news/2007/jun/30/platte-river-use-studied). [↑](#footnote-ref-131)
131. 131 See, e.g., [*Simpson v. Bijou Irrigation* ***Co****., 69 P.3d 50, 65, 72-3 (****Colo.*** *2003).*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:48GW-CRR0-0039-44HJ-00000-00&context=1516831) [↑](#footnote-ref-132)
132. 132 Application for Water Rights of Lower Logan Well Users, Inc., Case No. 03CW99, Water Court Division 1 (Feb. 2003); Application for Water Rights of Ground Water Management Subdistrict of Central ***Colorado*** Water Conservancy District, Case No. 02CW335, Water Court Division 1, 02CW335 (Dec. 2002). [↑](#footnote-ref-133)
133. 133 See Central ***Colorado*** Water Conservancy District, GMS Quota Raised to 40% (June 22, 2011), [*http://www.ccwcd.org/gms-quota-raised-to-40/*](http://www.ccwcd.org/gms-quota-raised-to-40/). [↑](#footnote-ref-134)
134. 134 Telephone Interview with Randy Ray, Executive Director, Central ***Colorado*** Water Conservancy District (April 4, 2012). [↑](#footnote-ref-135)
135. 135 Prairie Waters Project, FAQs, Aurora Water, [*http://www.prairiewaters.org/faqs.asp*](http://www.prairiewaters.org/faqs.asp) (last visited Feb. 21, 2012). [↑](#footnote-ref-136)
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137. 137 See, e.g., Chesapeake Energy Corp., Water Use in Niobrara Deep Shale Gas Exploration 1 (2012) available at [*http://www.chk.com/media/educational-library/fact-sheets/niobrara/niobrara\_water\_use\_fact&us*](http://www.chk.com/media/educational-library/fact-sheets/niobrara/niobrara_water_use_fact&us) core;sheet.pdf. [↑](#footnote-ref-138)
138. 138 Id. [↑](#footnote-ref-139)
139. 139 See Debra K. Higley & Dave O. Cox, U.S. Geological Survey, Oil and Gas Exploration and Development Along the Front Range in the Denver Basin of ***Colorado***, Nebraska and Wyoming 34 (2007) (explaining the scale of potential oil and gas development in the Denver basin). [↑](#footnote-ref-140)
140. 140 See Arkansas Valley Irrigators Incorporate "Super Ditch Company", Lower Ark. Valley Water Conservancy Dist., [*http://www.lavwcd.org/pressreleases/Arkansas-Valley-Irrigators-incorporate-Super-Ditch-Company.html*](http://www.lavwcd.org/pressreleases/Arkansas-Valley-Irrigators-incorporate-Super-Ditch-Company.html) (last visited Feb. 11, 2011) [hereinafter LAVWCD Plan]. [↑](#footnote-ref-141)
141. 141 Id. [↑](#footnote-ref-142)
142. 142 Id. [↑](#footnote-ref-143)
143. 143 According to the LAVWCD, it is expected that irrigators will forgo irrigation of approximately twenty five percent of their land and lease the water they do not use for municipal and other use. Feasibility studies show that 60,000 acre-feet or more of water can be available for lease each year. See LAVWCD Plan, supra note 140. [↑](#footnote-ref-144)
144. 144 See ***Colo.*** Rev. Stat. [*§ 37-92-301(2)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3FY-00000-00&context=1516831) (2012). [↑](#footnote-ref-145)
145. 145 See id. [*§ 37-92-309(1)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3G8-00000-00&context=1516831) ("This section is intended to enable water users to transfer the historical consumptive use of an absolute water right for application to another type or place of use on a temporary basis without permanently changing the water right."). [↑](#footnote-ref-146)
146. 146 Id. [↑](#footnote-ref-147)
147. 147 Id. [*§ 37-92-309(2)(a)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3G8-00000-00&context=1516831), (3)(c). [↑](#footnote-ref-148)
148. 148 Id. [*§ 37-92-309(3)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3G8-00000-00&context=1516831). [↑](#footnote-ref-149)
149. 149 Id. [*§ 37-92-309(3)(a)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3G8-00000-00&context=1516831). [↑](#footnote-ref-150)
150. 150 Id. [*§ 37-92-309(3)(b)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3G8-00000-00&context=1516831). [↑](#footnote-ref-151)
151. 151Produced water" is naturally occurring water that exists in the formation and is "produced" along with hydrocarbons. It is usually saline or high in total dissolved solids ("TDS"). In a fracked well, produced water mixes with hydraulic fracturing fluid returning to the surface. The mixture of produced water and hydraulic fracturing fluid "flow back" is generally referred to in this article as "produced water." NETL, Produced Water Management Information System: Introduction to Produced Water (last visited Feb. 11, 2011), [*http://www.netl.doe.gov/technologies/pwmis/intropw/index.html*](http://www.netl.doe.gov/technologies/pwmis/intropw/index.html) [hereinafter NETL Produced Water]. [↑](#footnote-ref-152)
152. 152 See Ken Cohen, "Fracking" Fluid Disclosure: Why It's Important, ExxonMobil Perspectives (Aug. 25, 2011), [*http://www.exxonmobilperspectives.com/2011/08/25/fracking-fluid-disclosure-why-its-important/*](http://www.exxonmobilperspectives.com/2011/08/25/fracking-fluid-disclosure-why-its-important/); cite to DOE SEAB August 2011 report that identified this as key. [↑](#footnote-ref-153)
153. 153 The COGCC is working to implement reuse plans between operators, and with the STRONGER Report recommendations, will institute guidelines and requirements for flowback pits in order to implement those reuse and recycle plans. STRONGER, ***Colorado*** Hydraulic Fracturing State Review 25 (October 2011) [hereinafter STRONGER Report]. [↑](#footnote-ref-154)
154. 154 See Fast Facts: Produced Water, at 2 ***Colorado*** Oil & Gas Association (June 14, 2011), [*http://www.coga.org/pdfs\_facts/produced\_water&usc*](http://www.coga.org/pdfs_facts/produced_water&usc) ore;fastfacts.pdf [hereinafter COGA Produced Water]. [↑](#footnote-ref-155)
155. 155 See id. [↑](#footnote-ref-156)
156. 156 Id. [↑](#footnote-ref-157)
157. 157 See [*33 U.S.C. § 1342*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8TXW-33X2-D6RV-H4D3-00000-00&context=1516831) (2008). [↑](#footnote-ref-158)
158. 158 Produced Water Treatment and Beneficial Use Information Center, State Regulations: ***Colorado*** [*http://aqwatec.mines.edu/produced\_water/regs/state/****co****/in*](http://aqwatec.mines.edu/produced_water/regs/state/co/in) dex.htm (last visited Feb. 11, 2012). [↑](#footnote-ref-159)
159. 159 COGA Produced Water, supra note 154, at 2. [↑](#footnote-ref-160)
160. 160 Natural Gas Water Usage Facts: Water Recycling, Chesapeake Energy [*http://www.naturalgaswaterusage.com/Water-Recycling/Pages/information.aspx*](http://www.naturalgaswaterusage.com/Water-Recycling/Pages/information.aspx) (last visited Feb. 11, 2012). [↑](#footnote-ref-161)
161. 161 Gayathri Vaidyanathan, Alternatives to fresh water eyed for fracturing, E&E News GREENWIRE, Mar. 6, 2012, [*http://connect.sierraclub.org/ActivistNetwork/home*](http://connect.sierraclub.org/ActivistNetwork/home) ["Teams", search "Hydrofracking Team", see March 6, 2012 dispatch]. [↑](#footnote-ref-162)
162. 162 Id. [↑](#footnote-ref-163)
163. 163 STRONGER Report, supra note 153, at 17. [↑](#footnote-ref-164)
164. 164 Compare Water Use in Niobrara Deep Shale Gas Exploration, Chesapeake Energy Fact Sheet 1, at 1 (September 2011), [*http://www.chk.com/Media/Educational-Library/Fact-*](http://www.chk.com/Media/Educational-Library/Fact-) Sheets/Niobrara/Niobrara\_Water\_Use\_Fact&us core;Sheet.pdf. (Fracing a single Niobrara deep shale well requires an average of 4 million gallons of water), with Well Completion & Hydraulic Fracturing: Piceance Basin, ***Colorado***, Encana Natural Gas, (April 2011), [*http://www.encana.com/pdf/communities/usa/wellcompletionandhydr*](http://www.encana.com/pdf/communities/usa/wellcompletionandhydr) aulicfracturing(Piceance).pdf. (the water requirement for fracing a well in the Piceance Basin is about 1.2 million gallons of water). [↑](#footnote-ref-165)
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166. 166 U.S. DEP'T OF INTERIOR, BUREAU OF RECLAMATION, Oil and Gas Produced Water Management and Beneficial Use in the Western United States, Sept. 2011, available at [*http://www.usbr.gov/research/AWT/reportpdfs/report157.pdf*](http://www.usbr.gov/research/AWT/reportpdfs/report157.pdf). [↑](#footnote-ref-167)
167. 167 ***COLORADO*** GEOLOGICAL SURVEY, Coalbed Methane Stream Depletion Assessment Study - Piceance, Basin, ***Colorado***, April 2008, available at [*http://geosurvey.state.****co****.us/water/CBM%20Water%20Depletion/Docu*](http://geosurvey.state.co.us/water/CBM%20Water%20Depletion/Docu) ments/Piceance\_Final\_Report.pdf. [↑](#footnote-ref-168)
168. 168 Gary Bryner, Coalbed Methane Development in the Intermountain West: Producing Energy and Protecting Water, ***4 Wyo. L. Rev. 541, 543 (2004).*** [↑](#footnote-ref-169)
169. 169 See Wyoming Geology, supra note 114 (For more information on the biological processes of bacteria-produced CBM). [↑](#footnote-ref-170)
170. 170 Bryner, supra note 168, at 543. [↑](#footnote-ref-171)
171. 171 Wyoming Geology, supra note 114. [↑](#footnote-ref-172)
172. 172 Id. [↑](#footnote-ref-173)
173. 173 Bryner, supra note 168, at 543. [↑](#footnote-ref-174)
174. 174 Id. at 541-42. [↑](#footnote-ref-175)
175. 175 Id. at 542. [↑](#footnote-ref-176)
176. 176 Id. at 543. [↑](#footnote-ref-177)
177. 177 See Bryner, supra note 168, at 549-550. [↑](#footnote-ref-178)
178. 178 [*Simpson v. Bijou Irrigation* ***Co****., 69 P.3d 50, 59 n.7 (****Colo.*** *2003).*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:48GW-CRR0-0039-44HJ-00000-00&context=1516831) [↑](#footnote-ref-179)
179. 179 ***Colo.*** Rev. Stat. [*§ 37-92-502*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:637R-W883-GXJ9-334R-00000-00&context=1516831) (2011). [↑](#footnote-ref-180)
180. 180 ***Colo.*** Rev. Stat. [*§ 37-90-137(1)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:689F-SN93-GXF6-81VM-00000-00&context=1516831); Id. [*§ 37-90-103(21)(a)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:68BY-DJC3-GXF6-82XJ-00000-00&context=1516831). [↑](#footnote-ref-181)
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182. 182 Dave Colvin et al., Origins of Produced Water Regulations in ***Colorado*** - A Brief History, AWRA - ***Colorado***, [*http://awracolorado.havoclite.com/newsletter/brief-history-of-produced-water-in-****colorado****/*](http://awracolorado.havoclite.com/newsletter/brief-history-of-produced-water-in-colorado/). [↑](#footnote-ref-183)
183. 183 Holly Franz & Rebecca W. Watson, Produced Water: Water Rights and Water Quality: "A "Meeting' of the Waters"? Rocky Mtn. Min. L. Found. Inst., Chapter 12, at 12-8 (2006) available at [*http://wsmtlaw.com/publications/*](http://wsmtlaw.com/publications/). [↑](#footnote-ref-184)
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186. 186 Mark Jaffe, Drilling Requires Water Permits, Denver Post (Apr. 21, 2009), [*http://www.denverpost.com/headlines/ci\_12187563*](http://www.denverpost.com/headlines/ci_12187563). [↑](#footnote-ref-187)
187. 187 [*Statement of Basis, supra*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3S4X-16V0-0039-M51P-00000-00&context=1516831) note 181, at 2. [↑](#footnote-ref-188)
188. 188 ***Colo.*** Rev. Stat. [*§§37-90-137*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:689F-SN93-GXF6-81VM-00000-00&context=1516831) (2011); [*§ 37-90-138(2)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3DG-00000-00&context=1516831) (establishing a reasonable period of delay - until April 30, 2010 - before oil and gas wells must obtain Ground Water Act permits); [*§ 37-92-308(11)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3G7-00000-00&context=1516831) (providing an additional transition period - until December 31, 2012 - wherein operators of CBM wells that withdraw tributary groundwater could obtain approval for substitute water plans without having to file applications for plans to augmentation in water court). [↑](#footnote-ref-189)
189. 189 [*Statement of Basis, supra*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3S4X-16V0-0039-M51P-00000-00&context=1516831) note 181, at 2. [↑](#footnote-ref-190)
190. 190 Id. at 2-3. [↑](#footnote-ref-191)
191. 191 See Jaffe, supra note 186 (noting that energy companies are disappointed with the ruling, but that it only affects wells using nontributary groundwater). [↑](#footnote-ref-192)
192. 192 ***Colo.*** Rev. Stat. [*§ 37-90-103(10.5)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:68BY-DJC3-GXF6-82XJ-00000-00&context=1516831) (2011). [↑](#footnote-ref-193)
193. 193 ***Colo.*** Rev. Stat. [*§ 37-92-305(11)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J3G3-00000-00&context=1516831) (2011). [↑](#footnote-ref-194)
194. 194 [*Statement of Basis, supra*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3S4X-16V0-0039-M51P-00000-00&context=1516831) note 181, at 1-3. [↑](#footnote-ref-195)
195. 195 See id. [↑](#footnote-ref-196)
196. 196 For example, the San Juan Basin ranges from 550 to 4,000 feet in depth, and parts of the Piceance Basin are up to 6,000 feet deep. Envtl. Prot. Agency, Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs Study 5-2 to 5-3 (2004), available at [*http://water.epa.gov/type/groundwater/uic/class2/hydraulicf*](http://water.epa.gov/type/groundwater/uic/class2/hydraulicf) racturing/wells\_coalbedmethanestudy.cfm. [↑](#footnote-ref-197)
197. 197 For instance, after 30 years of mining the West Decker Mine in Montana, 10 feet of drawdown were recorded at a distance of about 5 miles from the mine. John Wheaton & John Metesh, Potential Ground-Water Drawdown and Recovery from Coalbed Methane Development in the Powder ***River*** Basin, Montana 13 (2002), available at [*http://www.blm.gov/pgdata/etc/medialib/blm/mt/field\_*](http://www.blm.gov/pgdata/etc/medialib/blm/mt/field_) offices/miles\_city/og\_eis/techdocs.Par.26011. File.tmp/CBM3DGWReport.pdf. [↑](#footnote-ref-198)
198. 198 [*Statement of Basis, supra*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3S4X-16V0-0039-M51P-00000-00&context=1516831) note 181, at 3. [↑](#footnote-ref-199)
199. 199 Id. at 3-4. [↑](#footnote-ref-200)
200. 200 Id. at 11-34. [↑](#footnote-ref-201)
201. 201 See id. at 1-3. [↑](#footnote-ref-202)
202. 202 Id. at 2-3. [↑](#footnote-ref-203)
203. 203 Carrie Covington Doyle, The Modern Oil Shale Boom: An Opportunity for Thoughtful Mineral Development, [*20* ***Colo.*** *J. Int'l Envtl. L. & Pol'y 253, 254 (2009).*](https://advance.lexis.com/api/document?collection=analytical-materials&id=urn:contentItem:4X0N-C800-00CV-H00R-00000-00&context=1516831) [↑](#footnote-ref-204)
204. 204 About Oil Shale, Oil Shale and Tar Sands Programmatic EIS Info. Ctr., [*http://ostseis.anl.gov/guide/oilshale/index.cfm*](http://ostseis.anl.gov/guide/oilshale/index.cfm) (last visited Feb. 9, 2011). [↑](#footnote-ref-205)
205. 205 Covington Doyle, supra note 203, at 261-62. [↑](#footnote-ref-206)
206. 206 Id. at 262. See also Bureau of Land Management, U.S. Dep't of the interior, FES 08-32, Proposed Oil Shale and Tar Sands Resource Management Plan Amendments to Address land Use Allocations in ***Colorado***, Utah, and Wyoming and Final Programmatic Environmental Impact Statement (2008), available at [*http://ostseis.anl.gov/*](http://ostseis.anl.gov/). [↑](#footnote-ref-207)
207. 207 See Water Needs Assessment, supra note 4 at 3-26. [↑](#footnote-ref-208)
208. 208 See Center for the American West, What Every Westerner Should Know About Oil Shale, [*http://www.centerwest.org/publications/oilshale/2history/1boom*](http://www.centerwest.org/publications/oilshale/2history/1boom). php (last visited Feb. 8, 2012) [hereinafter Every Westerner]. [↑](#footnote-ref-209)
209. 209 Id. [↑](#footnote-ref-210)
210. 210 Most hold senior rights from the 1950s, but some hold water rights from as far back as the 1890s. See Lawrence J. MacDonnell, Western Res. Advocates, Water on the Rocks: Executive Summary, available at [*http://www.westernresourceadvocates.org/land/wotrreport/ind*](http://www.westernresourceadvocates.org/land/wotrreport/ind) ex.php. [↑](#footnote-ref-211)
211. 211 See Steve Lipsher, ***Colorado***'s oil shale draws Shell's interest, The Houston Chronicle (May 11, 2008), [*http://www.chron.com/business/energy/article/****Colorado****-s-oil-shale-draws-Shell-s-interest-1785278.php*](http://www.chron.com/business/energy/article/Colorado-s-oil-shale-draws-Shell-s-interest-1785278.php). [↑](#footnote-ref-212)
212. 212 See Shell, Operations Overview, [*http://www.shell.us/home/content/usa/aboutshell/shell\_*](http://www.shell.us/home/content/usa/aboutshell/shell_) businesses/upstream/ (last visited Feb. 6, 2012). [↑](#footnote-ref-213)
213. 213 The Colony Oil Project in Parachute Creek was spearheaded by Exxon in the early 1980s after the oil embargo in the 1970s fanned the flames of fear over reliance on foreign oil. After the oil bust in 1982, Exxon shut down the Colony Oil Project - a $ 5 billion project. See Anthony Andrews, Congressional Research Service, Developments in oil shale, at CRS-29 (2008), available at [*http://www.fas.org/sgp/crs/misc/RL34748.pdf*](http://www.fas.org/sgp/crs/misc/RL34748.pdf). [↑](#footnote-ref-214)
214. 214 Id. at Summary; Energy Policy Act of 2005 § 369, Pub. L. No. 109-58 (2005). [↑](#footnote-ref-215)
215. 215 Andrews, supra note 213. [↑](#footnote-ref-216)
216. 216 See Ctr. for the Am. W., We'll Get it Right Next Time: Commercial Leasing (last visited Jan. 23, 2011), available at [*http://www.centerwest.org/publications/oilshale/4getitright/2co*](http://www.centerwest.org/publications/oilshale/4getitright/2co) mmercial.php#30 [hereinafter Get It Right] [↑](#footnote-ref-217)
217. 217 Energy Policy Act § 369(d). [↑](#footnote-ref-218)
218. 218 Get It Right, supra note 217. [↑](#footnote-ref-219)
219. 219 See Bureau of Land Mgmt., Details on the Oil Shale & Tar Sands PEIS, [*http://www.blm.gov/wo/st/en/prog/energy/oilshale\_2/PEIS*](http://www.blm.gov/wo/st/en/prog/energy/oilshale_2/PEIS) \_details.html (last visited Feb 9, 2012). [↑](#footnote-ref-220)
220. 220 Id. [↑](#footnote-ref-221)
221. 221 See Stephen Power, Interior Secretary Scraps Oil-Shale Leasing, The Wall Street Journal (Feb. 25, 2009), available at [*http://online.wsj.com/article/SB123560039534376131.html*](http://online.wsj.com/article/SB123560039534376131.html). [↑](#footnote-ref-222)
222. 222 Get It Right, supra note 216. [↑](#footnote-ref-223)
223. 223 Press Release, Bureau of Land Mgmt., Salazar: Technology, Water Supplies, and Fair Return Must Guide Nation's Oil Shale Program (Feb. 5, 2011), available at [*http://www.blm.gov/wo/st/en/info/newsroom/2011/february/NR\_*](http://www.blm.gov/wo/st/en/info/newsroom/2011/february/NR_) 02\_15\_2011.html. [↑](#footnote-ref-224)
224. 224 Notice of Intent to Prepare a Programmatic Environmental Impact Statement (EIS) and Possible Land Use Plan Amendments for Allocation of Oil Shale and Tar Sands Resources on Lands Administered by the Bureau of Land Management in ***Colorado***, Utah, and Wyoming, [*76 Fed. Reg. 21003*](https://advance.lexis.com/api/document?collection=administrative-codes&id=urn:contentItem:52ND-MKN0-006W-80WR-00000-00&context=1516831) (proposed April 14, 2011), available at [*http://www.blm.gov/wo/st/en/prog/energy/oilshale\_2.html*](http://www.blm.gov/wo/st/en/prog/energy/oilshale_2.html). [↑](#footnote-ref-225)
225. 225 Id. See also U.S. Gov't Accountability Office, GAO-11-35, Energy-Water Nexus: A Better Coordinated Understanding of Water Resources Could Help Mitigate the Impacts of Potential Oil Shale Development (2010), available at [*http://www.gao.gov/products/GAO-11-35*](http://www.gao.gov/products/GAO-11-35). [↑](#footnote-ref-226)
226. 226 Fed. Reg. (Feb 3, 2012) available at [*http://http://ostseis.anl.gov/documents/index.cfm*](http://ostseis.anl.gov/documents/index.cfm) (***Colorado*** lands open to federal oil shale leasing were reduced by approximately ninety percent - 350,000 acres to 35,308). Bruce Finley, "Federal officials scale back plan to open Rocky Mountain land to shale development," Denver Post (Feb. 3, 2012). [↑](#footnote-ref-227)
227. 227 Shell, supra note 212, at ***Colorado***. [↑](#footnote-ref-228)
228. 228 Covington Doyle, supra note 203, at 263. [↑](#footnote-ref-229)
229. 229 Id. [↑](#footnote-ref-230)
230. 230 Andrews, supra note 213, at CRS-7. [↑](#footnote-ref-231)
231. 231 Covington Doyle, supra note 203, at 264. [↑](#footnote-ref-232)
232. 232 Get It Right, supra note 216. [↑](#footnote-ref-233)
233. 233 [*About Oil Shale, supra*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3XD9-D0F0-0039-4550-00000-00&context=1516831) note 204. [↑](#footnote-ref-234)
234. 234 Water on the Rocks: Executive Summary, supra note 210, at xiii. [↑](#footnote-ref-235)
235. 235 Initial process water requirement estimates of 2.1 to 5 barrels of water per barrel of oil developed in the 1970s has declined to the present estimated 1 to 3 barrels of water per produced barrel of oil shale. See DOE Office of Petroleum Reserves, Fact Sheet: Oil Shale Water Resources, fossil.energy.gov/.../reserves/npr/Oil\_Shale \_Water\_Requirements.pdf (last visited Jan. 23, 2011). [↑](#footnote-ref-236)
236. 236 ***Colorado*** ***River*** Water Conservancy Dist., Energy Development Water Needs Assessment: Phase II Final Report, at iii (Feb. 2011), [*http://www.crwcd.org/media/uploads/Energy\_Development*](http://www.crwcd.org/media/uploads/Energy_Development) \_Water\_Needs\_Assessment\_Phase\_I I\_Final\_Report.pdf. [hereinafter CRWCD Report]. [↑](#footnote-ref-237)
237. 237 Id. at iii. [↑](#footnote-ref-238)
238. 238 Id. at iv. [↑](#footnote-ref-239)
239. 239 Water on the Rocks: Executive Summary, supra note 210, at v. [↑](#footnote-ref-240)
240. 240 Energy companies have also acquired full or partial ownership of over 100 existing irrigation ditches, with rights to divert more than 650 cfs for oil shale deposits. See id. [↑](#footnote-ref-241)
241. 241 Id. at xiv ("Energy companies own large portions of the water rights historically used to irrigate lands in the region...Should oil shale move beyond the research phase, many...of these rights would be changed in use, and the lands historically irrigated would be taken out of agriculture."). [↑](#footnote-ref-242)
242. 242 An outcome of oil shale development would be the displacement of existing uses to new oil-shale-related uses with senior priorities - as some of these rights date back to the 1950's, more junior uses would be affected in western ***Colorado*** and the ***Colorado*** Front Range. See id. [↑](#footnote-ref-243)
243. 243 As increased consumption would increase the risk of a "call" by the Lower ***Colorado*** Basin states against the Upper Basin, decreasing the legal availability of water under the 1922 ***Colorado*** ***River*** Compact's associated laws and requirements. See id. [↑](#footnote-ref-244)
244. 244 According to the U.S. Fish and Wildlife Service, additional depletions from the ***Colorado*** ***River*** Basin would jeopardize the continued existence of four species of fish - any new water development program would be required to follow regulations associated with protection of the endangered fish. See id. [↑](#footnote-ref-245)
245. 245 [*Mun. Subdistrict, N.* ***Colo.*** *Water Conservancy Dist. v. Getty Oil Exploration* ***Co****., 997 P.2d 557 (****Colo.*** *2000);*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:400W-YF60-0039-40V7-00000-00&context=1516831) [*Mun. Subdistrict, N.* ***Colo.*** *Water Conservancy Dist. v. OXY USA, Inc., 990 P.2d 701 (****Colo.*** *1999);*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3Y3R-HFP0-0039-419S-00000-00&context=1516831) [*Mun. Subdistrict, N.* ***Colo.*** *Water Conservancy Dist. v. Chevron Shale Oil* ***Co****., 986 P.2d 918 (****Colo.*** *1999).*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3XD9-D0F0-0039-4550-00000-00&context=1516831) [↑](#footnote-ref-246)
246. 246 [*OXY, 990 P.2d at 705-06.*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3Y3R-HFP0-0039-419S-00000-00&context=1516831) [↑](#footnote-ref-247)
247. 247 [*Id. at 707-08.*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3Y3R-HFP0-0039-419S-00000-00&context=1516831) [↑](#footnote-ref-248)
248. 248 [*Id. at 711-12.*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3Y3R-HFP0-0039-419S-00000-00&context=1516831) [↑](#footnote-ref-249)
249. 249 In re Yellow Jack Water Conservancy Dist., No. 09CW48, 09CW50 (***Colo.*** Dist. Ct., Water Div. No. 6, July 1, 2011) [↑](#footnote-ref-250)
250. 250 ***Colorado*** Supreme Court Case No. 2011SA306 and 2011SA307, Consolidated into Case No. 2011SA306. [↑](#footnote-ref-251)
251. 251 Dennis Webb, Oil Shale Water Rights Nullified, Grand Junction Sentinel, July 1, 2011, available at [*http://www.gjsentinel.com/special\_sections/articles/oil*](http://www.gjsentinel.com/special_sections/articles/oil) \_shale\_water\_rights\_\_nullif. [↑](#footnote-ref-252)
252. 252 See Press Release, Western Res. Advocates, Coalition Praises Decision to Terminate Oil Shale Water Rights: Decision Upholds Agric. Traditions and Healthy ***Rivers*** (July 5, 2011), available at [*http://www.westernresourceadvocates.org/media/archive11/YellowJ*](http://www.westernresourceadvocates.org/media/archive11/YellowJ) acketwaterrights7-5-11.pdf. [↑](#footnote-ref-253)
253. 253 Get It Right, supra note 216, at 19. [↑](#footnote-ref-254)
254. 254 Id. at 19-20. [↑](#footnote-ref-255)
255. 255 Id. [↑](#footnote-ref-256)
256. 256 Joseph Glennon & Andrew Reeves, Solar Energy's Cloudy Future, [*1 Ariz. J. Envtl. L. & Pol'y 91, 105 (2010);*](https://advance.lexis.com/api/document?collection=analytical-materials&id=urn:contentItem:53MX-41N0-01DR-N0J4-00000-00&context=1516831) In 2012, U.S. Department of Energy, Secretary Chu noted the cost of solar panels have dropped four-fold over the past three years and he predicted those prices would likely fall by another 50% in the next eight years. Platts, Inside Energy at 11 (April 16, 2012). [↑](#footnote-ref-257)
257. 257 [*Id. at 106.*](https://advance.lexis.com/api/document?collection=analytical-materials&id=urn:contentItem:53MX-41N0-01DR-N0J4-00000-00&context=1516831) [↑](#footnote-ref-258)
258. 258 See generally Energy.gov, Department of Energy Awards More Than $ 145 Million for Advanced Solar Technologies (Sept. 1, 2011), available at [*http://energy.gov/articles/department-energy-awards-more-145-million-advanced-solar-technologies*](http://energy.gov/articles/department-energy-awards-more-145-million-advanced-solar-technologies). Despite its intense focus on developing renewable energy standards for electric utilities, California is also very strict about the use of water in clean energy projects. In addition to the requirement that solar developers not use any drinking-quality groundwater, they are encouraged to embrace dry-cooling technologies and to sign a power purchase agreement with a utility before applying for a license application with the California Energy Commission. See Todd Woody, Rules for Clean Energy Projects in California, green.blogs.nytimes.com (October 2, 2009), available at [*http://green.blogs.nytimes.com/2009/10/02/clean-energy-project-rules-for-california/#more-26091*](http://green.blogs.nytimes.com/2009/10/02/clean-energy-project-rules-for-california/#more-26091). [↑](#footnote-ref-259)
259. 259 Glennon & Reeves, supra note 256, at 97; U.S. Department of Energy, Energy Basics, "Thermal Storage Systems for Concentrating Solar Power" explaining the use of molten salt for solar storage, available at [*http://www.eere.energy.gov/basics/renewable\_energy/t*](http://www.eere.energy.gov/basics/renewable_energy/t) hermal\_storage.html. [↑](#footnote-ref-260)
260. 260 Id. at 97. [↑](#footnote-ref-261)
261. 261 Id. [↑](#footnote-ref-262)
262. 262 Id. at 99-100 (Various closed-loop CSP technologies consume between 750-920 gal/mWh. This is compared to approximately 300-480 gal/mWh for fossil fuels, 100-180 gal/mWh for natural gas, and 400-720 for nuclear. Solar does beat out geothermal, which consumes 1400 gal/mWh.). [↑](#footnote-ref-263)
263. 263 Bureau of Land Mgmt., California Desert Conservation Area Plan Amendment, Final Environmental Impact Statement: Ivanpah Solar Electric Generating System, FEIS-10-31 (2010), available at [*http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/needles/l*](http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/needles/l) ands\_solar.Par.79875.File.tmp/Ivanpah%20FEIS%20exec%20sum.pdf. [↑](#footnote-ref-264)
264. 264 See Bureau of Land Mgmt, Crescent Dunes Solar Project Environmental Impact Statement, Jan. 7, 2011), available at [*http://www.blm.gov/nv/st/en/fo/battle\_mountain\_fi*](http://www.blm.gov/nv/st/en/fo/battle_mountain_fi) eld/blm\_information/national\_environmental/cresce nt\_dunes\_solar.html. See also Paul Denholm and Mark Mehos, Enabling Greater Penetration of Solar Power via the Use of CSP Energy Storage, National Renewable Energy Laboratory, Nov. 2011, available at [*http://www.nrel.gov/csp/pdfs/52978.pdf*](http://www.nrel.gov/csp/pdfs/52978.pdf). [↑](#footnote-ref-265)
265. 265 John Farrell, When Picking Solar Options, It's the Water, Stupid, CleanTechnica (Aug. 5, 2011), available at [*http://cleantechnica.com/2011/08/05/when-picking-solar-power-options-its-the-water-stupid/*](http://cleantechnica.com/2011/08/05/when-picking-solar-power-options-its-the-water-stupid/). [↑](#footnote-ref-266)
266. 266 Reuters, Solar Thermal Plants Scrap Steam for Photovoltaic, cnet.com (July 1, 2011), available at [*http://news.cnet.com/8301-11128\_3-20076065-54/solar-thermal-plants-scrap-steam-for-photovoltaic/*](http://news.cnet.com/8301-11128_3-20076065-54/solar-thermal-plants-scrap-steam-for-photovoltaic/). [↑](#footnote-ref-267)
267. 267 Id. [↑](#footnote-ref-268)
268. 268 But compare SEIA, New Report Finds U.S. Solar Energy Installations Soared by 109% in 2011 to 1,855 Megawatts (March 14, 2012), [*http://www.seia.org/cs/news\_detail?pressrelease.id=2000*](http://www.seia.org/cs/news_detail?pressrelease.id=2000). 2011 was a record year for PV installation. While the US saw no new CSP projects last year, 10 new PV projects came online. At the end of 2011, cumulative PV capacity reached nearly 4,000 MW in 2011. [↑](#footnote-ref-269)
269. 269 See Bureau of Land Mgmt., Solar Draft Programmatic Environmental Impact Statement, 10.1-1 (December 2010), available at [*http://solareis.anl.gov/documents/dpeis/Solar\_DPEIS\_*](http://solareis.anl.gov/documents/dpeis/Solar_DPEIS_) ***Colorado***\_SEZs.pdf [hereinafter Solar DPEIS]; Solar Supplemental Programmatic Environmental Impact Statement C-79 (October 2011), available at [*http://solareis.anl.gov/documents/supp/index.cfm*](http://solareis.anl.gov/documents/supp/index.cfm). [↑](#footnote-ref-270)
270. 270 Id. [↑](#footnote-ref-271)
271. 271 Id. at 10.1-57. [↑](#footnote-ref-272)
272. 272 Id. at 10.1-57. [↑](#footnote-ref-273)
273. 273 Id. at 10.1-59. [↑](#footnote-ref-274)
274. 274 The Bureau of Land Management notes that the "viability of a solar project will depend on its ability to obtain water rights" in the SLV. Id. at 10.1-61. [↑](#footnote-ref-275)
275. 275 Id. at 10.1-61 to -62. [↑](#footnote-ref-276)
276. 276 Id. at 10.1-66. In compliance with ***COLO.*** REV. STAT. ANN. [*§ 25-8-204*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WW41-DYDC-J2DX-00000-00&context=1516831) (1981). [↑](#footnote-ref-277)
277. 277 Solar DPEIS, supra note 270, at 10.1-66. [↑](#footnote-ref-278)
278. 278 Smith, supra note 9. [↑](#footnote-ref-279)
279. 279 Sara Burnett and Mark Jaffe, Sprawling solar plant on tap for San Luis Valley, THE DENVER POST, March 27, 2012, [*http://www.denverpost.com/breakingnews/ci\_20262088/s*](http://www.denverpost.com/breakingnews/ci_20262088/s) prawling-solar-plant-tap-san-luis-valley. [↑](#footnote-ref-280)
280. 280 Position Paper, SAN LUIS VALLEY ECOSYTEM COUNCIL, [*http://www.slvec.org/images/stories/docs/Final.Position\_*](http://www.slvec.org/images/stories/docs/Final.Position_) paper4F1.pdf (last visited Feb. 9, 2012). [↑](#footnote-ref-281)
281. 281 Solar DPEIS, supra 270, at 10.1-61. This federal-state policy tug of war over energy and water is not unique to ***Colorado***. In 2010, Arizona Senator Jon Kyle issued a policy report on the state of solar energy development on federal lands in his state, stating: "Placing additional demands on Arizona's water supply in order to export "renewable energy' to other states that have greater energy demands is unsustainable. Arizona should not become a solar energy farm for the rest of the country, especially when its water supply is limited and it is currently in the midst of a long-term drought." OFFICE OF SENATOR JON KYL, DEPLOYING SOLAR POWER IN THE STATE OF ARIZONA: A BRIEF OVERVIEW OF THE SOLAR-WATER NEXUS 18 (2010), available at [*http://www.circleofblue.org/waternews/wp-content/uploads/2010/08/solar-water1.pdf*](http://www.circleofblue.org/waternews/wp-content/uploads/2010/08/solar-water1.pdf) . [↑](#footnote-ref-282)
282. 282 Solar DPEIS, supra note 270, at 10.1-61. [↑](#footnote-ref-283)
283. 283 Rio Grande Water Conservancy Dist., Proposed Plan Of Water Mgmt. 5 (2009), available at [*http://www.rgwcd.org/attachments/File/Plan\_of\_Wat*](http://www.rgwcd.org/attachments/File/Plan_of_Wat) er\_Management\_51109.pdf [hereinafter RGWCD PROPOSED PLAN]. [↑](#footnote-ref-284)
284. 284 See id. at 7-8. [↑](#footnote-ref-285)
285. 285 Id. at 6, 10. [↑](#footnote-ref-286)
286. 286 ***COLO.*** REV. STAT. ANN. [*§ 37-48-126(1)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:61P5-WY01-DYDC-J2WF-00000-00&context=1516831) (1975). [↑](#footnote-ref-287)
287. 287 Plan of Water Mgmt., RIO GRANDE WATER CONSERVATION DIST., available at [*http://www.rgwcd.org/page6.html*](http://www.rgwcd.org/page6.html) (last visited Jan. 23, 2012). [↑](#footnote-ref-288)
288. 288 Solar DPEIS, supra note 270, at 10.1-61; see also RGWCD PROPOSED PLAN, supra 284, at 10. [↑](#footnote-ref-289)
289. 289 RGWCD PROPOSED PLAN, supra 284, at 10-11. [↑](#footnote-ref-290)
290. 290 Id. at 8. [↑](#footnote-ref-291)
291. 291 Id. at 6. [↑](#footnote-ref-292)
292. 292 Solar DPEIS, supra note 269, at 10.1-61 to -62 [↑](#footnote-ref-293)
293. 293 K. K. DUVIVIER, THE RENEWABLE ENERGY READER 125-27 (2011). [↑](#footnote-ref-294)
294. 294 Id. at 125. [↑](#footnote-ref-295)
295. 295 Id. at 125-26. [↑](#footnote-ref-296)
296. 296 Id. at 126. However, some estimates show from five percent up to ten percent of United States electricity generated from hydropower. See, Carpe Diem - Western Water & Climate Project, Herding Cats: Dealing with Uncertainty and Many, Many Shareholders - Panel III, Summary of Proceedings 11 (2010). [↑](#footnote-ref-297)
297. 297 Hydro makes up 3.7 percent of the ten percent of electricity generated from renewables in ***Colorado***. Wind - at 6.3 percent - generated the most of other renewables. U.S. Energy Info. Admin., Summary Renewable Electric Power Industry Statistics (July 2011), available at [*http://www.eia.gov/cneaf/solar.renewables/page/state\_*](http://www.eia.gov/cneaf/solar.renewables/page/state_) profiles/pdfstate/***colorado***.pdf. [↑](#footnote-ref-298)
298. 298 Totals are from 2005 to 2009 data, reported in July 2011. Id. [↑](#footnote-ref-299)
299. 299 DuVivier, supra note 294, at 126. [↑](#footnote-ref-300)
300. 300 Volumes are written on the issues associated with hydropower and its effects on fish, particularly salmon. See generally Michael C. Blumm, Erica J. Thorson, & Joshua D. Smith, Practiced at the Art of Deception: The Failure of Columbia Basin Salmon Recovery Under the Endangered Species Act, [*36 Envtl. L. 709 (2006).*](https://advance.lexis.com/api/document?collection=analytical-materials&id=urn:contentItem:4M1M-2B40-00CW-B01C-00000-00&context=1516831) [↑](#footnote-ref-301)
301. 301 See, infra page 52, the Shoshone Hydro Plant; Chrissy Sloan, The Effect of the Shoshone and Cameo Calls on the Roaring Fork Watershed, Roaring Fork Conservancy 1 (2004), available at [*www.roaringfork.org/images/other/shoshone.pdf*](http://www.roaringfork.org/images/other/shoshone.pdf). [↑](#footnote-ref-302)
302. 302 U.S. Dep't of Interior, Bureau of Reclamation, Power Res.Office, Reclamation: Managing Water in the West - Hydroelectric Power 3 (2005) [hereinafter Power Resources Office]. [↑](#footnote-ref-303)
303. 303 Id. [↑](#footnote-ref-304)
304. 304 The DOI's analogy is helpful for understanding the role of dams: "The reservoir acts much like a battery, storing water to be released as needed to generate power." Id. [↑](#footnote-ref-305)
305. 305 Id. at 4. [↑](#footnote-ref-306)
306. 306 Id. [↑](#footnote-ref-307)
307. 307 Id. at 7. [↑](#footnote-ref-308)
308. 308 Id. at 4. [↑](#footnote-ref-309)
309. 309 Id. at 5. [↑](#footnote-ref-310)
310. 310 [*16 U.S.C. § 792*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8S8T-0KF2-8T6X-74M1-00000-00&context=1516831) (2006). [↑](#footnote-ref-311)
311. 311 See Sarah C. Richardson, The Changing Political Landscape of Hydropower Project Relicensing, 25 Wm. & Mary Envtl. l & Pol'y rev. 499, 511 (2000). [↑](#footnote-ref-312)
312. 312 [*16 U.S.C. § 797*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8S8T-0KF2-8T6X-74M7-00000-00&context=1516831)(e). [↑](#footnote-ref-313)
313. 313 See id. [↑](#footnote-ref-314)
314. 314 [*16 U.S.C. § 808*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8S8T-0KF2-8T6X-74MS-00000-00&context=1516831)(a)(1). [↑](#footnote-ref-315)
315. 315 See, e.g., [*North Carolina v. Fed. Energy Regulatory Comm'n, 112 F.3d 1175, 1189 (D.C. Cir. 1997)*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3S4X-GWW0-00B1-D2XK-00000-00&context=1516831) (finding that the withdrawal from Virginia Beach waters did not constitute a "discharge" under the CWA, and so FERC was not required to obtain a § 401 certificate in its relicensing process). [↑](#footnote-ref-316)
316. 316 US Fish & Wildlife Service, Hydropower: Examples of Accomplishments, [*http://www.fws.gov/habitatconservation/hydropower.html*](http://www.fws.gov/habitatconservation/hydropower.html) (last accessed Feb. 26, 2012). [↑](#footnote-ref-317)
317. 317 Id. [↑](#footnote-ref-318)
318. 318 [*Trout Unlimited v. U.S. Dep't of Agric., 320 F. Supp. 2d 1090, 1109 (D.* ***Colo.*** *2004).*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:4D02-S660-0038-Y258-00000-00&context=1516831) [↑](#footnote-ref-319)
319. 319 [*Id. at 1102.*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:4D02-S660-0038-Y258-00000-00&context=1516831) [↑](#footnote-ref-320)
320. 320 Id. [↑](#footnote-ref-321)
321. 321 [*Id. at 1106.*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:4D02-S660-0038-Y258-00000-00&context=1516831) [↑](#footnote-ref-322)
322. 322 Federal Energy Regulatory Comm'n., Order Issuing Subsequent License, Project No. 2275-002 (Issued May, 1997), available at [*http://www.ferc.gov/industries/hydropower.asp*](http://www.ferc.gov/industries/hydropower.asp) [hereinafter Salida Hydro License]. [↑](#footnote-ref-323)
323. 323 Id. at 12, 22. [↑](#footnote-ref-324)
324. 324 Id. at 12-13. [↑](#footnote-ref-325)
325. 325 Federal Energy Regulatory Comm'n., Order Issuing New License, Project No. 12589-001 (Issued Jan, 2010), available at [*http://www.ferc.gov/industries/hydropower/gen-info/licensing/issued-licenses.asp*](http://www.ferc.gov/industries/hydropower/gen-info/licensing/issued-licenses.asp) [hereinafter Tacoma Hydro License]. [↑](#footnote-ref-326)
326. 326 Id. at 8. [↑](#footnote-ref-327)
327. 327 Id. at 5, 14-15, 42. [↑](#footnote-ref-328)
328. 328 Chrissy Sloan, The Effect of the Shoshone and Cameo Calls on the Roaring Fork Watershed, Roaring Fork Conservancy 1 (Nov. 1, 2004), [*www.roaringfork.org/images/other/shoshone.pdf*](http://www.roaringfork.org/images/other/shoshone.pdf). [↑](#footnote-ref-329)
329. 329 Id. at 1; Donna Gray, Generating Electricity since 1909, Glenwood Springs Post Independent (Oct. 1, 2006), [*http://www.postindependent.com/article/20061001/VALLEYNEWS/*](http://www.postindependent.com/article/20061001/VALLEYNEWS/) 110010029 [↑](#footnote-ref-330)
330. 330 Sloan, supra note 329, at 1; Gray, supra note 330. [↑](#footnote-ref-331)
331. 331 Sloan, supra note 329, at 1. [↑](#footnote-ref-332)
332. 332 Id. [↑](#footnote-ref-333)
333. 333 Id. [↑](#footnote-ref-334)
334. 334 Id. [↑](#footnote-ref-335)
335. 335 Id. at 1-2. [↑](#footnote-ref-336)
336. 336 Id. [↑](#footnote-ref-337)
337. 337 Agreement Concerning Reduction of Shoshone Call (Mar. 13, 2006), available at [*http://www.crwcd.org*](http://www.crwcd.org) (follow "Public Information" hyperlink; then select "Shoshone Agreement"; then select "Agreement" hyperlink in the text) [hereinafter Shoshone Call Agreement]. [↑](#footnote-ref-338)
338. 338 Id. at 2-3. [↑](#footnote-ref-339)
339. 339 See id. at 4-5. [↑](#footnote-ref-340)
340. 340 Shoshone Power Plant and Xcel-Denver Franchise Agreement, ***Colo.*** ***River*** Water Conservation Dist., available at [*http://www.crwcd.org/media/uploads/Shoshone\_agreemen*](http://www.crwcd.org/media/uploads/Shoshone_agreemen) t\_06\_facts.pdf (last visited Feb. 12, 2012) [hereinafter Xcel-Denver Franchise Agreement]. [↑](#footnote-ref-341)
341. 341 See ***Colorado*** ***River*** Cooperative Agreement, ***Colo.*** ***River*** Water Conservatory Dist. (April 28, 2011 proposed agreement), [*http://www.crwcd.org/media/uploads/20110428\_CRAC\_*](http://www.crwcd.org/media/uploads/20110428_CRAC_) mediation\_agreement.pdf, 1, 36, 37-38, 40 [hereinafter ***Colorado*** ***River*** Cooperative Agreement]. [↑](#footnote-ref-342)
342. 342 See id. at 33-41. [↑](#footnote-ref-343)
343. 343 Proposed ***Colorado*** ***River*** Cooperative Agreement: Path to a Secure Water Future, Denver Water (last visited Feb. 3, 2012), [*http://www.denverwater.org/SupplyPlanning/Planning/****Colorado***](http://www.denverwater.org/SupplyPlanning/Planning/Colorado) RiverCooperativeAgreement. [↑](#footnote-ref-344)
344. 344 Id. [↑](#footnote-ref-345)
345. 345 Id. [↑](#footnote-ref-346)
346. 346 Bob Berwyn, ***Colorado***: Transmountain Water Deal Still on Hold, Summit County Citizen's Voice (Dec. 30, 2011), [*http://summitcountyvoice.com/2011/12/30/****colorado****-transmountain-water-deal-still-on-hold*](http://summitcountyvoice.com/2011/12/30/colorado-transmountain-water-deal-still-on-hold). [↑](#footnote-ref-347)
347. 347 There are a number of associations and groups working in ***Colorado*** on small hydropower systems that will not produce hydropower on a commercial scale. See generally ***Colo.*** Small Hydro Ass'n, [*http://www.smallhydro.****co***](http://www.smallhydro.co) (last visited Feb. 11, 2012); ***Colo.*** Small Hydro Working Group, [*http://coloradohydro.groupsite.com/main/summary*](http://coloradohydro.groupsite.com/main/summary) (last visited Feb. 11, 2012); Small Hydropower Loan Program, ***Colo.*** Water Resources and Power Dev. Auth., [*http://www.cwrpda.com/SHLPsubmenu.htm*](http://www.cwrpda.com/SHLPsubmenu.htm) (last visited Feb. 3, 2012). [↑](#footnote-ref-348)
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349. 349 Case Study: The Benefits of Small Hydro in Boulder, Chelsea Green Pub. (April 12, 2009), [*http://www.chelseagreen.com/content/case-study-the-benefits-of-small-hydro-in-boulder-****colorado***](http://www.chelseagreen.com/content/case-study-the-benefits-of-small-hydro-in-boulder-colorado). [↑](#footnote-ref-350)
350. 350 Bob Berwyn, Aspen Hydropower Plan Triggers Green v. Green Tussel, Summit County Citizen's Voice (Dec. 22, 2011), [*http://summitcountyvoice.com/2011/12/22/aspen-hydropower-plan-triggers-green-v-green-tussle*](http://summitcountyvoice.com/2011/12/22/aspen-hydropower-plan-triggers-green-v-green-tussle). [↑](#footnote-ref-351)
351. 351 Wendell A. Duffield & John H. Sass, U.S. Dep't of Interior, U.S. Geological Survey, Geothermal Energy: Clean Power From the Earth's Heat 2 (2003). [↑](#footnote-ref-352)
352. 352 Id. [↑](#footnote-ref-353)
353. 353 DuVivier, supra note 294, at 219 (quoting U.S. Secretary of Energy Steven Chu). [↑](#footnote-ref-354)
354. 354 George Vranesh & John D. Musick Jr., Geothermal Resources: Water and Other Conflicts Encountered by the Developer - An Alternative Energy Source Which Is "Gathering Steam", 13 Land & Water L. Rev. 109, 121-22 (1977). [↑](#footnote-ref-355)
355. 355 Bureau of Land Mgmt. & U.S. Forest Serv., Geothermal Programmatic Environmental Impact Statement: Geothermal Leasing in the United States, 1-3 to 1-4, 1-6 (2008). [↑](#footnote-ref-356)
356. 356 Duffield Sass, supra note 352, at 21. [↑](#footnote-ref-357)
357. 357 Donald J. Kochan & Tiffany Grant, In the Heat of the Law, It's Not Just Steam: Geothermal Resources and the Impacts on Thermophile Biodiversity, 13 Hastings W.-Nw. J. Envtl. L. & Pol'y 35, 42 (2007) (explaining that dry steam resources are the most readily usable form of geothermal energy). [↑](#footnote-ref-358)
358. 358 Id. [↑](#footnote-ref-359)
359. 359 Id. [↑](#footnote-ref-360)
360. 360 Id. at 43. [↑](#footnote-ref-361)
361. 361 See Alyssa Kagel, Diana bates & Karl Gawell, Geothermal Energy Ass'n, A Guide to Geothermal Energy and the Environment 5 (2007). [↑](#footnote-ref-362)
362. 362 Id. at 5-6. [↑](#footnote-ref-363)
363. 363 Geothermal Basics, Geothermal Energy Ass'n, [*http://geo-energy.org/Basics.aspx#how\_plant\_work*](http://geo-energy.org/Basics.aspx#how_plant_work) (last visited Jan. 29, 2012). [↑](#footnote-ref-364)
364. 364 Duffield & Sass, supra note 352, at 10, 22. [↑](#footnote-ref-365)
365. 365 Id. at 22. [↑](#footnote-ref-366)
366. 366 Id. at 17. [↑](#footnote-ref-367)
367. 367 Id. [↑](#footnote-ref-368)
368. 368 Id. at 21. [↑](#footnote-ref-369)
369. 369 GHPs offer opportunity for significant energy savings (up to seventy five percent), and can help reduce peak demand for power. Worldwide, there are more than five hundred thousand GHPs, for an output of seven thousand megawatts (U.S. output is five thousand megawatts). See Duffield & Sass, supra note 352, at 21. [↑](#footnote-ref-370)
370. 370 Glennon & Reeves, supra note 256, at 99-100. [↑](#footnote-ref-371)
371. 371 According to the USGS, The Geysers can generate one thousand megawatts of electricity. See Duffield & Sass, supra note 352, at 7. However, the authors do not address the commercially limiting issues associated with voluminous water consumption. Id. Cf. Glennon & Reeves, supra note 256, at 99-100; the Geysers has acquired and uses heated waste water to fuel the facility. "Santa Rosa (treated) Waste Water Facility Geothermal Reservoirs at the Geysers" (September 14, 2010). See LXRICHTER, Santa Rosa Treated Waste Water Fueling Geothermal Reservoirs at the Geysers, Think Geoenergy, Sept. 24, 2010, [*http://thinkgeoenergy.com/archives/5783*](http://thinkgeoenergy.com/archives/5783). [↑](#footnote-ref-372)
372. 372 Elizabeth C. Battocletti & William E. Glassley, Measuring the Costs and Benefits of Nationwide Geothermal Heat Pump Deployment, GHC Bulletin, Nov. 2010, at 4, available at [*http://geoheat.oit.edu/bulletin/bull29-3/art2.pdf*](http://geoheat.oit.edu/bulletin/bull29-3/art2.pdf). [↑](#footnote-ref-373)
373. 373 Id. [↑](#footnote-ref-374)
374. 374 Id. at 5. [↑](#footnote-ref-375)
375. 375 Id. at 4. [↑](#footnote-ref-376)
376. 376 Geopowering the West ***Colo.*** State Working Group, ***Colorado*** Geothermal Development: Strategic Plan, at 7 (August 2007) [hereinafter ***Colo.*** Geothermal Dev. Strategic Plan], available at [*http://geosurvey.state.****co****.us/SiteCollectionDocuments/Energy*](http://geosurvey.state.co.us/SiteCollectionDocuments/Energy) Resources/Geothermal/ColoradoGeothermalDevelopmentStratPlan.pdf. [↑](#footnote-ref-377)
377. 377 Id. at 10. The committee bases this observation on Alaska's production of economically competitive geothermal electricity via binary power plants where well temperatures are 165 degrees Fahrenheit. Id. However, the competitive electric utility market in ***Colorado*** makes this less economically viable. Id. [↑](#footnote-ref-378)
378. 378 The City of Aspen & Pitkin Cnt'y, [*http://aspenpitkin.com/Living-in-the-Valley/Green-Initiatives/Renewable-Energy/Geothermal/*](http://aspenpitkin.com/Living-in-the-Valley/Green-Initiatives/Renewable-Energy/Geothermal/) (last visited Jan. 29, 2012). The City of Aspen is conducting a geothermal test project to determine whether geothermal direct use is a viable option for its portfolio. Id. The project will resume in 2012. Id. [↑](#footnote-ref-379)
379. 379 ***Colo.*** Geothermal Dev. Strategic Plan, supra note 377, at 11. [↑](#footnote-ref-380)
380. 380***Colorado*** has the second largest areal heat flow anomaly in North America … [which] predominantly coincides with the mountainous central and western portions of ***Colorado***." ***Colo.*** Geothermal Dev. Strategic Plan, supra note 377, at 9. [↑](#footnote-ref-381)
381. 381 Id. at 11. [↑](#footnote-ref-382)
382. 382 Id. at 7. [↑](#footnote-ref-383)
383. 383 Id. at 29. ***Colorado*** enacted geothermal financial incentives under House Bill 07-1037. Id. [↑](#footnote-ref-384)
384. 384 Geothermal Steam Act of 1970, [*30 U.S.C.§§1001*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:8S9D-WCR2-8T6X-73HT-00000-00&context=1516831)-04 (2011). [↑](#footnote-ref-385)
385. 385 [*United States v. Union Oil* ***Co****. of Cal., 549 F.2d 1271, 1272 (9th Cir. 1977).*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3S4X-16V0-0039-M51P-00000-00&context=1516831) [↑](#footnote-ref-386)
386. 386 [*Id. at 1277.*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:3S4X-16V0-0039-M51P-00000-00&context=1516831) [↑](#footnote-ref-387)
387. 387 Energy Policy Act of 2005, Pub. L. No. 109-58,§§221-37, ***119 Stat. 594, 660-74 (2205);*** see also, Geothermal Leasing Under the Energy Policy Act of 2005, U.S. Dep't of Interior, Bureau of Land Mgmt. (Oct. 9, 2008), available at [*http://www.blm.gov/wo/st/en/info/regulations/Instruction\_*](http://www.blm.gov/wo/st/en/info/regulations/Instruction_) Memos\_and\_Bulletins/national\_instruction/ 2009/IM\_2009-022.html. [↑](#footnote-ref-388)
388. 388 Energy Policy Act of 2005 § 225(b)(3). [↑](#footnote-ref-389)
389. 389 U.S. Dep't of Interior, Bureau of Land Mgmt., Geothermal Programmatic Environmental Impact Statement 1 (2008), available at [*http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS\_*](http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS_) \_REALTY\_\_AND\_RESOURCE\_PRO TECTION\_/energy/geothermal\_eis/final\_ programmatic.Par.41814.File.dat/Volume\_I\_FINAL.pdf. [↑](#footnote-ref-390)
390. 390 Id. at 2-19. [↑](#footnote-ref-391)
391. 391 See Elizabeth Doris, Claire Kreycik, Katherine Young, Nat'l Renewable Energy Lab. Policy Overview and Options for Maximizing the Role of Policy in Geothermal Electricity Development, 16,18 (2009), available at [*http://www.nrel.gov/docs/fy10osti/46653.pdf*](http://www.nrel.gov/docs/fy10osti/46653.pdf). [↑](#footnote-ref-392)
392. 392 [*Vance v. Wolfe, 205 P.3d 1165, 1169 (****Colo.*** *2009);*](https://advance.lexis.com/api/document?collection=cases&id=urn:contentItem:7VM5-7FF1-2R6J-232N-00000-00&context=1516831) see also C.R.S.A. [*§ 37-92-103(4)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:689F-SY73-CGX8-03R2-00000-00&context=1516831) (West 2012). [↑](#footnote-ref-393)
393. 393 ***Colo.*** Rev. Stat. Ann. [*§ 37-90.5-107(1)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:689F-SSN3-CGX8-03PS-00000-00&context=1516831). [↑](#footnote-ref-394)
394. 394 See generally id. [*§ 37-90.5-107*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:689F-SSN3-CGX8-03PS-00000-00&context=1516831). [↑](#footnote-ref-395)
395. 395 Id. [*§ 37-90.5-107(2)(a)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:689F-SSN3-CGX8-03PS-00000-00&context=1516831). [↑](#footnote-ref-396)
396. 396 Id. [*§ 37-90.5-104(1)*](https://advance.lexis.com/api/document?collection=statutes-legislation&id=urn:contentItem:689F-SN93-GXF6-81VN-00000-00&context=1516831), -107(1). [↑](#footnote-ref-397)
397. 397 The BLM notes on its leasing websites that BLM leases do not authorize ground-disturbing activities to explore for or develop geothermal resources without further application, environmental review, and approval by the BLM. See Gunnison Field Office Geothermal Lease Nomination, Bureau of Land Mgmt. (Aug. 11, 2011), available at [*http://www.blm.gov/****co****/st/en/fo/gfo/geothermal\_lease&usco*](http://www.blm.gov/co/st/en/fo/gfo/geothermal_lease&usco) re;nomination.html. [↑](#footnote-ref-398)
398. 398 See Trey, BLM Defers Mt. Princeton Geothermal Lease Sale, The Salida Citizen (Nov. 12, 2009), [*http://salidacitizen.com/2009/11/blm-defers-mt-princeton-geothermal-lease-sale/*](http://salidacitizen.com/2009/11/blm-defers-mt-princeton-geothermal-lease-sale/). [↑](#footnote-ref-399)
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400. 400 Id. [↑](#footnote-ref-401)
401. 401 Id.; Mark Jaffe, Geothermal Lease Set to Go in ***Colorado***: Hurdles Cleared, the BLM Will Offer 799 Acres in Chaffee County, The Denver Post (Sept. 6, 2010), available at [*http://www.denverpost.com/business/ci\_16086540.Jaffe.</N*](http://www.denverpost.com/business/ci_16086540.Jaffe.</N) T2> [↑](#footnote-ref-402)
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403. 403 Mark Jaffe, BLM to Offer New Oil and Gas and Geothermal Leases in ***Colorado***, The Denver Post (Nov. 9, 2011), available at [*http://blogs.denverpost.com/thebalancesheet/2011/11/09/blm-to-offer-new-oil-and-gas-and-geothermal-leases-in-****colorado****/1658/*](http://blogs.denverpost.com/thebalancesheet/2011/11/09/blm-to-offer-new-oil-and-gas-and-geothermal-leases-in-colorado/1658/). [↑](#footnote-ref-404)
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