LOVELAND CITY COUNCIL
STUDY SESSION
TUESDAY, APRIL 24, 2012
CITY COUNCIL CHAMBERS
500 EAST THIRD STREET
LOVELAND, COLORADO

THE CITY OF LOVELAND DOES NOT DISCRIMINATE ON THE BASIS OF DISABILITY, RACE, CREED, COLOR, SEX, SEXUAL ORIENTATION, RELIGION, AGE, NATIONAL ORIGIN, OR ANCESTRY IN THE PROVISION OF SERVICES. FOR DISABLED PERSONS NEEDING REASONABLE ACCOMMODATION TO ATTEND OR PARTICIPATE IN A CITY SERVICE OR PROGRAM, CALL 962-2343 OR TDD # 962-2620 AS FAR IN ADVANCE AS POSSIBLE.

6:30 P.M. **STUDY SESSION - City Council Chambers**

1. **<u>Economic Development</u>** **(60 minutes)**
Downtown Strategic Plan Review
Staff will review the Downtown Strategic Plan, Infrastructure Plan and Downtown Vision Book. Together, the documents have been used to guide the actions of City staff in the ongoing Downtown revitalization effort over the past four years.

2. **<u>Water & Power</u>** **(60 minutes)**
Water For Hydraulic Fracturing
Information on the impacts of supplying Loveland municipal water for hydraulic fracturing (fracking) will be presented in two parts. The first provides background information regarding the city's policies on leasing and selling water, focusing on water to be used for hydraulic fracturing (fracking). The second section will present information from Platte River Power Authority (PRPA) regarding water leasing opportunities which would provide water for fracking.

ADJOURN

CITY OF LOVELAND
ECONOMIC DEVELOPMENT OFFICE
Civic Center • 500 East Third • Loveland, Colorado 80537
(970) 962-2304 • FAX (970) 962-2900 • TDD (970) 962-2620

AGENDA ITEM: **1**
MEETING DATE: 4/24/2012
TO: City Council
FROM: Mike Scholl, Economic Development Department
PRESENTER: Mike Scholl

TITLE: Downtown Strategic Plan Review

DESCRIPTION:
Staff will review the Downtown Strategic Plan, Infrastructure Plan and Downtown Vision Book. Together, the documents have been used to guide the actions of City staff in the ongoing Downtown revitalization effort over the past four years.

BUDGET IMPACT:
☐ Positive
☐ Negative
☒ Neutral or negligible

SUMMARY:
Loveland City Council approved the Downtown Strategic Plan as part of the City's Comprehensive Master Plan in 2009. Since that time it has been used to guide the efforts of staff in the Downtown Revitalization effort. Staff will review the elements of the plan; review the successes, and next steps. Staff will also review the Infrastructure Plan and the Downtown Vision Book.

REVIEWED BY CITY MANAGER: William D Cahill

LIST OF ATTACHMENTS: (to view the attachments electronically double click on the title)
A. Downtown Strategic Plan
B. Downtown Infrastructure Plan
C. Downtown Vision Book

CITY OF LOVELAND
WATER & POWER DEPARTMENT
200 North Wilson • Loveland, Colorado 80537
(970) 962-3000 • FAX (970) 962-3400 • TDD (970) 962-2620

AGENDA ITEM:	**2**
MEETING DATE:	4/24/2012
TO:	City Council
FROM:	Steve Adams, Director, Water & Power
PRESENTER:	Larry Howard, Senior Civil Engineer/Water Resources Greg Dewey, Civil Engineer/Water Resources

TITLE: Water For Hydraulic Fracturing (a.k.a. 'Fracking')

RECOMMENDED CITY COUNCIL ACTION:
Discuss and provide staff with feedback and comments.

DESCRIPTION:
Impacts of supplying Loveland municipal water for hydraulic fracturing

BUDGET IMPACT:
☐ Positive
☐ Negative
☒ Neutral or negligible – This is a discussion item only.

SUMMARY:

This information is presented in two parts. The first provides background information regarding the city's policies on leasing and selling water, focusing on water to be used for hydraulic fracturing (fracking). The second section will present information from Platte River Power Authority (PRPA) regarding water leasing opportunities which would provide water for fracking. These leasing opportunities will be considered at the PRPA board meeting on May 30, 2012.

<u>City policies on leasing and selling water:</u>

> *The question for consideration is the following: Should the city continue its current policy which allows the lease or sale of treated or raw water to be used for the purpose of hydraulic fracturing?*

Council has recently requested information about the use of water for hydraulic fracturing (fracking) purposes in the oil and gas industry. Staff provides water through leases for various legal uses, and water haulers known to supply water to oil and gas drillers regularly purchase water from the City. This water is supplied through hydrant meters in the same manner used for construction purposes.

Staff provides water through hydrant meters and through leases in a number of ways, briefly described as follows:

Typical Raw Water Leases:

1. Agriculture, including farmers and the city parks and open spaces: Shares or rights from ditch companies are usually leased on an annual basis, at approximately the cost to the city for assessments, for raw water irrigation. Prices will vary according to supply and demand and throughout the season, typically becoming less valuable as the season progresses. About 800 acre-feet is used each year for parks, and hundreds more acre-feet are typically leased to farmers, depending on annual demands.
2. Augmentation: These leases place raw water in the river to mitigate the effects other diversions, such as wells or evaporation from gravel pits, cause on the river. The water provided must be carefully managed by city staff, which also provides the appropriate accounting to prove water is used from sources which may legally be used for this purpose. Leases for substitute supply plans often extend for up to three years. Water may also be required as a permanent source for decreed augmentation plans. Gravel pit owners are frequent customers, as they are under direction from the state to augment for their impacts on the river from evaporation of the ponds often exposed during the mining process. This water is much more valuable, and is commonly leased for $400/acre-foot annually.

Typical Treated Water Sales:

1. Ranch water: A metered connection is provided on the Service Center site, allowing customers to fill mobile tanks with treated water for use as desired. This source is sometimes used for construction projects, and is commonly used to fill tanks for hauling water to cisterns at homes located where domestic water service is unavailable and a well is not a feasible water source. Water is currently sold at $1.00/300 gallons, and customers are not required to provide raw water to the City for treatment.
2. Construction meters:
   - Temporary meters are set on hydrants around the city for developers to use during construction projects. Water is currently sold at $1.00/300 gallons, and developers are not required to provide raw water to the city for treatment.
   - Water haulers taking water for fracking also take water from seven temporary meters located on hydrants in the east part of the city. They pay the same $1.00/300 gallons, but in addition, through leases they have provided an equivalent quantity of raw water to the city for treatment, in addition to paying for the metered water.

Water used for hydraulic fracturing is mixed with proprietary components and pumped into the ground under pressures high enough to open small fissures for a limited area surrounding the drill bore through which gas and oil will flow, allowing their recovery. Sand in the fracking mixture serves to prevent the openings from closing back up when the pressure is released.

Only water which may legally be used under Colorado law is applied toward meeting this demand. The process is commonly used in the promising Niobrara shale formations, about 5000 to 7000 feet below the surface of significant portions of northeastern Colorado, southeastern Wyoming, and western Kansas and Nebraska, several thousand feet lower than the depth of wells used for water. Properly casing and grouting the wells prevents contamination of the surface water supplies.

Loveland's current annual supplies of water are in excess of 24,000 acre-feet, and are projected to be over 27,000 acre-feet when the Windy Gap Firming Project is completed. Current demands vary from year to year, in a range from about 12,000 acre-feet to 15,000 acre-feet, so water above the city's demands is available. The city actively leases raw water and sells metered hydrant water as described previously to generate revenues when there is opportunity. Water which the city provides to water haulers that is used for fracking purposes is meeting a temporary demand and is only leased on a temporary basis. No long term commitments have been requested or made for this purpose. The city can end the leases as needed to meet its own demand for water in the future.

Drilling a new oil or gas well reportedly requires between five and fifteen acre-feet of water, and older wells may be treated a number of years later to enhance flows as production declines. Statewide, less than 0.1% of water use is required for fracking. Between 30% and 80% of water pumped into the wells while drilling is recovered as 'flowback', and returns to the surface during approximately the first week of production. The percentage recovered as flowback is commonly referred to as being in excess of 50%. It is separated from the petroleum products and treated to allow reusing the majority of the water for further well fracking operations. Following treatment, the unused portion of the water is injected into the geologic formations, evaporated from ponds, or released to surface streams or lakes, depending on the conditions.

In addition, oil and gas wells commonly provide what is referred to as 'produced' water, which is 'new' water from the shale formation brought to the surface through the extraction process over the life of the well. This produced water tends to increase as a percentage of the total pumped production as wells age.

The city currently reports totals of all hydrant meters, which includes water haulers and water provided for construction. Below are the total volumes delivered and amounts of money the City earned from all sales and/or rentals of municipal water through hydrant meters and the ranch water station over the last two years:

2010		
Hydrant and ranch water sales	32,668,975 gallons (100 af)	$128,052
Total metered sales by the city	4,155,300,000 gallons (12,752 af)	
	0.8% of total	
2011		
Hydrant and ranch water sales	27,905,059 gallons (87 af)	$112,038
Total metered sales by the city	4,317,800,000 gallons (13,251 af)	
	0.6% of total	

In summary, leasing this water poses no risk to the city's long term raw water supplies, and in the short term provides a significant source of income from this municipal asset.

Platte River Power Authority lease opportunities

The question for consideration is the following: Is Council in favor of having water from Platte River Power Authority made available for lease to haulers or drillers for the purpose of hydraulic fracturing?

As outlined in Attachment 5, the PRPA board learned of raw water leasing opportunities. After preliminary discussion, it was determined that each board member would seek further input from their respective communities. Action on this item was then scheduled for May 30, 2012.

Bill Emslie, project Engineer for PRPA, will be at the city council study session and will provide an update to this request of PRPA so the Loveland City Council can then have a discussion.

REVIEWED BY CITY MANAGER: William D Cahill

LIST OF ATTACHMENTS:

1. Copy of the PowerPoint presentation slides for the meeting
2. *Water Sources and Demand for the Hydraulic Fracturing of Oil and Gas Wells in Colorado from 2010 through 2015*, a report prepared jointly by the Colorado Division of Water Resources, the Colorado Water Conservation Board, and the Colorado Oil and Gas Conservation Commission.
3. *Hydraulic Fracturing: the Process*, a paper by FracFocus, of the Chemical Disclosure Registry.
4. Colorado Oil and Gas (COGA) *Fast Facts* Information on:
    - Hydraulic Fracturing White Paper
    - Seismic Activity Fast Facts
    - Hydraulic Fracturing Disclosure Fast Facts
    - Truth about Gasland Fast Facts
    - HF-Fluids Exciting Clean and Green Developments
5. Platte River Power Authority March 21, 2012, board agenda item on Surplus Water Leasing Policy

Water for Hydraulic Fracturing (aka Fracking)

City of Loveland, CO

City Council Study Session

April 24, 2012

Today's Goal

Staff seeks Council's input on two questions:

1. Should the City of Loveland continue to provide raw or treated water to support fracking?
2. Should the City of Loveland support the leasing of Platte River Power Authority's water for fracking operations?

Agenda

- Water Fracking Use in Colorado
- City of Loveland water leasing
- Two questions
- Discussion by Platte River Power Authority staff

What is Hydraulic Fracturing?

- Hydraulic fracturing is the process of creating small cracks, or fractures, in underground geological formations to allow oil and natural gas to flow into the wellbore and thereby increase productions.
- To fracture the formation special proprietary fluids are injected at high pressure down the well.
- These fluids typically consist of about 90% water, 9.5% sand and 0.5% chemicals.

Retrieved April 11, 2012 from
http://images.coloradoindependent.com/Oil_and_Gas_Water_Sources_Fact_Sheet.pdf

How much water does Hydraulic Fracturing require?

Less than 1/10 of 1% of Colorado's total water use.

Sector	2010 Use (Acre-Feet/Yr)[4]	Percent of State Total
Total	**16,359,700**	
Agriculture	13,981,100	85.5%
Municipal and Industrial	1,218,600	7.4%
Total All Others	1,160,000	7.1%
Breakdown of "All Others"		
Total All Others	**1,160,000**	
Recreation	923,100	5.64%
Large Industry	136,000	0.83%
Thermoelectric Power Generation	76,600	0.47%
Hydraulic Fracturing	13,900	0.08%
Snowmaking	5,300	0.03%
Coal, Natural Gas, Uranium, and Solar Development	5,100	0.03%
Oil Shale Development	0	0.00%

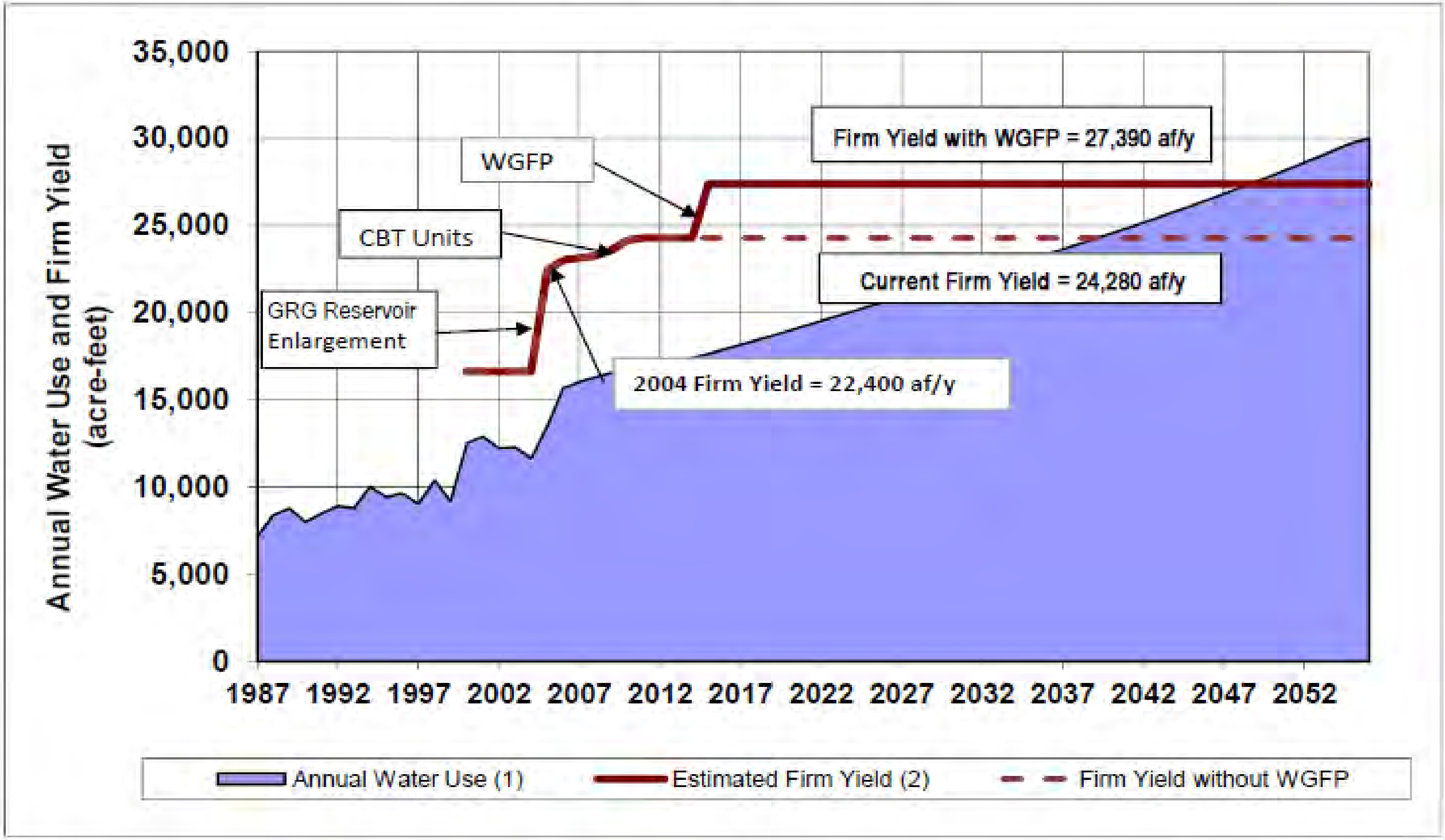
Retrieved April 11, 2012 from http://images.coloradoindependent.com/Oil_and_Gas_Water_Sources_Fact_Sheet.pdf

General Fracking Water Use

- *Approximately 80%* of the injected water returns to the ground surface as produced or flowback water.
  - Flowback is the water which surfaces in the first 5 days of fracking.
  - Produced water is naturally occurring water in the geologic formation which can also surface over the life of the well.
- *Approximately 20%* of the injected water is evenutally disposed of.
- All disposal of water conforms with applicable law.

Attachment 1

Illustration of Historical and Projected Water Demand vs. Estimated Firm Water Supply Yield
City of Loveland
1987 - 2056
(acre-feet per year)



Notes:

(1) Actual water use through 2006 (year of highest demand), and projected by City staff thereafter. Projected use includes augmentation demand of 590 af/y.

(2) Firm yield does not include additional supply from additional future water sources .

Leasing Water by the City of Loveland

- City leases water, in excess of projected demand
- Typically short-term commitments
- Typical uses include:
  – Agriculture, including City parks & golf courses
  – Augmentation
  – Ranch water
  – Construction Meters

Attachment 1

City of Loveland Hydrant Meters and Ranch Water

2010		
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Today's Goal

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1. Should the City of Loveland continue to provide raw or treated water to support fracking?
2. Should the City of Loveland support the leasing of Platte River Power Authority's water for fracking operations?

Questions / Discussion?

Attachment 1

Presentation by Platte River Power Authority Staff

(Slides to be provided at the meeting.)

Water Sources and Demand for the Hydraulic Fracturing of Oil and Gas Wells in Colorado from 2010 through 2015[1]

Recently, questions have been raised about the quantity of water that will be needed for the hydraulic fracturing of oil and gas wells in Colorado. This report is intended to address these questions.

Hydraulic fracturing is the process of creating small cracks, or fractures, in underground geological formations to allow oil and natural gas to flow into the wellbore and thereby increase production. To fracture the formation, special fracturing fluids are injected down the well bore and into the formation under high pressure. These fluids typically consist of approximately 90% water, 9.5% sand, and 0.5% chemicals. The volume of fluids used for this purpose depends upon a variety of factors, including the well type and the formation depth and geologic composition. For example, horizontal wells require more water than vertical or directional wells (because of the length of the borehole that will be fracture stimulated), and deeper shale formations require more water than shallower coal bed methane formations. Hydraulic fracturing has been used in Colorado to increase the production of oil and gas wells since the 1970s, and in recent years most Colorado oil and gas wells have been hydraulically fractured.

The following pages will examine the current and projected water demands for hydraulic fracturing in Colorado, compare those demands to the amount of water that is used for other purposes in Colorado, identify potential sources of water for hydraulic fracturing, and summarize the legal and administrative requirements for using those sources.

Projected Water Demands for Hydraulic Fracturing in Colorado During the Period from 2010 Through 2015

The pace and type of oil and gas well construction in Colorado and other states depend upon a variety of factors that are difficult to predict or control. These factors include national and regional economic conditions, oil and gas prices, capital availability, corporate strategies, and technological innovations. The variability in these factors is reflected in recent well starts in Colorado, which increased from 2007 to 2008, decreased from 2008 to 2009, and then increased again from 2009 to 2010 and from 2010 to 2011:

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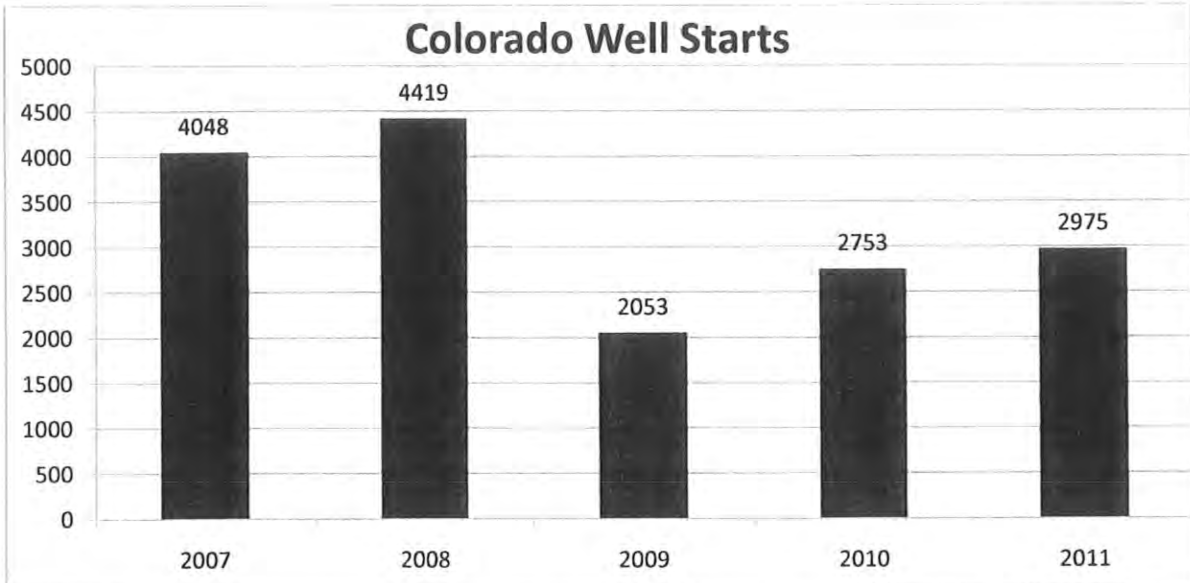
[1] Jointly prepared by the Colorado Division of Water Resources, the Colorado Water Conservation Board, and the Colorado Oil and Gas Conservation Commission



The various factors that influence oil and gas development, and the resulting variations in development activity, make it extremely difficult to predict future development levels. Nevertheless, the Colorado Oil and Gas Conservation Commission has attempted to predict such development during the period of 2010 through 2015 for the purpose of quantifying the amount of water that could be used for hydraulic fracturing during these years. These predictions are tentative, general, and should be used with caution. They are based upon the following assumptions, which may or may not prove accurate:

- The demand for new gas wells will remain relatively flat.
- The number of drilling rigs in the state will remain relatively flat.
- The number of wells drilled will remain relatively flat because of rig count.
- The number of horizontal oil wells drilled will increase approximately 20% each year.
- The number of vertical wells drilled will decrease proportionally with the increase in horizontal wells drilled.

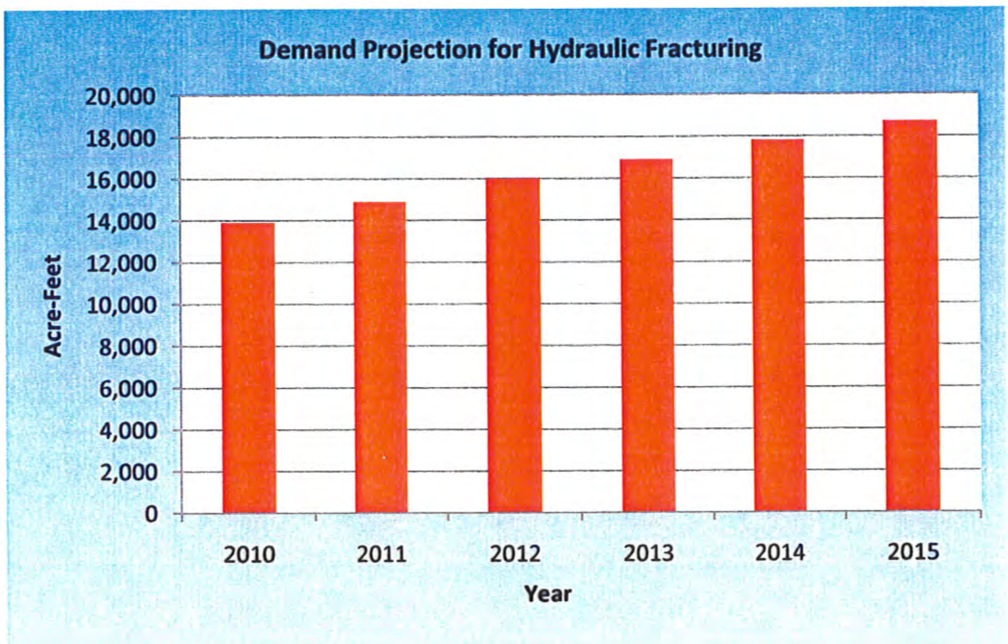
Based upon these assumptions, the Colorado Oil and Gas Conservation Commission estimates that during the period from 2010 through 2015 hydraulic fracturing will require the following volumes of water:

Projection of Annual Demand for Hydraulic Fracturing (Acre-Feet[2])[3]					
2010	2011	2012	2013	2014	2015
13,900	14,900	16,100	16,900	17,800	18,700

[2] One acre-foot is approximately equal to 326,000 gallons.

[3] The demands for hydraulic fracturing are based on actual numbers of wells constructed for the years 2010 and 2011 and estimated numbers of wells to be constructed for the following years based on a county-specific projection. The amount of water demand was determined using the number of wells, using vertical or horizontal construction practices, multiplied by an amount of water required for hydraulic fracturing per well. The amount of water required per well is based on reported data.

Regional geology dictates how wells will be drilled, either vertical or horizontal, and the volume of water that will be necessary to provide the most effective fracture stimulation treatment (frac). Frac water volumes have been calculated by predicting the number of new vertical and horizontal wells to be drilled in each county. Completion records were then evaluated to determine a typical water volume used in 2011 completions for each type of well construction in the county. The number of vertical and horizontal wells was multiplied by the typical water volume used in order to predict a total county water use. All of the county volumes were summed to determine the statewide use.



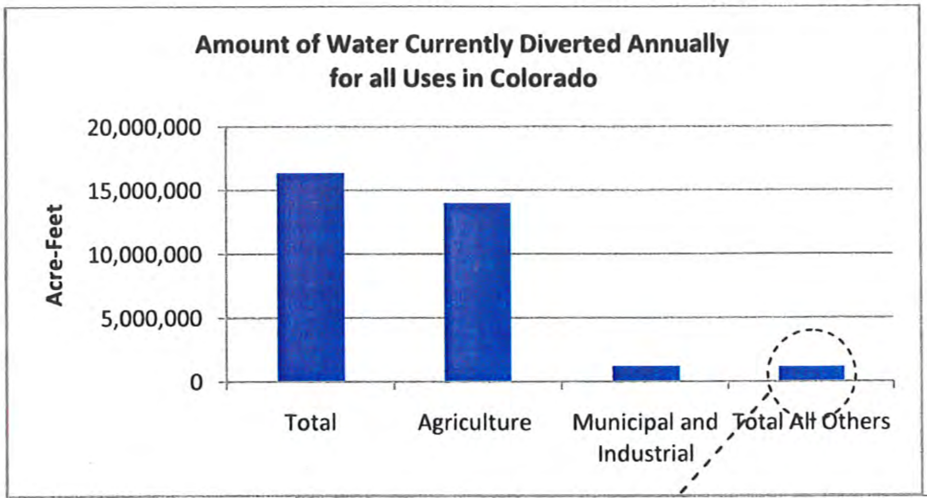
Water Demands in Colorado

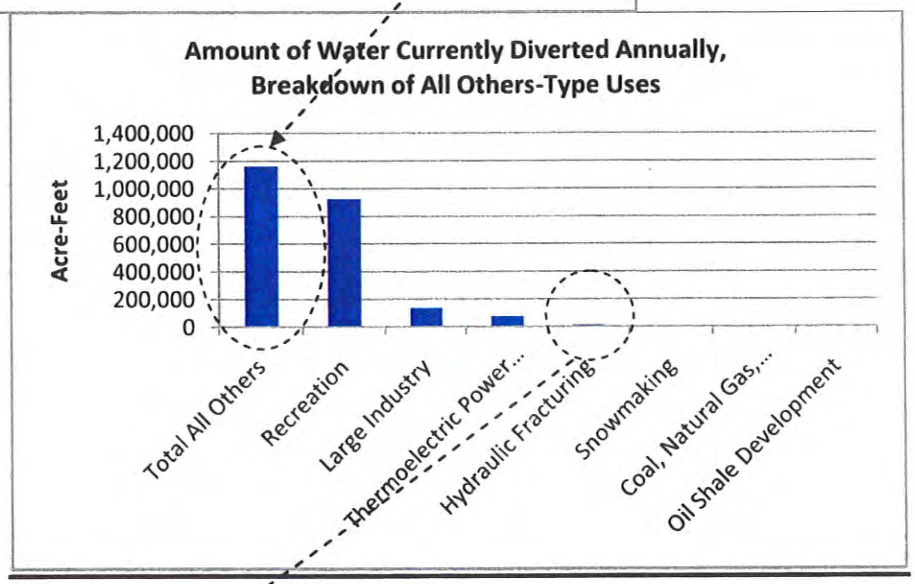
The table below shows the amount of water currently diverted for beneficial use for all uses in Colorado on an average annual basis. It is important to note that water use in Colorado varies significantly on a year to year basis, and the projected increase in demand for hydraulic fracturing is well within Colorado's current year to year variation. This table is broken down into three categories. The third category, "Total All Others", is then further broken down into seven categories, including hydraulic fracturing.

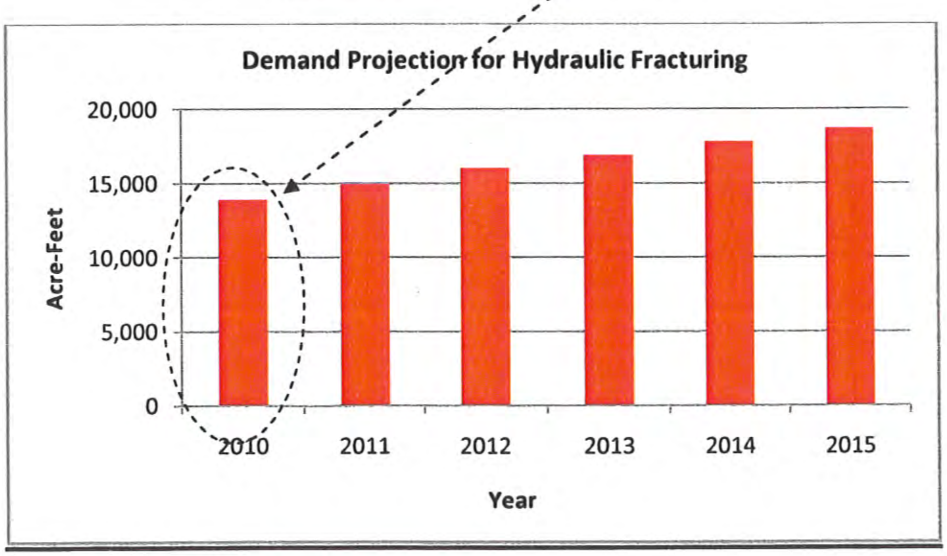
Sector	2010 Use (Acre-Feet/Yr)[4]	Percent of State Total
Total	**16,359,700**	
Agriculture	13,981,100	85.5%
Municipal and Industrial	1,218,600	7.4%
Total All Others	1,160,000	7.1%
Breakdown of "All Others"		
Total All Others	**1,160,000**	
Recreation	923,100	5.64%
Large Industry	136,000	0.83%
Thermoelectric Power Generation	76,600	0.47%
Hydraulic Fracturing	13,900	0.08%
Snowmaking	5,300	0.03%
Coal, Natural Gas, Uranium, and Solar Development	5,100	0.03%
Oil Shale Development	0	0.00%

The graphs on the following pages indicate that the amount of water currently used for hydraulic fracturing in Colorado is a small portion of the total amount of water used. In 2010, it reflected slightly less than one-tenth of one percent of the total water used. In 2015, it is projected to increase by 4,800 acre-feet to slightly more than one-tenth of one percent of the total water used.

[4] The estimated values for Current Annual Use are based on diversion records from the Colorado Division of Water Resources. For some categories, those amounts are further apportioned consistent with 2010 Statewide Water Supply Initiative data from the Colorado Water Conservation Board.


Amount of Water Currently Diverted Annually for all Uses in Colorado
Acre-Feet
20,000,000
15,000,000
10,000,000
5,000,000
0
Total
Agriculture
Municipal and Industrial
Total All Others


Amount of Water Currently Diverted Annually, Breakdown of All Others-Type Uses
Acre-Feet
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Total All Others
Recreation
Large Industry
Thermoelectric Power...
Hydraulic Fracturing
Snowmaking
Coal, Natural Gas,...
Oil Shale Development


Demand Projection for Hydraulic Fracturing
Acre-Feet
20,000
15,000
10,000
5,000
0
2010
2011
2012
2013
2014
2015
Year

Potential Sources of Water for Hydraulic Fracturing

Several sources of water are available for hydraulic fracturing in Colorado. Because Colorado's water rights system is based in the prior appropriation doctrine, water cannot be simply diverted from a stream/reservoir or pumped out of the ground for hydraulic fracturing without reconciling that diversion with the prior appropriation system. Like any other water user, companies that hydraulically fracture oil and gas wells must adhere to Colorado water laws when obtaining and using specific sources of water for this purpose.

Below is a discussion of the sources of water that could potentially be used for hydraulic fracturing. The decision to use any one source is dependent on the ability to satisfy the water rights obligations and will also be driven by the economics associated with that source.

Water transported from outside the state
An Operator may transport water from outside of the state. As long as the transport and the use of the water carries no legal obligation to Colorado, this is an allowable source of water from a water rights perspective.

Irrigation water leased or purchased from a landowner
A landowner may have rights to surface water, delivered by a ditch or canal, that is used to irrigate land. An Operator may choose to enter into an agreement with the owner of the water rights to purchase or lease a portion of that water. This is allowable, however, in nearly every case, the use of an irrigation water right is likely limited to irrigation uses and cannot be used for Well Construction. To allow its use for Well Construction, the owner of the water right and the Operator may apply to change the water right through a formal process. (See "Change of Water Right" below.)

Treated water or raw water leased or purchased from a water provider
An Operator may choose to enter into an agreement with a water provider to purchase or lease water from the water provider's system. Municipalities and other water providers may have a surplus of water in their system before it is treated (raw water) or after treatment that can be used for Well Construction. Such an arrangement would be allowed only if the Operator's use is compliant with the water provider's water rights.

Water treated at a waste water treatment plant leased or purchased from a water provider
An Operator may choose to enter into an agreement with a water provider to purchase or lease water that has been used by the public, and then treated as waste water. Municipalities and other water providers discharge their treated waste water into the streams where it becomes part of the public resource, ready to be appropriated once again in the priority system. But for many municipalities a portion of the water that is discharged has the character of being "reusable." As a result, it is possible that after having been discharged to the stream, it could be diverted by the Operator to be used for Well Construction. Such an arrangement could only be exercised with the approval of the Division of Water Resources' Division Engineer and would be allowed only if the water provider's water rights include uses for Well Construction.

New diversion of surface water flowing in streams and rivers
In most parts of the state, the surface streams are "over appropriated," that is, the flows do not reliably occur in such a magnitude that all of the vested water rights on those streams can be satisfied. Therefore, the only time that an Operator will be able to divert water directly from the

river is during periods of higher flow and lesser demand. Those periods do occur but not necessarily reliably or predictably.

Ground water diverted from wells completed in tributary formations ***outside*** Designated Ground Water Basins ("Designated Basins")

An Operator may choose to enter into an agreement with the owner of a well outside of the Designated Basins to divert the well's water for Well Construction, or to divert additional water for Well Construction. However, most existing wells will be located in parts of the state where the surface streams are over appropriated. In those locations, because of the wells' relatively junior water rights, the well is actually a diversion structure only and not a source of appropriated water. Instead, all water withdrawn by the well must be withdrawn according to a plan that acknowledges the impact of the well's pumping on the over-appropriated stream and an accompanying plan for replacing that water to the stream to correct for the depletive impact. Therefore, the complexity of using the well to divert ground water for Well Construction will be primarily a result of the need to develop a plan for replacing depletions to the stream system. (See "Augmentation Plans" below.)

Ground water diverted from wells ***inside*** Designated Basins

An Operator may choose to enter into an agreement with the owner of a well inside the Designated Basins to divert the well's water for Well Construction. If the well's water right allows Well Construction as a use and there are no other restrictions on its use, this is a viable source of water. However, the water right for most wells in the Designated Basins generally does not include an allowance for oil and gas well construction purposes. If there is a question as to whether some other term in the well's water right can be construed as an allowance for Well Construction, since these terms are usually ambiguous, the Division of Water Resources will evaluate them on a case-by-case basis to determine whether the intent of that term could have been for Well Construction purposes. If the well's water right does not allow for Well Construction, the owner of the well and the Operator may apply to change the water right through a formal process. (See "Change of Water Right" below.)

Ground water diverted from wells completed or to be completed in nontributary aquifers

An Operator may choose to enter into an agreement with a landowner to divert nontributary ground water from the aquifer underlying the landowner's land. The most recognizable occurrence of nontributary ground water is the water in the **Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers** of the **Denver Basin** situated along the Front Range of Colorado. This is permissible and can be done through the issuance of a well permit. In most cases there are no restrictions on the types of use allowed for nontributary ground water if it is not already subject of a decree or a well permit. There are, however, limits to the amount of water that may be withdrawn in a given period of time. Specifically, the amount of water that may be withdrawn from a piece of land under consideration is the amount of ground water calculated to be contained in the aquifer underlying that land; and no more than one percent of the amount calculated may be withdrawn annually (many will recognize this limitation as the basis for the term: "100-year aquifer life"). This withdrawal limitation would be applied to any well permit that allows the use of Well Construction and it is the exact same limitation that would be applied to wells that would withdraw the water for domestic, commercial, agricultural, or other uses. The amount of water currently being withdrawn for all uses from the bedrock aquifers of the Denver Basin is estimated to be 350,000 acre-feet annually.[5]

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[5] According to the *Citizens Guide to Denver Basin Groundwater*, 2007, produced and distributed by the Colorado Foundation for Water Education.

Produced Water

An Operator may choose to use water produced in conjunction with oil or gas production at an existing oil or gas well. The water that is produced from an oil or gas well falls under the administrative purview of the State Engineer's Office and as a result is either nontributary, in which case, it is administered independent of the prior appropriation system; or is tributary, in which case, the depletions from its withdrawal must be fully augmented if the depletions occur in an over-appropriated basin. The result in either case is that the produced water is available for consumption for other purposes, including Well Construction. The water must not be encumbered by other needs and a proper well permit must be obtained by the Operator before the water can be used for Well Construction. The exception to this permitting requirement is the allowance in Section 37-90-137(7), C.R.S., whereby produced water from a nontributary formation using a non-coal-bed methane operation may be applied to uses associated with Well Construction without a well permit.

Reused or Recycled Well Construction Water

For all of the different sources listed above that are used for Well Construction, the water right in question must contain provisions that allow the water to be fully consumed. Under that scenario, water that is used for well construction of one well may be recovered and reused in the construction of subsequent wells.

The COGCC encourages reuse and recycling of both the water used in Well Construction and the water produced in conjunction with oil or gas production. Reuse and recycling of water is covered in COGCC Rule 907 MANAGEMENT OF E&P WASTE, which describes the process for submitting a plan to the COGCC for review and approval. In the Piceance Basin several of the larger operators have constructed pipelines and use trucks to convey produced and already used water and other fluids to their centrally located water management facilities. At these facilities the water is treated so that it can be reused for drilling and completing new wells.

Explanation of Terms

Change of water right

In Colorado, a water right may be changed to allow for uses other than those originally granted to the water right and the water right can keep its original priority date. However, whether it is a water right inside or outside of the Designated Basins, such a change of use must be done through a formal process with notice to other water users. While the standards vary for each individual situation, in each case the change process is meant to ensure there will be no increase in use of the water right over what the water right allows or what has historically been done. Further, the change must include provisions to ensure that other owners of vested water rights are not impacted by a change to the system as a result of the change of water right. For designated ground water in the Designated Basins, the change of water right will be accomplished through an application to the Colorado Ground Water Commission according to the Designated Basin Rules [2-CCR-410-1]. Outside the Designated Ground Water Basins, the change of water right may be accomplished through an application to the water court or an application to the State Engineer for temporary approval of a substitute water supply plan pursuant to 37-92-308 and the State Engineer's Policy No. 2003-2, or an Interruptible Water Supply Agreement pursuant to 37-92-309.

Augmentation plans

In Colorado, water may be diverted when the result is a depletive effect on the stream system even though the diverter does not a have a water right with the priority to do so, as long as the diverter obtains formal approval of a plan to offset the depletive effect on the stream with a source of replacement water. Such a plan is called an augmentation plan. The plan must acknowledge the depletive effect of the diversion on the stream, including consideration of the amount of the depletion as well as the time and location of the depletion. Then the plan must identify a source of water that has been obtained to replace those depletions to ensure that no party with a senior vested water right will be injured. Approval to operate the augmentation plan may be accomplished through an application to the water court or an application to the State Engineer for temporary approval of a substitute water supply plan pursuant to 37-92-308.

Attachment 3

Hydraulic Fracturing: the Process

Hydraulic Fracturing: The Process

What Is Hydraulic Fracturing?

Contrary to many media reports, hydraulic fracturing is not a "drilling process." Hydraulic fracturing is used after the drilled hole is completed. Put simply, hydraulic fracturing is the use of fluid and material to create or restore small fractures in a formation in order to stimulate production from new and existing oil and gas wells. This creates paths that increase the rate at which fluids can be produced from the reservoir formations, in some cases by many hundreds of percent.

The process includes steps to protect water supplies. To ensure that neither the fluid that will eventually be pumped through the well, nor the oil or gas that will eventually be collected, enters the water supply, steel surface or intermediate casings are inserted into the well to depths of between 1,000 and 4,000 feet. The space between these casing "strings" and the drilled hole (wellbore), called the annulus, is filled with cement. Once the cement has set, then the drilling continues from the bottom of the surface or intermediate cemented steel casing to the next depth. This process is repeated, using smaller steel casing each time, until the oil and gas-bearing reservoir is reached (generally 6,000 to 10,000 ft). A more detailed look at casing and its role in groundwater protection is available HERE (http://fracfocus.org/hydraulic-fracturing-how-it-works/casing).

With these and other precautions taken, high volumes of fracturing fluids are pumped deep into the well at pressures sufficient to create or restore the small fractures in the reservoir rock needed to make production possible.

What's in Hydraulic Fracturing Fluid?

Water and sand make up 98 to 99.5 percent of the fluid used in hydraulic fracturing. In addition, chemical additives are used. The exact formulation varies depending on the well. To view a chart of the chemicals most commonly used in hydraulic fracturing and for a more detailed discussion of this question, click HERE (http://fracfocus.org/water-protection/drilling-usage).

Why is Hydraulic Fracturing Used?

Experts believe 60 to 80 percent of all wells drilled in the United States in the next ten years will require hydraulic fracturing to remain operating. Fracturing allows for extended production in older oil and natural gas fields. It also allows for the recovery of oil and natural gas from formations that geologists once believed were impossible to produce, such as tight shale formations in the areas shown on the map below. Hydraulic fracturing is also used to extend the life of older wells in mature oil and gas fields.

Source: Modern Shale Gas Development in the United States, US Department of Energy

How is Hydraulic Fracturing Done?*

The placement of hydraulic fracturing treatments underground is sequenced to meet the particular needs of the formation. The sequence noted below from a Marcellus Shale in Pennsylvania is just one example. Each oil and gas zone is different and requires a hydraulic fracturing design tailored to the particular conditions of the formation. Therefore, while the process remains essentially the same, the sequence may change depending upon unique local conditions. It is important to note that not all of the additives are used in every hydraulically fractured well; the exact "blend" and proportions of additives will vary based on the site-specific depth, thickness and other characteristics of the target formation.

1. An acid stage, consisting of several thousand gallons of water mixed with a dilute acid such as hydrochloric or muriatic acid: This serves to clear cement debris in the wellbore and provide an open conduit for other frac fluids by dissolving carbonate minerals and opening fractures near the wellbore.

2. A pad stage, consisting of approximately 100,000 gallons of slickwater without proppant material: The slickwater pad stage fills the wellbore with the slickwater solution (described below), opens the formation and helps to facilitate the flow and placement of proppant material.

3. A prop sequence stage, which may consist of several substages of water combined with proppant material (consisting of a fine mesh sand or ceramic material, intended to keep open, or "prop" the fractures created and/or enhanced during the fracturing operation after the pressure is reduced): This stage may collectively use several hundred thousand gallons of water.

Proppant material may vary from a finer particle size to a coarser particle size throughout this sequence.

4. A flushing stage, consisting of a volume of fresh water sufficient to flush the excess proppant from the wellbore.

Other additives commonly used in the fracturing solution employed in Marcellus wells include:

• A dilute acid solution, as described in the first stage, used during the initial fracturing sequence. This cleans out cement and debris around the perforations to facilitate the subsequent slickwater solutions employed in fracturing the formation.

• A biocide or disinfectant, used to prevent the growth of bacteria in the well that may interfere with the fracturingoperation: Biocides typically consist of bromine-based solutions or glutaraldehyde.

• A scale inhibitor, such as ethylene glycol, used to control the precipitation of certain carbonate and sulfate minerals

• Iron control/stabilizing agents such as citric acid or hydrochloric acid, used to inhibit precipitation of iron compounds by keeping them in a soluble form

• Friction reducing agents, also described above, such as potassium chloride or polyacrylamide-based compounds, used to reduce tubular friction and subsequently reduce the pressure needed to pump fluid into the wellbore: The additives may reduce tubular friction by 50 to 60%. These friction-reducing compounds represent the "slickwater" component of the fracing solution.

• Corrosion inhibitors, such as N,n-dimethyl formamide, and oxygen scavengers, such as ammonium bisulfite, are used to prevent degradation of the steel well casing.

• Gelling agents, such as guar gum, may be used in small amounts to thicken the water-based solution to help transport the proppant material.

• Occasionally, a cross-linking agent will be used to enhance the characteristics and ability of the gelling agent to transport the proppant material. These compounds may contain boric acid or ethylene glycol. When cross-linking additives are added, a breaker solution is commonly added later in the frac stage to cause the enhanced gelling agent to break down into a simpler fluid so it can be readily removed from the wellbore without carrying back the sand/ proppant material.

Fractures: Their orientation and length

Certain predictable characteristics or physical properties regarding the path of least resistance have been recognized since hydraulic fracturing was first conducted in the oilfield in 1947. These properties are discussed below:

Fracture orientation

Hydraulic fractures are formed in the direction perpendicular to the least stress. Based on experience, horizontal fractures will occur at depths less than approximately 2000 ft. because the Earth's overburden at these depths provides the least principal stress. If pressure is applied to the center of a formation under these relatively shallow conditions, the fracture is most likely to occur in the horizontal plane, because it will be easier to part the rock in this direction than in any other. In general, therefore, these fractures are parallel to the bedding plane of the formation.

As depth increases beyond approximately 2000 ft., overburden stress increases by approximately 1 psi/ft., making the overburden stress the dominant stress This means the horizontal confining stress is now the least principal stress. Since hydraulically induced fractures are formed in the direction perpendicular to the least stress, the resulting fracture at depths greater than approximately 2000 ft. will be oriented in the vertical direction.

In the case where a fracture might cross over a boundary where the principal stress direction changes, the fracture would attempt to reorient itself perpendicular to the direction of least stress. Therefore, if a fracture propagated from deeper to shallower formations it would reorient itself from a vertical to a horizontal pathway and spread sideways along the bedding planes of the rock strata.

Fracture length/ height

The extent that a created fracture will propagate is controlled by the upper confining zone or formation, and the volume, rate, and pressure of the fluid that is pumped. The confining zone will limit the vertical growth of a fracture because it either possesses sufficient strength or elasticity to contain the pressure of the injected fluids or an insufficient volume of fluid has been pumped.. This is important because the greater the distance between the fractured formation and the USDW, the more likely it will be that multiple formations possessing the qualities necessary to impede the fracture will occur. However, while it should be noted that the length of a fracture can also be influenced by natural fractures or faults as shown in a study that included microseismic analysis (http://www.worldoil.com/July-2005-Advanced-hydraulic-fracture-diagnostics-optimize-development-in-the-Bossier-sands.html) ‡ of fracture jobs conducted on three wells in Texas, natural attenuation of the fracture will occur over relatively short distances due to the limited volume of fluid being pumped and dispersion of the pumping pressure regardless of intersecting migratory pathways.

The following text and graphs are excerpts from an article written by Kevin Fisher of Pinnacle, a Halliburton Company for the July 2010 edition of the American Oil and Gas Reporter.

"The concerns around groundwater contamination raised by Congress are primarily centered on one fundamental question: Are the created fractures contained within the target formation so that they do not contact underground sources of drinking water? In response to that key concern, this article presents the first look at actual field data based on direct measurements acquired while fracture mapping more than 15,000 frac jobs during the past decade.

Extensive mapping of hydraulic fracture geometry has been performed in unconventional North American shale reservoirs since 2001. The microseismic and tiltmeter technologies used to monitor the treatments are well established, and are also widely used for nonoil field (*sic*) applications such as earthquake monitoring, volcano monitoring, civil engineering applications, carbon capture and waste disposal. Figures 1 and 2 are plots of data collected on thousands of hydraulic fracturing treatments in the Barnett Shale in the Fort Worth Basin in Texas and in the Marcellus Shale in the Appalachian Basin.

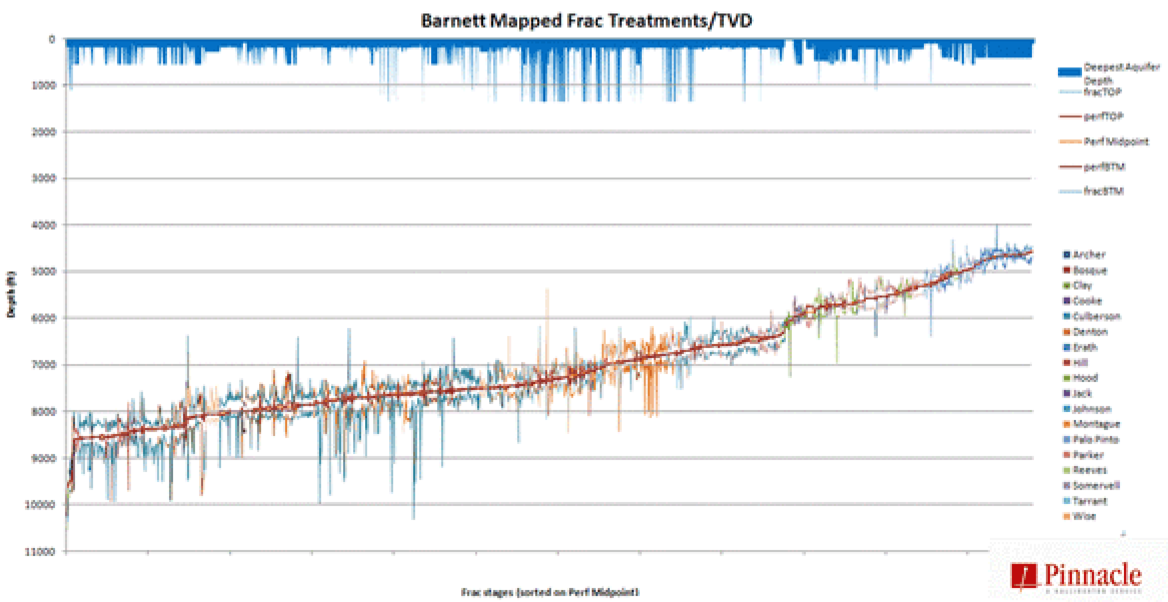


Figure 1. Barnett Shale

More fracs have been mapped in the Barnett than any other reservoir. The graph illustrates the fracture top and bottom for all mapped treatments performed in the Barnett since 2001. The depths are in true vertical depth. Perforation depths are illustrated by the red-colored band for each stage, with the mapped fracture tops and bottoms illustrated by colored curves corresponding to the counties where they took place.

The deepest water wells in each of the counties where Barnett Shale fracs have been mapped, according to United States Geological Survey (http://nwis.waterdata.usgs.gov/nwis (http://nwis.waterdata.usgs.gov/nwis) ‡), are illustrated by the dark blue shaded bars at the top of Figure 1. As can be seen, the largest directly measured upward growth of all of these mapped fractures still places the fracture tops several thousands of feet below the deepest known aquifer level in each county.

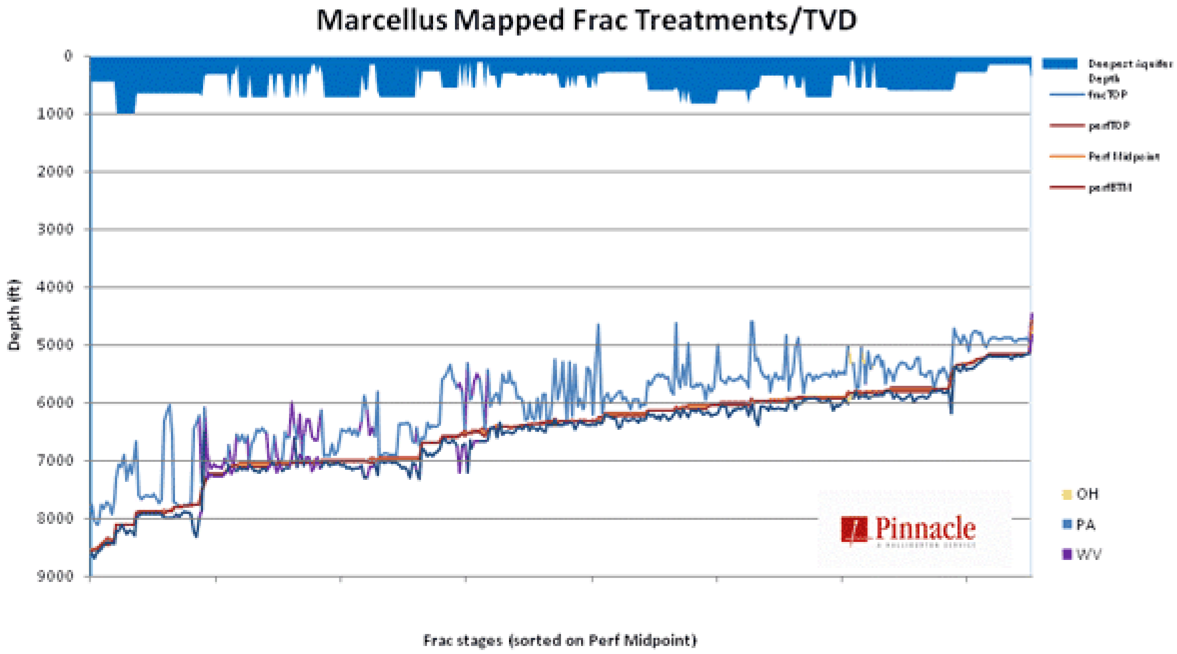


Figure 2 Marcellus Shale

The Marcellus data show a similarly large distance between the top of the tallest frac and the location of the deepest drinking water aquifers as reported in USGS data (dark blue shaded bars at the top of Figure 2). Because it is a newer play with fewer mapped frac stages at this point and encompasses several states, the data set is not as comprehensive as that from the Barnett. However, it is no less compelling in providing evidence of a very good physical separation between hydraulic fracture tops and water aquifers.

Almost 400 separate frac stages are shown, color coded by state. As can be seen, the fractures do grow upward quite a bit taller than in the Barnett, but the shallowest fracture tops are still ±4,500 feet, almost one mile below the surface and thousands of feet below the aquifers in those counties.

The results from our extensive fracture mapping database show that hydraulic fractures are better confined vertically (and are also longer and narrower) than conventional wisdom or models predict. Even in areas with the largest measured vertical fracture growth, such as the Marcellus, the tops of the hydraulic fractures are still thousands of feet below the deepest aquifers suitable for drinking water. The data from these two shale reservoirs clearly show the huge distances separating the fracs from the nearest aquifers at their closest points of approach, conclusively demonstrating that hydraulic fractures are not growing into groundwater supplies, and therefore, cannot contaminate them."

* Pennsylvania Department of Environmental Protection

"Hydraulic Fracturing Overview." 07/20/2010.

http://www.dep.state.pa.us/dep/deputate/minres/oilgas/new_forms/marcellus/Reports/DEP%20Fracing%20overview.pdf (http://www.dep.state.pa.us/dep/deputate/minres/oilgas/new_forms/marcellus/Reports/DEP%20Fracing%20overview.pdf) ‡ (4/11/2011).

‡ - *When you click links marked with the ‡ symbol, you will leave the FracFocus website and go to websites that are not controlled by or affiliated with this site.*

Attachment 4

Colorado Oil and Gas (COGA) *Fast Facts* information on:

- Hydraulic Fracturing White Paper
- Seismic Activity Fast Facts
- Hydraulic Fracturing Disclosure Fast Facts
- Truth about Gasland Fast Facts
- HF-Fluids Exciting Clean and Green Developments

COGA | Hydraulic Fracturing Whitepaper

COLORADO OIL & GAS ASSOCIATION

WHAT IS HYDRAULIC FRACTURING?
Hydraulic fracturing is one of the final components of the overall drilling procedure and is used far below ground surface (often more than a mile) to allow the recovery of oil and gas. It is often confused with the entire drilling practice, but it is just one part. This fact sheet explains what hydraulic fracturing is, describes what concerns stakeholders have with the process, provides some technical explanations, and discusses the regulatory framework. Hydraulic fracturing is often referred to as "fracing," pronounced fracking.

WHY DO WE NEED HYDRAULIC FRACTURING?
Hydraulic fracturing is a critical part of the oil and gas production process; it allows wells to produce that would otherwise be uneconomical. It therefore allows us to maximize our domestic resource and get the most of the oil and gas infrastructure that is in place. It is estimated that up to 90 percent of the wells currently operating today have been hydraulically fractured. Without this technique, thousands of wells across the country would be closed, thereby reducing our domestic production, failing to make the most of our oil and gas infrastructure, and negatively impacting the local economies.

WHAT ARE CONCERNS WITH HYDRAULIC FRACTURING?
Many stakeholders are concerned that hydraulic fracturing may create pathways to underground sources of drinking water (called aquifers) and release hydraulic fracturing fluids into those aquifers. The oil and gas industry and the agencies that regulate us are committed to preventing these pathways and any kind of release to groundwater. Individual, community, and environmental health and safety are our priority! There is a robust regulatory framework in place to prevent any environmental effects. In addition, our industry takes every precaution in its pre-drilling well design and actual operations to prevent any release to the environment. Both the regulatory framework and the precautions that we take are described further in this fact sheet.

LET'S GET TECHNICAL
Individuals often confuse the entire drilling process with hydraulic fracturing. Because the drilling process is already extensively regulated, it is important to clarify exactly what we are talking about when we discuss hydraulic fracturing.

First, let's describe drilling. For the vast majority of wells drilled onshore in the United States, drilling a well involves two key components: the first or top part of the hole (or surface hole) is drilled at least 50 feet below all known drinking water supplies and has a hole size of approximately 12 ¼ inches in diameter.

This boring is lined with a layer of heavy steel casing and encased in cement. For all wells drilled, the cement sheath is created by pumping a cement slurry down and around the steel casing and back to the surface. When this cement solidifies, it provides a solid barrier of cement and steel casing isolating all potable water zones from the drilling and fracturing fluids used in the remainder of the drilling process. The second component involves drilling a smaller concentric hole (usually 8 ½ inches or smaller) an additional 5,000 to 10,000 feet to the proposed hydrocarbon bearing zones. This part of the hole is also lined with a string of heavy steel casing (also known as the production casing or long string) and is run inside the surface casing to the total depth of the well drilled and then totally encased with cement through and across all the oil and gas (hydrocarbon) formations. These two concentric strings of steel casing (surface casing and production casing) are totally encased with concrete that prevents all fracturing fluids and hydrocarbons from migrating up to the shallow aquifers near the surface.

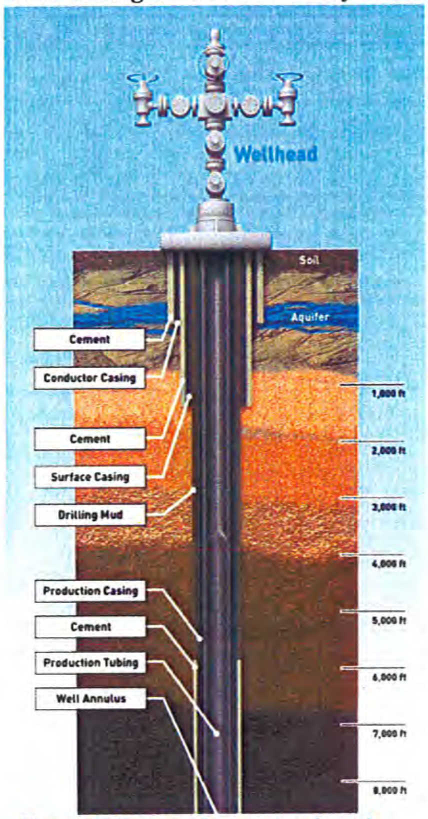


Figure 1: Layers of cement and steel casing of a typical well

For some formations, hydraulic fracturing is needed to facilitate the removal of the hydrocarbons located more than a mile or more below ground level. Now, we'll describe that process. First, the finished well bore construction as described above is tested with hydrostatic pressure greater than that calculated to occur during the fracturing treatment process itself. This measured pressure is monitored for a period of time (usually 15 to 30 minutes) to ensure that there are no leaks and well bore integrity has been obtained. Once this pressure test passes the designed engineering specifications, small holes or perforations are mechanically punched through the steel and cement directly into the hydrocarbon bearing formation. Hydraulic fluids are then pumped under pressure down the cement encased well exiting through the mechanical perforations and directly into the prospective formation. This fluid (99.5 percent water) opens or enlarges any natural fractures in the rock at the depth of the hydrocarbon formation. These fractures are initiated in the hydrocarbon formation near the bottom of the well and usually extend laterally several hundred feet within the reservoir rock. As the formation begins to fracture, a "propping agent" (usually sand carried by a high-viscosity additive) follows the first fluid and is pumped into the created fractures to keep them from closing completely when the pumping pressure is released. The oil or natural gas then uses these created "hydraulic fractures" to move through the rock pore space to the production well. The production well as described above serves as the conduit to bring the hydrocarbons to the surface.

STUDIES

The U.S. Environmental Protection Agency (EPA) has begun planning that will begin a second study "to investigate the potential adverse impact that hydraulic fracturing may have on water quality and public health." The study is expected to have preliminary results by 2012, with a final deadline of 2014.

Previous studies conducted by respected authorities have all concluded that hydraulic fracturing is safe. EPA (2004), the Ground Water Protection Council (2009), and the Interstate Oil and Gas Compact Commission (2002) have all found hydraulic fracturing non-threatening to the environment or public health.

REGULATORY OVERSIGHT

There is a lot of misunderstanding about what is and is not regulated in drilling and hydraulic fracturing –so we've provided a step-by-step overview.

1. In Colorado, operators have to apply to get a permit to drill describing all of their surface and downhole activities through the Colorado Oil and Gas Conservation Commission (COGCC). This includes well design, location, spacing, operation, water management and disposal, waste management and disposal, air emissions, wildlife impacts, surface disturbance, and worker health and safety.
2. COGCC oversees all drilling operations including prevention of surface spills, ensuring adequate cementing through cement bond logs and mechanical integrity tests, and monitoring the surface casing and production casing annulus (Bradenhead) during fracturing operations for signs of any fluids migration.
3. Information related to the constituents of hydraulic fracturing fluids are disclosed to www.Fracfocus.org, an online registry managed by the Groundwater Protection Council. If a constituent is considered a trade secret, the chemical company will be required to complete a form which is subject to review justifying its need for confidentiality. In the case of a release, COGCC could provide detailed constituent information.
4. State-level oversight and enforcement is important because drilling practices vary according to the unique geological characteristics of the region. State-level scrutiny ensures that agency officials understand the operations in each basin. By law, state regulations must be at least as protective as federal standards.

CONCERNS WITH FRACTURING FLUIDS

First, stakeholders are concerned about what is in these fluids. Fracturing fluids vary based on the specific requirements of the formation, but they generally contain 99.5 percent water and sand. The remaining chemicals are used to facilitate the flow of sand into the formation. These chemicals pose serious hazards when full strength and our operators handle them extremely carefully to ensure personnel health and safety is protected and surface spills are prevented. The types of chemicals used in fracturing are described below. Remember – in fracturing, all chemicals combined are diluted to less than one half of one percent of the fluid!

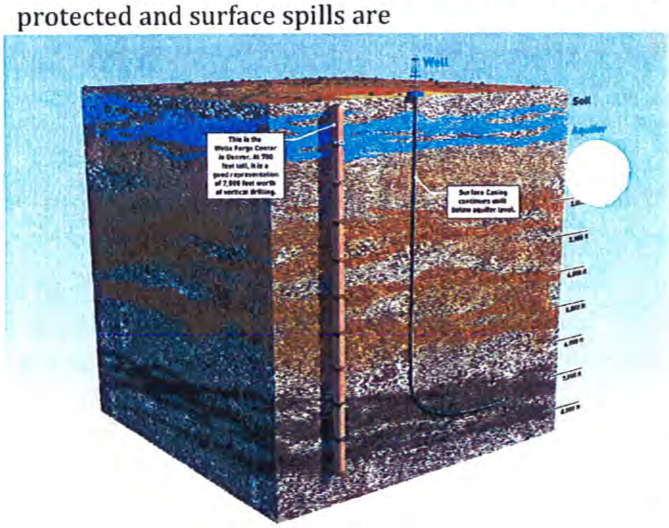


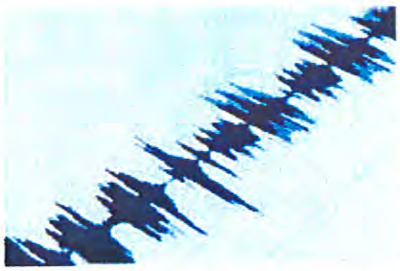
Figure 2: Horizontal wells extending 7000+ feet to reach shale formations

Second, stakeholders are concerned about the potential of fracturing fluids to be released into underground sources of drinking water from the fractures created in the hydrocarbon formation. In fact, fracturing has too small of an area of influence to release fluids through thousands of feet of rock to reach underground aquifers. The volume of fluid for each fracture treatment is individually designed to impact a few hundred feet of lateral growth in the reservoir, not thousands of vertical feet.

In reality, our industry has to focus on two areas to prevent impacting underground sources of drinking water: (1) preventing surface spills, and (2) ensuring casing protection. Both of these areas are currently regulated in Colorado. We work closely with regulatory agencies and communities to continue to prevent releases in these areas.

FRACTURING INGREDIENTS			
Product Category	**Main Ingredient**	**Purpose**	**Other Common Uses**
Water	99.5%	Expand fracture and deliver sand	Landscaping and manufacturing
Sand		Allows the fractures to remain open so the gas can escape	Drinking water filtration, play sand, concrete and brick mortar
OTHER	**Approximately 0.5%**		
Diluted Acid	Hydrochloric acid or muriatic acid	Helps dissolve minerals and initiate cracks in the rock	Swimming pool chemical and cleaner
Antibacterial agent	Glutaraldehyde	Eliminates bacteria in the water that produces corrosive by-products	Disinfectant; Sterilizer for medical and dental equipment
Breaker	Ammonium persulfate	Allows a delayed break down of the gel	Used in hair coloring, as a disinfectant, and in the manufacture of common household plastics
Corrosion inhibitor	n,n-dimethyl formamide	Prevents the corrosion of the pipe	Used in pharmaceuticals, acrylic fibers and plastics
Crosslinker	Borate salts	Maintains fluid viscosity as temperature increases	Used in laundry detergents, hand soaps and cosmetics
Friction reducer	Polyacrylamide	"Slicks" the water to minimize friction	Water treatment, soil conditioner
	Mineral Oils		Used in cosmetics including hair, make-up remover, nail and skin products
Gel	Guar gum or hydroxyethyl cellulose	Thickens the water in order to suspend the sand	Thickener used in cosmetics, baked goods, ice cream, toothpaste, sauces and salad dressings
Iron control	Citric acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice ~7% citric acid
Clay stabilizer	Potassium chloride	Creates a brine carrier fluid	Used in low-sodium table salt substitute, medicines and IV fluids
pH adjusting agent	Sodium or potassium carbonate	Maintains the effectiveness of other components, such as crosslinkers	Used in laundry detergents, soap, water softener and dishwasher detergents
Scale inhibitor	Ethylene glycol	Prevents scale deposits in the pipe	Used in household cleansers, de-icer, paints and caulk
Surfactant	Isopropanol	Used to increase the viscosity of the fracture fluid	Used in glass cleaner, multi-surface cleansers, antiperspirant, deodorants and hair color

Figure 3: "Modern Shale Gas Development in the United States: A Primer" U.S. Department of Energy Office of Fossil Energy and National Energy Technology Laboratory. April 2009 and Chesapeake Energy



Does Hydraulic Fracturing Cause Earthquakes?

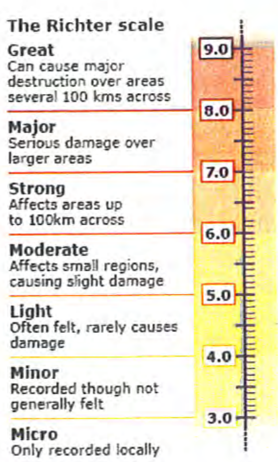
Facts on Geo-Seismic Activity & Natural Resource Development

Colorado has a long history of seismic activity. Since as early as 1867, geologists have logged hundreds of earthquakes across the state. While earthquakes are a natural result of movements in the Earth's crust, they can also be caused by humans. Recently many Coloradoans have started to wonder whether oil and gas drilling and hydraulic fracturing can cause earthquakes that affect our communities: The answer is no.

Hydraulic fracturing is known to cause very minor seismic activity when the fluids are injected into a formation. Geologists know this because microseismic geophones are placed in the ground during a fracture treatment to pick up the seismic waves, which can then be mapped to show the extent of fractures. Are these earthquakes large enough to cause damage or disturbance? Highly unlikely says the U.S. Department of Energy:

"To our knowledge hydrofracturing to intentionally create permeability rarely creates unwanted induced seismicity large enough to be detected on the surface even with very sensitive sensors, let alone be a hazard or an annoyance."[1]

As a matter of fact, just about anything we do above surface creates microseismic activity. Stanford University geophysicist Professor Mark Zoback stated that the typical energy release from hydraulic fracturing: Is the equivalent to a gallon of milk falling off the kitchen counter. [2]



Experts and geologists around the globe are convinced that the seismic activity caused by hydraulic fracturing is not a hazard or nuisance. Seismic events caused by hydraulic fracturing typically have a magnitude ranging from -4.5 to -1, with some seismicity rarely extending above +1 on the Richter scale. All of these readings are generally not felt above ground.[3]

There are currently two well-documented cases of induced seismicity above +1 magnitude related to hydraulic fracturing. In 2011, Cuadrilla Resources identified seismic events occurring from their fracture operations of 1.5 and 2.3 magnitudes. After suspending operations, Cuadrilla conducted tests to assess why their fractures were inducing events much larger than the norm.[4] Also in 2011, the Eola field in Oklahoma experienced earthquakes from magnitude 1.0 to 2.8 from fracturing the Picket Unit B well 4-18.[5]

Sources:

[1] http://esd.lbl.gov/research/projects/induced_seismicity/primer.html

[2] http://www.boston.com/news/science/articles/2011/11/07/experts_okla_quakes_too_powerful_to_be_man_made/

[3] http://www.pe.tamu.edu/blasingame/data/z_web_Archive/100522_TGS_MEOS/2011_MEOS_Other/2008_SPE_SGPC_Ses_04_02_Warpinksi.pdf

In both cases, fracture stimulations were affecting existing fault lines, which amplified the tremors. However, the magnitudes of these events were not large enough to cause damage to structures. Considering that there have been over 1,000,000 fracture stimulations in the United States alone, the amount of well-known seismic events above +1.0 is extremely small.

Recent speculation about hydraulic fracturing and earthquakes has been raised because of events in Ohio and Arkansas. But reports of these events confused hydraulic fracturing with disposal wells. Underground injection control (UIC) wells pump liquids from many industrial processes deep into the ground, typically into a formation that can support the absorption of trillions of gallons. Waste injection wells are nothing new; they have been around since the 1930s and there are more than 500,000 across the country.

The Environmental Protection Agency (EPA) regulates this disposal method.[6] Underground waste injection is not solely used by the oil and gas industry. Municipalities, chemical companies, and other industries use these wells to dispose of hazardous liquids, stormwater, or other unwanted liquid waste. Since the 1930s, the EPA has gone through multiple reviews that increase safety around these wells, including methods and practices to ensure safety of groundwater by ensuring the injected waste stays in the target formation.[7]

In states such as Ohio and Arkansas, these waste wells are speculated to activate existing natural faults, which can in turn cause seismic activity. It makes sense that injection of fluids over periods of weeks and months could build up pressure in existing faults, causing earthquake activity. Tremors from the two events in Ohio and Arkansasa did not exceed 4.7, causing minor damage to buildings.[8] While geologists and geophysicists are studying a possible connection between underground injection waste wells, data indicate that earthquake activity stops when injection ceases, limiting concerns for future earthquakes.

In Colorado, there are 575 underground injection control waste disposal wells, 355 of these are active.[9] To see a map of known earthquake activity and corresponding faults in Colorado, please click here.

In summary, while hydraulic fracturing is known to cause very small seismic activity beneath the ground surface, this activity cannot be detected at the surface. Of one-half million disposal wells across the country, two have been associated with minor seismic activity. In Colorado, we know that oil and gas development activity can be conducted safely, without fear of earthquakes.

Sources:

4 http://www.cuadrillaresources.com/cms/wp-content/uploads/2011/12/Geosphere-Final-report-rev-1.pdf
5 http://www.ogs.ou.edu/pubsscanned/openfile/OF1_2011.pdf
6 http://water.epa.gov/type/groundwater/uic/
7 http://water.epa.gov/type/groundwater/uic/history.cfm
8 http://www.foxnews.com/scitech/2011/03/01/fracking-earthquakes-arkansas-man-experts-warn/
9 COGCC

Note to Readers:
COGA welcomes feedback and corrections on our fact sheets. Please email Travis@coga.org.

- Natural Gas
- Hydraulic Fracturing
- Economic Benefits
- Environmental Benefits
- Baseline Water Sampling
- Niobrara
- Water Use
- Additional Topics

Hydraulic Fracturing

Governor Hickenlooper: 30 sec Public Service Announcement
Governor Hickenlooper PSA Because Environment Matters
Governor Hickenlooper PSA Because Safety Matters
Fulbright Brothers: 30 sec Public Service Announcement
Fulbright Brothers Print PSA


Photo courtesy of Whiting Petroleum

Hydraulic fracturing is a proven technology that has been refined over 60 years. It has allowed companies to safely produce natural gas from more than one million U.S. wells, and now it is being used to extract oil and other liquids from shale formations, such as in the Niobrara play. The State of Colorado has been regulating drilling activity since 1951. Every aspect is overseen by the COGCC. Over 90 percent of wells in Colorado are hydraulically fractured. The essential factor with respect to the safety of hydraulic fracturing is proper well construction, including casing and cementing to isolate the production formations being stimulated from shallow groundwater aquifers.

For More Info

- HF Rules for Communities
- API Frac Video
- Chesapeake Frac Video
- API HF Primer
- Debunking GasLand

Fast Facts

- Hydraulic Fracturing White Paper
- Seismic Activity Fast Facts
- Hydraulic Fracturing Disclosure Fast Facts
- Truth about Gasland Fast Facts
- Produced Water Fast Facts
- HF-Fluids Exciting Clean and Green Developments

Studies

- COGCC Gasland Comments
- COGA EPA Frac Statement

print

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HYDRAULIC FRACTURING AND DISCLOSURE IN COLORADO

There is a lot of misunderstanding about what is and is not regulated in drilling and hydraulic fracturing – so we've provided a step-by-step overview of Colorado's rules.

1. In Colorado, operators have to apply to get a permit to drill describing all of their surface and downhole activities through the Colorado Oil and Gas Conservation Commission (COGCC). This includes well design, location spacing, operation, water management and disposal, waste management and disposal, air emissions, wildlife impacts, surface disturbance, and worker health and safety.
2. COGCC oversees all drilling operations including prevention of surface spills, ensuring adequate cementing through cement bond logs and mechanical integrity tests, and monitoring the surface casing and production casing annulus Bradenhead) during fracturing operations for signs of any fluids migration.
3. Information related to the contents of hydraulic fracturing are disclosed to the website www.Fracfocus.org on a well by well basis. FracFocus, which is maintained and run by the Groundwater Protection Council, lists all chemicals used in the fracture stimulation with their Material Safety Data Sheets.
4. State-level oversight and enforcement is important because drilling practices vary according to the unique geological characteristics of the region. State level scrutiny ensures that agency officials understand the operations in each basin. By law, state regulations must be at least as protective as federal standards.

CONCERNS WITH FRACTURING FLUID

First, stakeholders are concerned about what is in these fluids. Fracturing fluids vary based on the specific requirements of the formation, but they generally contain 99.5 percent water and sand. The remaining chemicals are used to facilitate the flow of sand into the formation. These chemicals pose serious hazards when full strength, and our operators handle them extremely carefully to ensure personnel health and safety is protected and surface spills are prevented. Remember – in fracturing, all chemicals combined are diluted to less than one half of one percent of the fluid! See our Hydraulic Fracturing Fact Sheet for more information about hydraulic fracturing fluid.

Second, stakeholders are concerned about the potential of fracturing fluids to be released into underground sources of drinking water from the fractures created in the hydrocarbon formation. In fact, fracturing has too small of an area of influence to release fluids through thousands of feet of rock to reach underground aquifers. The volume of fluid for each fracture treatment is individually designed to impact a few hundred feet of lateral growth in the reservoir, not thousands of vertical feet.

In reality, our industry has to focus on two areas to prevent impacting underground sources of drinking water: **(1) preventing surface spills,** and **(2) ensuring casing protection.** Both of these areas are currently regulated in Colorado. We work closely with regulatory agencies and communities to continue to prevent releases in these areas.

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HYDRAULIC FRACTURING AND DISCLOSURE IN COLORADO

COLORADO REQUIRES DISCLOSURE

COGCC mandates all fractured wells to be catalogued on www.FracFocus.org. Chemical Inventory and Disclosure, requires the following of operators:

- Maintain material safety data sheets (MSDS) for any chemical products brought to a well site for use downhole, including for hydraulic fracturing.
- Maintain a chemical inventory for any chemical product used downhole, including hydraulic fracturing, in cumulative amounts exceeding 500 pounds (about a standard barrel's worth) in any quarterly reporting period.
- Identify trade secret chemical products with the COGCC. Forms are required to justify its trade secret status.
- Identify constituents of trade secret product if requested by COGCC for a spill response or landowner contamination complaint; information will be held confidential.
- Supply trade secret information to a health professional who makes a written request and executes a confidentiality agreement

FRACFOCUS

The online hydraulic fracturing chemical disclosure registry website or www.FracFocus.org was developed by the Groundwater Protection Council (GWPC) and the Interstate Oil and Gas Compact Commission (IOGCC). The database collects information from oil and gas operators around the country.

Colorado rules require reporting on all wells hydraulically fractured on and after April 1st, 2012. Thousands of wells had been documented since April 2011 on a voluntary basis. The registry details the chemicals supplier, the purpose of use, the ingredients, the Chemical Abstract Service (CAS) number, the maximum concentration in the additive, and the maximum concentration in the hydraulic fracturing fluid. When searching for wells, an interactive map is available to easily identify nearby wells. Operators require a technician to provide details for each well, including total depth and water volume, all of which are catalogued with chemicals, and easily searchable through FracFocus.

The website also provides information regarding the hydraulic fracturing process by providing answers to frequently asked questions, and information about site set-up, water management, and subsurface fluid physics. There are additional details on groundwater protection, water well construction and testing, water usage, and indicators of contamination. Plus, FracFocus provides links via an interactive map for contact information to each state's oil and gas regulating body.

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ASSOCIATION

COGA | The Truth About "GasLand" Whitepaper

On Monday, June 21st, HBO aired "GasLand" a documentary by Josh Fox which discusses the natural gas industry. While Mr. Fox's original film was changed after the screenings in response to factual critiques, it is still filled with much misleading information.

Natural gas is a clean, abundant, and domestic energy source that has created 2.8 million American jobs and is vital to our nation's clean-energy future and economy. Colorado is fifth in the country in natural gas employment by supporting 137,000 Colorado jobs which adds $8.4 billion in labor income and $18.3 billion in annual contribution to the economy.

Natural gas is the cleanest-burning hydrocarbon fuel on earth. Natural gas at the burnertip is methane (CH_4), a molecule containing one carbon atom and four hydrogen atoms. By transitioning from wood, to coal, to oil, to natural gas, industrial economies have been steadily moving away from carbon-based energy for two centuries. The primary combustion products of natural gas are nitrogen oxide (NO_x), CO_2, and water vapor. Most air pollution in the United States comes from the transportation and utility sectors. We could reduce total air pollution by nearly 30% using natural gas vehicles. In the electric power sector, by using natural gas-fired generation we can reduce carbon monoxide (CO) and emissions of particulates by 90% and emit 80% less nitrogen oxide (NO_x) with virtually no SO_2,or Mercury.

Drilling for natural gas leaves a small footprint, and most of the infrastructure is underground. Technological advances in the last few years have allowed us to extract 10 times the natural gas with 1/10 of the footprint.

THE REAL STORY OF HYDRAULIC FRACTURING'S SAFETY AND REGULATIONS

Hydraulic fracturing (often referred to as "fracking") is a proven technology that has been refined over 60 years. It has allowed companies to safely produce natural gas from more than one million U.S. wells. The Environmental Protection Agency, Ground Water Protection Council, Interstate Oil and Gas Compact Commission and others have all examined the process and found it to be safe. The essential factor with respect to the safety of hydraulic fracturing is proper well construction, including casing and cementing to isolate the production formations being stimulated from shallow groundwater aquifers.

Contrary to the film's assertions, natural gas production is subject to federal, state, and local regulations that cover everything from initial permits to well construction to water disposal. The natural gas industry is committed to ongoing environmental stewardship and ensuring that we are an excellent neighbor in the communities in which we live and work. We also are committed to answering the public's questions and concerns in a factual and science-based way. While there are many examples of erroneous claims in the film, the following are just a few examples.

"GASLAND" CLAIMS HYDRAULIC FRACTURING IS EXEMPT FROM THE SAFE DRINKING WATER ACT

Mr. Fox claims that the 2005 energy bill pushed through Congress by Dick Cheney exempts the oil and natural gas industries from the Safe Drinking Water Act (SDWA). While the 2005 energy bill does contain language relating to hydraulic fracturing and the SDWA, it does not exempt the industry from the SDWA but reiterates Congress's long-standing position that hydraulic fracturing was never intended to be regulated under SDWA, and that the process is best regulated by state experts and officials on the ground, not by Environmental Protection Agency (EPA) staff. It was simply a restatement of current law.

The Energy Policy Act of 2005 received 74 "yea" votes in the United State Senate including the top Democrat on the Energy Committee; current Interior secretary and then Senator Ken Salazar, from Colorado; and President Barack Obama, then a senator from Illinois. In the U.S. House, 75 Democrats joined 200 Republicans in supporting the final bill, including the top Democratic members on both the Energy & Commerce and Resources Committees. In reality, this effort was a bipartisan achievement.

"GASLAND" CLAIMS THAT THERE ARE HUNDREDS OF CHEMICALS USED IN HYDRAULIC FRACTURING

"GasLand" also asserts that that fracturing fluid is a mix of over 596 unknown and proprietary chemicals. The truth is, the fracturing process uses a mixture comprised almost entirely (99.5%) of water and sand. The remaining materials, used to condition the water, are typically found and used around the house. The average fracturing operation use fewer than 12 of these additives, according to the Ground Water Protection Council — not 596. The entire universe of additives used in the fracturing process is known to the public and the state agencies that represent them.

FLUIDS DISCLOSURE IN COLORADO

Colorado requires companies to maintain a well-by-well chemical inventory for the life of the well plus five years. While the list does not have to be filed with state regulators as a matter of course, it is required to be made available to the Colorado Oil and Gas Conservation Commission (COGCC) upon request, in order to investigate a spill or release, a landowner complaint of well contamination, or an incident of personnel exposure. The Commission shares the information with local health officials, or a treating physician, subject to a confidentiality agreement. The inventory can be shared more broadly if the company does not request trade secret protection.

Not only do individual states mandate disclosure, the federal government does as well. The Occupational Safety and Health Administration (OSHA) mandates that chemical information be kept at every wellsite, and made readily available to response and medical personnel in case of an emergency. Over the course of its history, fracturing has been used to access water and geothermal energy as well as by EPA to cleanup Superfund sites.

COLORADO FLAMING FAUCET NATURALLY OCCURING METHANE

Locally, in Fort Lupton, CO, the film shows a resident igniting his tap water, leaving the impression that the flaming tap water is a result of natural gas drilling. However, according to the Colorado Oil and Gas Conservation Commission (COGCC), which tested this resident's water in 2008, at his request,: "Dissolved methane in well water appears to be biogenic [naturally occurring] in origin. ...There are no indications of oil & gas related impacts to water well."(COGCC 9/30/08). This means that the natural gas in the resident's well water is of recent bacterial origin, which could result from the poor well completion and hygiene, or penetration of shallow coal seams. The film's implication that natural gas production and hydraulic fracturing are to blame is blatantly false.

COLORADO CREEK METHANE ALSO NATURALLLY OCCURING

"GasLand" blamed natural gas development for methane in West Divide Creek, Colorado. Again, the truth is the COGCC visited the site six separate times over 13 months and confirmed that: "Stable isotopes from 2007 consistent with 2004 samples indicating gas bubbling in surface water features is of biogenic origin." (July 2009, COGCC environmental protection supervisor Margaret Ash). In a follow-up email to the complainent: "As you know since 2004, the COGCC staff has responded to your concerns about potential gas seepage along West Divide Creek on your property and to date we have not found any indication that the seepage you have observed is related to oil and gas activity." (email from COGCC to Lisa Bracken, 06/30/08)

COLORADO INDUSTRY'S COMMITMENT TO SAFETY AND ENVIRONMENTAL PROTECTION

Do incidents occur? Yes. And in those rare cases, companies work with the appropriate regulatory authorities to identify and correct the issue, and to implement measures to ensure they don't happen again. We in the oil and gas industry understand and respect your concerns and questions about the safety of your water and air. We are committed to working with community members, policymakers, and stakeholders to ensure the safety of natural gas production.

We are committed to providing economy, environmental, and energy solutions to Colorado. Our state had more than 30,000 natural gas wells in production in 2009. Ten of the Nation's 100 largest natural gas fields and three of its 100 largest oil fields are found in Colorado. Severance tax is levied on extraction of metals, coal, oil and gas and is part of TABOR revenue base. Oil and gas pay over 90% of the state's severance tax. The total assessed values for taxable Oil and Gas property in 2009 was $11.9 billion or 12.1% of the state total.

FOR MORE INFORMATION GO TO:

Debunking 'GasLand' (from www.EnergyInDepth.org)
The Truth About 'GasLand' (from America's Natural Gas Alliance)

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Produced Water

Produced water is naturally-occurring ("connate") water that exists in the formation and is "produced" along with hydrocarbons. This water is generally saline (due to formation deposition in marine environments), containing minerals such as barium, calcium, iron, and magnesium. Produced water can require treatment before surface disposal. When drilling and hydraulic fracturing (HF) occur, produced water flows are high due to "flowback" of water injected during the operations. Approximately 50% of all produced water that is released from drilling and stimulation comes out of the well in the first few days to a week, and is stored in holding and treatment tanks. After the well is serviced, water can keep flowing from the well for long periods of time depending on the quantity of water in the target formation. The remainder of this water is stored in holding tanks, for eventual disposal.

Flowback water is recovered water from HF use that returns to the surface. As it travels up the well bore, it mixes with produced water, and often times when it reaches the surface, it is referred to as produced water. This water contains clay, dirt, metals, and chemicals, and generally requires treatment before reuse.

Regulation

In Colorado, produced water is regulated by the Colorado Oil and Gas Conservation Commission (COGCC). Rules 907, 908 and 325 govern the disposal methods for produced water and requirements for those disposal methods.

Rule 907, Management of Exploration and Production (E&P) Waste: Covers the treatment, disposal, reuse/recycling, and mitigation of E&P waste, including produced water

Rule 908 - E&P Waste Management Facilities Regulation: describes the requirements for waste management facilities, including those treating produced water

Rule 325 - Underground Injection of Water: identifies construction requirements for wells that dispose of produced water and describes that eligibility of zones to receive waste water

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Produced Water

Produced Water Management Practices in Colorado

In Colorado, most of the flowback water is recycled. The rest of the water is disposed according to COGCC guidelines. Of the water disposed, approximately 60 percent is disposed of in underground injection wells, 20 percent is managed in evaporation ponds, and 20 percent is discharged to surface waters under permits by the Colorado Department of Public Health and Environment (CDPHE).

Recycling/Reuse

Produced water recovered in the first few days of servicing a well is generally reused for future operations. Often times, this water comes back brackish, withhigh total dissolved solids (TDS). Dilution of this water can prepare it for reuse in another well. Reuse and recycling rates vary due to field conditions. For example, if there is high demand for water for other operations, then nearly all of the water recovered is reused for servicing new wells. Conversely, if production is slow, then more produced water is disposed.

Disposal Practices

Underground Injection

Produced water that is not recovered in the first few days after servicing a well is often disposed of. In Colorado, the most common method of disposal is through an underground injection control (UIC) well. These wells are permitting by COGCC under the Environmental Protection Agency's UIC program. This includes requirements for casing and cementing, monthly reporting on materials and volumes injected, and periodic pressure tests to ensure the waste stays in the designated formation.

Evaporative Pits

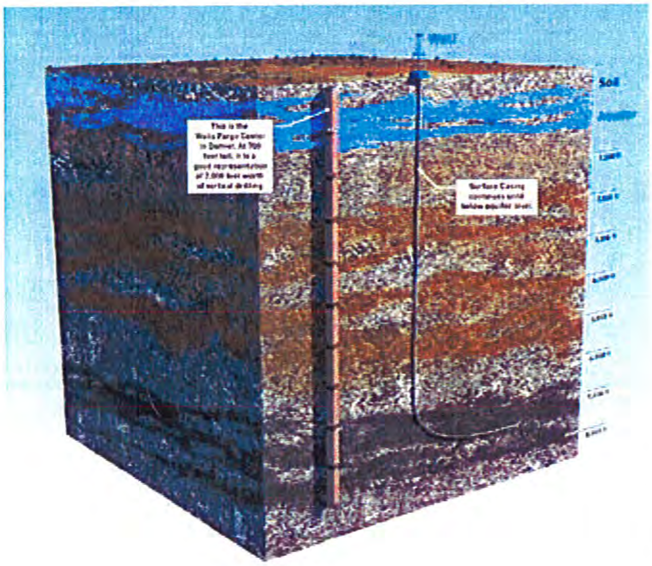
In Colorado, the majority of evaporative pits are used in in the Raton Basin in the southern part of the state. Operations there are dominated by coalbed methane production, which produces water with low TDS.

Surface Discharge

In Colorado, produced water may be permitted for discharge to streams or surfaces. Guidelines for surface disposal are established by the Colorado Water Control Division, and such discharge requires a permit. If the stream or river is a drinking source, then the water must meet stringent parameters. Water can also be spread on roads for dust suppression if it meets TDS requirements.

Updated 6/14/11

HF Fluids – Exciting Clean and Green Developments



The fluid formulation is the rocket science behind hydraulic fracturing (HF). A subtle difference in formulation can make a huge difference in the effectiveness of the fracturing treatment in releasing oil and gas resources.

The design of each HF process focuses on understanding the reservoir rock and subsurface conditions in order to design HF fluids that can optimize results. Particularly in new areas, such the emerging shale plays, HF optimization is an exciting area of discovery, imagination, development, and ultimately increasing degrees of success.

What is particularly amazing, is that this subsurface rocket science is all happening in less than 0.5 percent of the total fluids used. 99.5% is sand and water! In addition to water, HF fluids include:

- **Proppant** – This is sand or other hard spherical material used to hold cracks open during well production life.
- **Gelling Agents** – These make the fluids thicker and slicker.
- **Cross Linkers** – These are used to react with the gelling agents to make the fluid even thicker.
- **Breakers** – These are used to thin the fluid after time and temperature to ensure production.
- **Surfactants** – These aid in HF fluid recovery and improve well production.
- **Biocides** – These control the growth of bacteria, which can impact the gelling agents.
- **Additional Additives** – These are used to address other subsurface challenges such as pH, clay control, and scaling.

Increasingly, industry stakeholders are asking operators and service companies to design and provide green fluids. But what makes a fluid green? Is the color in the eye of the beholder?

Most stakeholders will consider a fluid green if its health, safety or environmental impact is reduced compared to what has traditionally been utilized for a similar purpose. Green HF fluids are increasing under development and use in the industry.

For example, Halliburton, an oil field service provider, has developed the CleanStim fluid system which sources its additives from the food industry. A second innovation called CleanStream can eliminate the use of chemical biocides.

"We are excited about these developments as the next phase in the evolution of HF technology," said David Adams, vice president, Production Enhancement, Halliburton.

For its part, Pioneer Natural Resources, an exploration and production company, has its own HF laboratory in southern Colorado. Pioneer develops fluids that are formulated with products commonly found in household products.

"We heavily favor products that are environmentally friendly," says Kevin Tanner, manager at Pioneer Natural Resources. "This is the direction that we, as a company, have decided to go, and we all believe that this choice is the right way to run our business. Our employees live in the areas where we work, and they have a vested interest in ensuring that we do everything possible to protect the environment."

"The lab," explains Tanner, "gives us the flexibility to optimize the chemical loadings and evaluate other products without the bias of the chemical companies that are selling to us."

Looking forward, the use of green chemistry in HF operations is only limited by the technical compatibility of these new processes with the subsurface environment. Companies like Halliburton and Pioneer continue to invest in HF technologies that reduce the environmental footprint while increasing their effectiveness.

We are seeing evidence of this investment in action in the Niobrara play in northeast Colorado. Halliburton's Brighton camp is one of the first camps to use Advanced Dry Polymer Blender, providing viscous HF fluids without the use of mineral oil – a meaningful environmental improvement. Stay tuned for further HF fluid developments with positive implications for the entire industry.

PLATTE RIVER
POWER AUTHORITY

MEMORANDUM

March 21, 2012

To: Board of Directors

From: Bill Emslie, Project Engineer

Subject: Surplus Water Leasing Policy

Background

At the February 23, 2012, Board meeting a request was made for a future agenda item to discuss Platte River's policy as to the lease of surplus water. The lease of surplus water involves both surplus effluent and surplus Windy Gap units.

Surplus Water Supply

Platte River has an allocation of 160 units of the Windy Gap Project. These units were transferred in 1974 to Platte River from Estes Park (40 units), Fort Collins (80 units) and Loveland (40 units). This water was purchased by Platte River at the time because it was available from the municipalities and Platte River had a need for a fully consumable water supply to provide cooling for future generating units within the Platte River drainage basin. Initially, 5,150 acre-feet of the Windy Gap water was planned for use at Rawhide Unit 1. An additional 4,060 acre-feet was identified and held in reserve for future generation units at the Rawhide Energy Station. This left approximately 6,790 acre-feet as surplus Windy Gap water.

It is unlikely that future coal units will be constructed at Rawhide, but the water held in reserve can be used for other types of generation, such as gas-fired combined cycle generation. Even with the use of all water identified for current and future generation, Platte River still has surplus Windy Gap water. In the past, the Board has wanted to hold this Windy Gap water for potential future use by the four cities, but this surplus Windy Gap may be leased to the cities or others subject to Board approval. Board Resolution 7-94 established this policy.

In addition to surplus Windy Gap water, Platte River has surplus reusable effluent resulting from its Windy Gap order and the Reuse Agreement with Fort Collins. Under the Reuse Agreement Platte River receives 4,200 acre-feet of reusable effluent in exchange for a like amount of Windy Gap water. In addition, Platte River is entitled to the return flows from the first use of Windy Gap water by Fort Collins. These return flows provide approximately 1,115 acre-feet of additional reusable water. Rawhide Energy Station's current annual average use is 3,400 acre-feet. Platte River has annual augmentation requirements up to 309 acre-feet. The surplus after Platte River's needs averages 1,606 acre-feet per year and is calculated as follows:

Annual Reusable Effluent Sources	**Quantity (acre-feet)**
Water generated by Reuse Agreement	4,200
Anticipated return flows from MOU with Fort Collins and Anheuser-Busch, Inc.	615
Anticipated Windy Gap return flows	500
Total annual reusable effluent	5,315
Annual reusable effluent water use	**Quantity**
Annual average effluent pumped to Rawhide via 24" pipeline for cooling	3,400
Annual allocation for augmentation	309
Total annual effluent use	3,709
Net annual average surplus reusable effluent 5,315 AF - 3,709 AF	1,606

Platte River has marketed this surplus effluent over the years with a limited degree of success. The following is a summary of effluent leased to date:

Windy Gap Year	**Acre-Feet Leased**	**Revenues**	**Average Price/AF**
1997	9	$ 270	$ 30
2001	2,000	$ 30,000	$ 15
2006	1,400	$ 42,000	$ 30
2007	1,000	$ 47,000	$ 47
2009	1,538	$ 123,852	$ 81
2010	163	$ 19,376	$ 119
2011	167	$ 19,825	$ 119
2012 (to date)	121	$ 30,198	$ 251
2013 (to date)	97	$ 24,362	$ 252
Total	**6,494**	**$ 336,882**	

Traditionally two markets existed for the lease of surplus effluent: agricultural and augmentation. Agricultural water is considered single use and typically rents for approximately $10 to $40 per acre-foot. Augmentation water requires a reusable source and prices vary, but can be up to $500 per acre-foot. Historically, demand for reusable water in Northern Colorado has been limited; therefore, Platte River has been compelled to lease any excess water for single use when it cannot be leased as reusable. Platte River's reusable rental rate was raised in 2010 and 2012 to be more in-line with market prices as requests increased for water for specific augmentation needs that required a reusable source of water. Platte River's current rental rate for reusable water is $300 per acre-foot. Although this rate is higher than past rates charged by Platte River for reusable water, it is still on the low end of the current rental price range for reusable augmentation water in this region. Because of this, demand continues in the limited augmentation market for Platte River's reusable water in spite of the recent price increases.

Surplus Water Lease Policy

The demand for lease of water has changed significantly over the past year due to local oil and gas well development. A number of entities have started leasing their surplus water for this purpose. A recent article in the *Coloradoan* addresses this topic. It can be found at http://www.coloradoan.com/apps/pbcs.dll/article?AID=/201203110505/NEWS01/120310012. Both reusable and single use water have been leased. The use of Colorado-Big Thompson (C-BT) water for this purpose has led to the development of an Oil and Gas Well Development policy by the Northern Colorado Water Conservancy District. This policy restricts the use of C-BT water to within the boundaries of the District. It also restricts the first use of Windy Gap water to within the boundaries of the District and Municipal Subdistrict. Because of this policy, the demand for other sources of reusable and single use water is expected to increase.

A request was recently made of Platte River for lease of all its surplus reusable effluent for oil and gas development. There has also been a request for lease or possible purchase of some of Platte River's surplus Windy Gap units, probably for this purpose. Platte River's surplus effluent is in demand because a large portion of the effluent is reusable and can be used to extinction anywhere within the State of Colorado, thereby making it an ideal supply of water for oil and gas well development. Windy Gap return flow water may also be used for oil and gas well development anywhere within the State of Colorado.

Because of the desirability of Platte River's surplus reusable effluent for oil and gas well development, the Board may wish to develop a policy addressing leases for this purpose. The Board may also wish to consider such use on a case-by-case basis.

Attached to this memo are Platte River's current water policy resolutions 07-94 and 25-09.

A discussion and brief presentation have been scheduled for the March 29 Board meeting. Should you have questions; staff will be prepared to respond.

Attachments