When Water Rights Ebb into Energy Development: Unconventional Oil & Gas Development and Changes to Water Allocation in Northern Colorado

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Overview of Project Design from Proposal:

My research will examine intersections between water rights and unconventional oil and gas (O&G) development in northern Colorado. Specifically, I aim to interrogate ways in which northern Colorado agriculturalists, community leaders and stakeholders, industry participants, Colorado State University Extension personnel, and other mediating institutions and actors negotiate water rights amid expanding unconventional O&G development. I intend to analyze how leasing or selling water rights may empower Colorado communities and agriculturalists, especially those in the latter group who do not own mineral rights due to split estate, to participate in the industry boom.

My research questions will include the following:
1a) How have Colorado communities, agriculturalists, and industry actors negotiated water rights for unconventional oil and gas development, given the industry's rapid growth in agriculture-centered areas like Weld and Larimer counties?;
1b) What roles have government institutions, NGOs, community leaders, and Colorado State University Extension personnel played in navigating relevant shifts in water allocation and rights?; and
2) How does leasing or selling water rights empower communities and/or agriculturalists?; and
3) Given contested water rights and impending water scarcity in the region, are shifting water rights and allocations sustainable?

Final Project Summary

Background

While oil and gas development is not new to Colorado, the pace and scale of less conventional methods of extraction like hydraulic fracturing are unique and unprecedented. Colorado plays a central role in oil and gas industry growth – the state produced a record 48 million barrels of oil in 2013 and Colorado's rural Weld County hosts over 18,000 gas wells alone, a national record.[1] While agriculture dwarfs hydraulic fracturing in terms of water consumption in the state (agriculture consumes about 85% of water in the state, while hydraulic fracturing consumes less than 1%), the Colorado Oil and Gas Conservation Commission estimates that the industry's water demands in Colorado will grow substantially, increasing from 13,900 acre-feet in 2010 to 18,700 acre-feet by 2015.[2] At the same time, water

[1] See Executive Summary of the EIA's 2013 projections, which extend through 2040 at: http://www.eia.gov/forecasts/aeo/er/executive_summary.cfm. Also see specific information on Colorado's record oil production at: http://oilpro.com/post/648/top-5-unconventional-oil-plays-in-the-us#niobrara_formation.

[2] Colorado Oil and Gas Conservation Commission's (COGCC's). "Water Sources and Demand for the Hydraulic Fracturing of Oil and Gas Wells in Colorado from 2010 through 2015." Accessed at: http://cogcc.state.co.us/Library/Oil_and_Gas_Water _Sources_Fact_ Sheet.pdf.

scarcity is projected to grow substantially in arid Colorado within two decades. Despite projected industry growth alongside water scarcity, however, we still have very little data about vital relationships among water rightsholders, industry, community stakeholders, and mediating institutions that help govern common pool resources like water. This project helps address these important gaps in knowledge.

Main Findings

My key findings, detailed below, included the following:

- Unconventional O&G production's demand for potable water intersects with demands for water from agriculture (dominant) and municipal uses (growing) in northern Colorado.
- Farmers, ranchers, and ditch companies play pivotal roles in mediating land and water access and use, though their economic power is limited by their structural dependency on volatile natural resource markets.
- Due to its ability to pay exponentially higher rates for water, the unconventional O&G industry has a substantial and significant impact on access to water markets in northern Colorado. This was the case especially in relation to renting/purchasing shares of water in northern Colorado, particularly during 'dry years' when junior rights holders and non-rights holders may compete fiercely for access to water to run their operations.
- As industry drives up these prices, they become the most competitive and rational buyers for municipalities, such as Greeley, and other institutions, such as ditch companies, who are able to lease their water or infrastructure for O&G production (especially in 'wet years' or under 'free river' conditions).
- Corporations' individualized approaches to water acquisition vary, as do their interactions with landholders, owners, and water rights holders, which I identify as two distinct strategies.
- In many ways, ditch companies act as bridges between the agricultural sector and the unconventional O&G industry. Or, perhaps more accurately, they have the power to broker whether and when water will flow through their ditches and into/out of their reservoirs, connecting agricultural production directly with unconventional oil production in Weld County.

Activities During Grant Period

Fieldwork & Methods

Shortly after beginning my research, it became clear that the 'water world' is a closed universe; it takes a bit of time and energy to be accepted and trusted by the people and institutional actors shaping that world in Colorado. To help me more fully understand these dynamics, I used mixed-method fieldwork, including in-depth interviews, participatory observation, archival analyses, and other ethnographic methods. These methods allowed me flexibility and facilitated a well-rounded perspective as I explored my research questions. Importantly, I learned

from early fieldwork that instead of focusing on water rights, it would instead be more appropriate and rich to interrogate ways in which the O&G industry impacted water markets in the state.

Preliminary Ethnography. My fieldwork began with preliminary fly-overs of Larimer & Weld County, to observe and photograph interactions between unconventional oil and gas (O&G) facilities and water resources in northern Colorado and to monitor lingering flood damage from historic September 2013 flood in northern Colorado.

My two flights (provided by non-profit Lighthawk Foundation) allowed me a unique view of unconventional O&G development's large footprint in Weld County, particularly as it wove into farmland and in close proximity to vital water resources like the South Platte River, various reservoirs, and irrigation water distributed across northern Colorado. (See Photos in Appendix). The extensive interactions between water users, unconventional O&G production, and agricultural production in northern Colorado became quite apparent.

In-Depth Interviews. After my flights with LightHawk and extensive historical research on Colorado's complex systems of water rights allocation and adjudication, I used this information to help select networks and institutions that should be included in my pool of interviewees. In-depth interviews were conducted in people's homes or places of work or at various ditch company offices, with each interviewee choosing the location. Interviews lasted anywhere from 30 minutes – 3 hours, though the majority of them lasted between 60 – 80 minutes.

I conducted 46 in-depth interviews overall. I interviewed Local Government Designees, a variety of farmers and ranchers, municipal water manager/planners, ditch company managers and board members, industry representatives with major O&G companies, water hauler/provides, members of the State Department of Water Resources, river commissioners, water rights lawyers, experts in water irrigation and agricultural resource economics, Colorado State extension agents, and community members with specific concerns related to water rights or equitable access to water markets. The majority of my interviews were with farmers/ranchers and ditch company administrators, given their centrality at the food-water-energy nexus. Given the breadth and complexity of the water world, I intend to continue these interviews beyond the fellowship period.

I began my interviews with COGCC's Local Government Designees (LGDs), who work as liaisons between the regulatory agency and relevant communities. I also attempted to interview Colorado State University Extension agents who specialize in energy. While the latter group had little knowledge of or interaction with the O&G industry, some of the LGDs were able to explain the structure and dynamics of water rights systems affecting municipalities, the O&G industry, and agriculture, even as they highlighted the centrality of ditch companies and farmers/ranchers in water markets and systems of water rights in the state.

From initial interviews, it became apparent that I would focus my efforts on municipal water managers/planners (who interacted regularly with the O&G industry via water lease agreements) and on ranchers and farmers. As my network sample grew, regional ditch companies emerged as central institutions of interest. I found that ditch companies – or formal groups of water rights holders, many of whom are farmers or ranchers – have become central institutions mediating interactions between the agricultural community, its vast water resources and infrastructural capacity, and the O&G industry's keen needs for millions of gallons of water. As a result, their participation in this research became a key goal of mine.

As I focused in on the agricultural community, it became apparent that conducting focus groups would not be especially conducive to my research goals. The farmers and ranchers, ditch company managers, and municipal water managers/planners I interviewed had incredibly busy schedules that were often ruled by unpredictable factors like the weather. Further, most of them preferred to discuss these topics privately, given their controversial and politicized nature. I aim to cater to the schedules and comfort levels of my interviewees, so I decided to visit places of work and farms individually to conduct interviews at people's discretion.

The 46 interviews conducted to date have been transcribed verbatim and have been coded for preliminary emergent themes. I am continuing additional iterations of coding this summer, while preparing manuscripts for publication from that data.

Additional Fieldwork. My additional ethnographic fieldwork and participant observation included about 20 farm visits. I was invited to observe operations at local agricultural businesses, while also being able to observe wellpads, tank batteries, pipelines, compressors, and other infrastructure related to unconventional O&G production and transportation on those farms. These visits allowed me to observe important details about the size and type of each farm and their irrigation systems, while also allowing me to observe regional oil production on private land. These visits crystallized for me the complex ways O&G production overlaps with agricultural production (especially conventional, large-scale agriculture) in Weld County.

In addition to farm visits, I made site visits to several ditch company offices around Weld and Larimer counties. These visits allowed me to observe the daily operations of ditch companies, talk to board members and managers about each company's relationship with O&G production, and see detailed maps of their assets and sometimes even financial statements and other important but tightly-guarded details of the financial relationships between ditch companies and the O&G industry.

Finally, I conducted extensive general ethnographic fieldwork in Weld County, as I drove throughout Weld and Larimer counties and to farms and ditch companies for interviews and participant observation. I took hundreds of photographs of the intersections between agricultural production, O&G production, and intensive water

usage. (See sample Photographs in Appendix.) My fieldwork took me to central water resources, including Milton Reservoir, which is now nearly surrounded by an industrial zone of water extraction, oil production, semi-truck traffic, dust, and refineries. My fieldwork took me to several rural, primarily agricultural communities that now adapting to thousands of wellpads and hundreds of semi-trucks roaring around unpaved county roads each day, transporting thousands of gallons of water, flowback water, and other effluents and resources related to unconventional, large-scale oil extraction. Months of these sorts of experiences left an indelible impression of how extensive, widespread, and industrialized unconventional O&G operations are in Weld County, and how tightly they map on to valuable rural agricultural lands – and the water resources that are often tied to that land.

Archival & Media Analyses. The last portion of my research included archival analyses and informal media analyses. This research has been on-going for the duration of the project and continues as I write this report.

I first acquainted myself with Colorado's current regulatory framework related to unconventional O&G development (via the COGCC), focusing on regulations related to water resources and water use. With a dearth of water-specific regulations and information, I delved in to more general literature and historical accounts related to Colorado water law; the state's complex systems of water rights, water courts, and problems with over-allocation; and the ways in which municipalities, agriculturalists, and industry have worked to acquire water even as companies increasingly vie for access to this scarce resource in arid regions like Colorado and the American West.

I also accessed several databases as my research progressed, including databases on water change cases in Colorado's Water Court (historical and pending). A few other databases I repeatedly utilized attempt to quantify the amount of water used by the O&G industry in various towns and counties in northern Colorado over various time periods.

I utilized a large volume of white papers, agency reports, and county/state government data and reports that I uncovered or which were suggested by my interviewees as I met with them or contacted them for follow-up. These reports added context, a variety of perspectives, and also allowed me to understand how my interviewees accessed information and gained knowledge of unconventional O&G production and water use/consumption.

Finally, I have monitored local and regional media sources, especially the *Greeley Journal, The Coloradoan, the Denver Post*, and other media and social media accounts. These sources allowed me to observe public response and even highlight important community members I would attempt to interview.

Central Findings

My research was exploratory in nature, given the dearth of academic investigation on the relationships between unconventional O&G production and water use in northern Colorado.

Two *general findings* substantiated what I had suspected in my initial proposal to conduct this project. Namely:

- Unconventional O&G production's demand for potable water intersects with demands for water from agriculture (dominant) and municipal uses (growing) in northern Colorado.
- Farmers, ranchers, and ditch companies play pivotal roles in mediating land and water access and use, though their economic power is limited by their structural dependency on volatile natural resource markets.

Over the first few months of fieldwork, I learned that water rights were being changed and affected by the O&G industry's presence. **But I concluded that the *real* sociological story was in the substantial and significant impacts the industry has on water *markets* in northern Colorado, especially on the price market actors may have to pay to lease (and occasionally purchase) a share (or an acre-foot) of water.** When the booming unconventional O&G industry entered the northern Colorado water market with their intense demand for water, they affected prices dramatically. At times, like the extra-dry year of 2012, the industry drove up prices from a normal $30/acre-foot (which a farmer might normally pay to lease a share of water) to over $3,000/acre-foot – a price affordable to industry actors but well beyond the reach of even most large-scale farmers.

As such, two other key findings emerged, namely:

- Due to their ability to pay exponentially higher rates for water, the unconventional O&G industry has a substantial and significant impact on access to water markets. This was the case especially in relation to renting/purchasing shares of water in northern Colorado, particularly during 'dry years' when junior rights holders and non-rights holders may compete fiercely for access to water to run their operations.
- As industry drives up these prices, they become the most competitive and rational buyers for municipalities, such as Greeley, and other institutions, such as ditch companies, who are able to lease their water or infrastructure for O&G production.

My preliminary analyses also uncovered **several key themes** emerging in my triangulated data. These include the following:

EXTENSIVE WATER MARKET IMPACTS

Water markets in northern Colorado have been uniquely and significantly shaped by unconventional O&G production's growth. This has happened alongside booming

population growth and increasing demands for scarce water resources from a variety of sources. The nexus of conventional food production, unconventional energy production, water use, and population presents a suite of concerns for the Colorado water community and other leaders, and it adds extra pressure to over-allocated water resources. As each set of stakeholders vies for their share of the water resources pie, sociological outcomes such as differential access to markets and institutional power are vitally important outcomes to consider.

My central related findings include the following:

- While the unconventional O&G industry may consume a small percentage of state's water (they claim to consume less than 1% of the state's water resources), the industry has substantial impacts on Colorado water markets.
    - To a lesser extent, the industry affects systems of water rights, as some wealthy agriculturalists or ditch companies have been persuaded go to Water Court to redesignate their agricultural water as multiple-use.
- As such, the goals and consequent impacts of the industry are both shorter-term (access to markets) and longer-term (re-designation of water rights and acquisition by O&G corporations).
- Several interviewees expressed concerns over the nature of water use – consumptive use – by O&G companies for unconventional production methods. They were especially concerned that water is being utilized to extinction, as flowback fluid and other wastewater is permanently removed water from hydrologic cycles and from future access (unless recycling technologies are developed).

Sample Interview Quotation:

- "The oil and gas people can essentially set the market price to lease shares of water. And the price of rental water has gotten so high, especially in dry years, that only oil and gas companies can afford it. Farmers especially are priced right out."

    --Colorado water market expert & Conservancy District board member

VARIED CORPORATE CULTURES AND COMMUNITY RELATIONS

Corporations' individualized approaches to water acquisition vary, as do their interactions with landholders, owners, and water rights holders. These impacts will certainly change over time, depending on oil prices and other market dynamics. While my respondents at Anadarko expressed a desire to work with communities and especially with the agricultural community in Weld County, Noble was more adamant about wanting to acquire their own land and other resources over time to provide stability for their shareholders.

My central related findings include the following:

- Strategies for water acquisition varied markedly among water haulers/providers and the O&G companies. Water haulers/providers I interviewed, particularly working with A&W Water (operating out of Fort Lupton, Colorado), asserted that their company had a strong culture of adhering to water designations. At the same time, these same respondents all mentioned a multitude of new water providers who had set up shop during the oil boom. These companies were not highly regarded by better-established providers, who believed that they might not be adhering to system of water rights and designation as stringently as their company was.
- Certain O&G companies, especially Noble, expressed interest in acquiring more permanent access to water resources. They want to buy land directly and acquiring related water rights or, more desirably, acquire land on which they can drill into non-tributary sources of water for their operations, and thereby bypass hotly contested systems of water rights and unpredictable water markets. Anadarko, on the other hand, wanted to work more directly with municipalities and farmers/ranchers to lease any excess water they could from those entities.
- These strategies can be categorized as follows:
  - Strategy #1 (Anadarko):
    - Shorter-term leases with farmers/municipalities for land and water, pipeline space
    - Want to move water using pipelines rather than trucks
    - Use relationships with farmers to secure land
  - Strategy #2 (Noble):
    - Buy tracts of land with (senior) water rights attached
    - Lease (or buy) farmland to access non-tributary groundwater
      - Corp gets water right but "in family's name"

Sample Interview Quotations:

Strategy #1: Informal subsidies benefit farmer

- "There is no more adaptable creature than the farmer. And farmers here have adapted to this industry because it gives them some relief from all the pressures they face as they try to sell commodity crops that have been bringing in no money."

  --Conservancy District Director

Strategy #2: O&G companies become landowners/rights-holders **and** lease land/water from farmers

- "We're trying to be aware of our water and land holdings but also cultivate a strong ag-energy-community relationship."

In the context of either strategy:

- Both companies asserted that their institutions had invested heavily in developing pipeline systems, and acquiring land for their implementation, in order to reduce the number of water trucks on the road. How this will affect

water providers/haulers remains to be seen, but it would likely reduce the number of providers necessary to supply the industry.

* Ditch companies have also been central in providing alternative transportation mechanisms for the O&G industry, especially by leasing their ditch space in the off-season and even reservoir space in certain cases.

INSTITUTIONAL IMPORTANCE OF DITCH COMPANIES

In many ways, ditch companies act as bridges between the agricultural sector and the unconventional O&G industry. Or, perhaps more accurately, they have the power to broker whether and when water will flow through their ditches and into/out of their reservoirs, connecting agricultural production directly with unconventional oil production in Weld County. This sort of relationship has of course been much more developed and multi-faceted for ditch companies that have holdings in the Denver-Julesburg Basin (DJB) and the Niobrara Shale formation, as they have been most often approached by the industry to use their infrastructure or to lease water from their centrally-located reservoirs.

My central related findings include the following:

* Without the ditch companies, industry would have much more limited ability to move water to their sites and more limited access to leasing shares of water. Without leasing ditch companies' excess water, and especially without leasing access to the ditch companies infrastructure to "move water" to their 'fracking' sites, the industry would be largely unable to operate in northern Colorado. Leasing from ditch companies allows O&G companies more discretion and invisibility than leasing from municipalities like Greeley, which may end up in newspapers during dry years.
* Certain ditch companies mediate needs of their farmer member-owners and the wealthy O&G industry
* Many ditch companies above DJB have leased "right color" water to O&G companies if excess supply available.
* They have also leased space, facilitated transportation of other water through their ditches and gates, and otherwise leased their infrastructure to facilitate transportation from one site to another of water needed for 'fracking'.
* Ditch companies, especially those with holding above the DJB, asserted that they have been able to routinely lease storage space in reservoirs to O&G companies operating in the area.
* Some ditch companies were also able to lease land for wellpad construction, pipeline placement, or the placement of other production infrastructure.
* The ditch companies – and their shareholders – benefit immensely from these informal subsidies. Ditch company administrators I interviewed asserted that their relationships with the industry had been positive, discussing this almost exclusively in economic terms. Managers and board

members consistently emphasized that due to their various leases with O&G companies, they have been able to do the following:
    - Reduce or eliminate shareholders' assessments
    - Pay off substantial debts
    - Pay for substantial repairs to their head-gates, ditches, etc. from the September 2013 floods.
    - Invest in new equipment or pay off equipment for ditch maintenance
    - Pay for other improvements to their operations
- Farmers who were able to lease their mineral rights, surface rights, or water rights also expressed many of the same general economic gains as ditch companies did. They either saved this bonus income or used it for similar debt repayment or investments in their farming operations. Mineral rights holders seemed to experience the most gains.

Sample Interview Quotation:

- "We have been able to waive assessments for our shareholders, pay for and execute damages to our infrastructure from the 2013 floods, and invest in new equipment and other improvements due to lease monies coming from the oil and gas folks."
    --Manager of a Northern Colorado Ditch Company

- "We see Colorado farmers and ranchers as our partners in this new economy here in Colorado. We have made an extraordinary effort to develop agreements with farmers that are quite beneficial to them because we depend on what they can offer us – or not."
    - --Noble Energy Water Resources Energy Manager

Sociological Significance

As an environmental sociologist, my primary concern is with the community-level sustainability of resource-based economic relationships brokered between powerful oil and agricultural institutions.
I am especially concerned with: unequal market prices and bifurcated access to markets for water, created by the O&G industry's demands for that resource; the boom-bust nature of unconventional O&G production as it intersects with agricultural economies; and social sustainability (or lack thereof) in the context of these two intersecting natural resource dependencies.

Double the Natural Resource Dependence. Farmers, ranchers, and even ditch companies in Weld County find themselves at the intersection of two forms of structural dependence on natural resource markets. Farmers' and ranchers' economic dependence on globalized, volatile agricultural commodity markets can structure debt and economic vulnerability and instability for those households. At the same time, the O&G industry wants access to the mineral wealth (oil) beneath large swaths of agricultural land in Weld County and needs access to water

resources as well. The industry can offer those economically vulnerable farmers some security, in the forms of leases – and bonuses and royalties for those leases – for surface or (better yet) mineral rights access.

But farmers take on several substantial risks alongside the rewards. Once underway, O&G producers use parcels of leased land (often agricultural) for drilling, for placement of other production components like tank batteries, and to lay pipeline for eventual water transport. This land can remain out of production for long periods or may even be withdrawn from production, removing that portion of farmers' or ranchers' income streams.

While O&G income helps many farmers, ranchers, and ditch companies temporarily during times of booming production, lower oil prices in the last six months have signaled an inevitable bust cycle and generated accompanying lay-offs, even among larger producers like Noble. During these busts, royalty and lease payments slow or stop, farmers must contend with impacts to their land without extra industry income, and they must also contend with other community-wide elements of bust cycles, including de-population and loss of services. As such, farmers/ranchers who are implicated in unconventional O&G production via various leases experience vulnerability to agricultural commodity and oil markets, both notoriously volatile, leading to the potential for social disruption seen in related literature (see Stedman and Brown 2003).

Inequality. Equally important, this food-energy-water nexus structures new forms of inequality, particularly in access to rewards from booming production, such as lease monies and access to markets for resources like water. Only those with mineral rights and/or substantial senior water rights are able to capitalize on the industry's booming production. Even then, they contend with lack of regulatory oversight and other complications (Opsal and Shelley 2014).

At the regional level, these relationships help structure uneven (bifurcated) water markets, where some players can afford access even as others cannot. While the industry was widely rumored to have leased shares of water for $3,000/acre-foot in dry years like 2012, my interviewees confirmed that most farmers would be hard-pressed to spend more than $50/acre-foot, and certainly no more than $100/acre-foot, even in the driest years. Because the industry can afford access to water at virtually any price and can afford to buy access to water even (and maybe especially) in "dry years," it has a distinct and uneven advantage in its market participation. Economically vulnerable farmers, small-scale farmers, and other less wealthy participants in water markets will not be able to afford that price to access markets.

This does not bode well for social sustainability outcomes related to these two industries, especially as they intersect in Weld County. While most farmers, ranchers, and ditch company representatives I interviewed asserted that they saw O&G money as a 'bonus' and not as a reliable income stream, they did use this

money to enhance their operations. And each year they have used it, they become more accustomed to its presence. In this way, farmers, ranchers, and ditch companies may come to rely on temporary, unstable sources of income from the unconventional O&G industry. In this sense, there is the risk of perpetuating overlapping "addictive economies" (Freudenburg 1992) due to normalization of industrialization.

In many ways, this parallels my findings in Pennsylvania, where farmers have used lease bonuses and royalties to pay off substantial debts, to transition out of labor-intensive forms of farming like dairy, or to keep their land in their families for future generations. At the same time, they also contend with similar boom-bust patterns and economic vulnerabilities.

Deliverables

Deliverables from this research include my public presentation of this data for the Water Center's seminar series, which I delivered on 13 April 2015. I completed a guest lecture for the Civil and Environmental Engineering Department at CSU in Fall 2014 as well, with much of the content coming from early interviews related to this project.

As I complete my final rounds of data analysis, I intend to submit at least two conference abstracts and draft at least three peer-reviewed articles based on my observations related to water market dynamics, natural resource dependence, and parallels between outcomes in Colorado and Pennsylvania. Further, I will be sending copies of this report to several of my interviewees, who have requested to have my findings and results shared with them. I have also offered to present findings to these individuals and others I have interviewed.

Outcomes & Impacts

This research has been used to apply to the American Sociological Association's Funding for the Advancement of the Discipline fellowship, which funds research related to underexplored aspects of sociology. Using this project's data as a baseline, I proposed to interrogate environmental justice outcomes of O&G development in Weld County, particularly its impacts on agricultural workers, related labor markets, and small-scale agricultural producers.

This project has also informed my on-going National Institutes of Health project, a two-year study examining the quality of life and stress impacts of living near unconventional O&G facilities.