LOCALIZED PRODUCED WATER MANAGEMENT PRACTICES AND DISPOSAL ECONOMICS

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ABSTRACT

Produced water disposal can significantly contribute to an operator's natural gas production costs. In some regions of the United States, the cost of produced water disposal has been reported by operators to be as high as $7.00/bbl. Rising costs of transportation coupled with the development of new gas fields in remote locations, will continue to affect and increase produced water disposal costs. Operators, working in conjunction with the regulatory agencies, are developing ways to lower their disposal costs by finding new uses for the water and new ways to dispose of it. Beneficial re-use and technologies such as Freeze-thaw/ Evaporation (FTE®) and down hole gas/water separation are helping operators lower their costs.

A study was recently funded by Gas Technology Institute to identify what produced water disposal methods operators in several western states are using, and the costs they associate with water disposal. Individuals in state regulatory agencies were also contacted to determine the climate for the application of new produced water disposal technologies in each of the states considered. Results of this study are summarized in this paper.

GTI PRODUCED WATER MANAGEMENT STUDY

In 1996, Gas Research Institute funded a project to develop an ACCESS database containing production information (oil, gas and water volumes) for the Rocky Mountain States of Wyoming, New Mexico, Utah and Colorado. One of the primary goals of the project was to identify gas fields in the region that were experiencing high volumes of produced water, and to also identify the producers at those fields who were managing large volumes of water. A second component of the study was to personally contact professionals in those companies who could discuss the methods being used to manage the produced water and to identify the costs that they were experiencing with water disposal. That project was expanded in 1998 to include additional information on the wells in the database and to update the existing production data to the most current available. Montana, Oklahoma, Kansas, Illinois, Michigan, Louisiana and Alberta, Canada were also added to the project, along with an ArcView mapping component.

At the time of this publication, the database has been updated to include publicly available well data for most of the states in the study, and operators in all of the US study states have been contacted for economic information. This paper focuses on the states of Wyoming, Colorado, Utah and New Mexico, primarily because of the availability of comparative data. Further economic information from operators in the other states will be made available through GTI after the conclusion of the project. The information provided in this study is a reflection of data provided by the operators who were contacted. Not all operators in a given basin were contacted and therefore, some management practices may have been excluded and economic data may vary more than the representation provided.

COST CONSIDERATIONS

Several of the questions that producers were asked pertained to how they managed produced water volumes at specific fields in specific basins. These questions were generally answered knowledgeably and with specific methods identified. Those responses were either re-injection (either for disposal or for secondary recovery), surface discharge, evaporation or a combination of methods. More specific information such as whether or not the injection well or evaporation pits were company-owned or a commercial facility was considered. The method of how water was transported from the well site to the disposal site was also identified and was generally reported as either use of a commercial water hauling service or a pipeline system -- which might have been exclusively for one company's use or by a partnership. Disposal costs were generally highest when producers combined the use of a commercial water hauling service with a commercial disposal facility and lowest for surface discharge, although the low figures in several basins were for disposal by evaporation. Specific information follows.

Producers were also asked to provide information about capital costs related to produced water disposal. This included any information that they felt comfortable identifying and most frequently was a report on what they paid to either install a new disposal well or to convert an existing well from production to disposal. In some cases,

the cost of constructing an evaporation pit was provided, in others, the cost of installing pipeline. Again, these specific costs are included in the study for basins where they were identified.

DISPOSAL ECONOMICS FOR THE STATE OF WYOMING

State Overview

Massive volumes of water are co-produced with oil and gas in the State of Wyoming each year. These volumes, when coupled with real dollar values provided by producers as their estimated disposal costs, are significant indicators that a water management plan can benefit the operator. The volumes of produced water in each basin are summarized in Table 1 and were arrived at by adding the volumes of water reported by producers to the Wyoming Oil and Gas Conservation Commission for their leases in each county.[1] Produced water reported by operators with leases in Wyoming to the WOGCC totaled 1,903,700,000 barrels in the year 2000. Figure 1 shows where the gas producing basins in Wyoming are located.

Powder River Basin

The development and production of coal bed methane gas in the Powder River Basin of northeastern Wyoming is a relative newcomer. That area of the state has been producing gas and oil for decades. The fact that coalbed methane dewatering produces massive volumes of produced water that must be disposed in some manner, only complicates the many problems faced by operators in that region. Surface discharge is the most commonly used method of produced water management in this region, and it is reportedly coupled with a variety of beneficial re-uses in many of the cases. Producers most frequently reported the use of pipeline systems to convey the water either to natural drainages, to impoundments constructed for livestock and/or wildlife watering, or to irrigation systems managed by the landowner. Water in this region is of good quality in most locations and when possible, is being re-used to benefit landowners. The operating costs associated with disposal using surface discharge coupled with conveyance by pipeline were reported in the range of $0.01 - $.80 per barrel. The high end of the range reflects one producer's high cost associated with electricity to run their pumps. Most operators reported values closer to the low end of the range.

Several operators reported that they were re-using produced water for secondary oil recovery projects in the basin, but were not able to provide economic data. In some cases, this information is proprietary, and in others, it was not within the respondent's area of expertise.

An interesting produced water disposal method which was reported by many of the respondents was the use of misting towers, which could be classified as a new approach to evaporation. This disposal method appears to be unique to this region and well suited to both large volumes of water and the climate. Personnel in both the Wyoming Department of Environmental Quality and the Wyoming Oil and Gas Conservation Commission were contacted for information about this water management

method and agreed that at this time, this method is sanctioned by both agencies for use without going through a permitting process. The misting tower is a 30' high structure that operates on the same principles as a snowmaking machine. Water is pumped upward through the center of the tower and sprayed out a nozzle on the top of the structure. In the hot, arid climate found in Wyoming during the summer months, the water evaporates before it hits the ground. This equipment is legitimate as long as water is not allowed to puddle below or around the tower. One company reported that they can evaporate 30 gallons a minute using the misting process. Specific economic data was not provided by operators using this method, it was usually described as a method of "enhanced" evaporation.

A couple of respondents reported that they were experimenting with shallow injection wells, with a goal of helping to recharge the aquifer. Specific operating costs were not provided, however, the costs of electricity to operate the equipment coupled with well maintenance costs were acknowledged as being "out there".

In this region, producers reported a range of values associated with capital costs for produced water disposal. Costs reported for installing a new CBM well were identified around $100,000 with costs of $50,000 to drill and $50,000 to complete the well. This amount varied according to the depth of the well to be drilled. Impoundment construction ranged from $3,000 per reservoir to $8,000, and again, that varied with the size of the impoundment and whether or not it was lined. Pipeline costs were reported to run $0.30 per foot to $1.00 per foot. When operators look at installing a complete distribution and gathering system, the cost could range from $2.00 to $6.00 per foot. Several producers reported that they were enjoying lower costs for pipeline installation because they dig one trench (rather than two) and could run their water distribution system alongside their gas lines. Many producers reported that they experienced a very high cost during the permitting process, and this was attributed to the need for third party consultants, water testing and the costs associated with developing environmental assessments.

The use of commercial water hauling or commercial disposal facilities was not reported by operators in either the 1997 or 2001 telephone survey. In 1997, when the survey was first completed, about 50% of the producers reported using surface discharge and paying less than $0.01/barrel. 20% of the respondents reported using evaporation pits - with similar low costs reported. 25% of the respondents were re-using their water for waterflood projects; and 5% reported using company owned disposal wells. In 2001, when the most recent survey was completed, about 85% of the producers reported using surface discharge coupled with some type of beneficial re-use. The remainder of the producers reported the use injection for secondary recovery or for shallow injection wells for aquifer recharge. Although evaporation pits were not specified as a use for managing water in this basin, the fact that water will evaporate as it resides in an impoundment for livestock watering was certainly a consideration.

Greater Green River Basin

The Greater Green River Basin, for the purpose of this study, encompasses the area that the Wyoming Geological Survey classifies as the Washakie Basin, the Great Divide Basin, the Green River Basin and the Hoback Basin (including the Pinedale Anticline). All of those basins are located in the southwestern quadrant of Wyoming.

This area includes many wilderness areas and remotely located gas fields. The fact that the terrain is not conducive to the extensive use of water pipelines noticeably affected the cost of produced water disposal. The most frequently cited alternative for transporting water in this area was the utilization of commercial water haulers. Producers acknowledged that weather and the distance the water needed to be transported significantly affected their disposal costs. Two companies reported paying as much as $5.50/barrel to dispose their produced water. Both reported the use of commercial water hauling coupled with commercial disposal pits. Several companies reported the use of company owned injection wells and cited their disposal costs to be between $1.85 - $2.65. Again, this varied according to where the wells were located in relationship to the disposal site. One company cited the use of it's own pits for produced water disposal and reported the cost of disposal to be about $0.20/barrel. Many operators reported using a combination of methods to dispose their water.

One producer reported the use of a commercial disposal facility in the Red Desert area that utilizes the Freeze-Thaw Evaporation process to treat their produced water. He reported paying $2.65/bbl to dispose produced water at this facility as opposed to others in the area paying around $5.00/bbl. One factor contributing to the difference is the distance the water needed to be transported.

Big Horn Basin

Huge volumes of water are produced in the Big Horn Basin, which is located in north central Wyoming. In Park County alone, producers reported 419 million barrels. Fortunately, water in this area is very fresh and meets the EPA standards for NPDES permits. All disposal costs in this basin were very low, with reports of free to $0.10/bbl. Some producers reported using on-site pits and/or reinjection. The cost of disposal using pits was also reported as virtually free to pennies per barrel. The high end cost of $0.10/bbl was reported by a producer who was using re-injection.

Central Western Overthrust

The Central Western Overthrust is located in western Wyoming and northeastern Utah. Producers with leases in this basin reported that much of the water produced in this area is a bi-product of sour gas and is transported by pipeline to an injection well owned by one operator. Operators reported paying between $0.10 per barrel and $0.95 per barrel for both transportation and disposal fees in 1997. Those figures have not changed significantly since then.

Wind River Basin

The Wind River Basin is located in central Wyoming and ranges over the Wind River Reservation and Fremont County. Producers in this basin reported that they use a variety of methods to dispose of their water -- and primarily consider the location of the well when making their decision. Some of the operators reported using a commercial water hauling service, some had installed water gathering and distribution systems to transport their water to either commercially operated disposal wells or to company owned injection wells. In some cases, producers reported using surface discharge. The cost of produced water disposal in this basin ranged from $0.04 to $0.35 in 1997. An

insufficient amount of economic data was collected in the 2001 survey to provide an accurate range of disposal costs.

DISPOSAL ECONOMICS FOR THE STATE OF COLORADO

State Overview

Colorado reported about one-eighth the volume of produced water found in Wyoming. Production volumes for CY2000 for selected Colorado basins are reported in Table 2 and were originally reported on the Colorado Oil and Gas Conservation Commission website.[2] Figure 2 shows a map of the basins and their locations. Other gas producing basins exist in the state but were not included in this study.

Denver Basin

The Denver Basin is located in the northeastern quadrant of Colorado and southeastern Wyoming. In both the 1997 and the 2001 study, operators with leases throughout the basin were contacted for water management practices and disposal economics. In 1997, operators reported that they were using evaporation pits coupled with flow lines; surface discharge – where the water quality met EPA discharge standards, and commercial water hauling coupled with commercial injection wells. Operators reported that their costs for disposal ranged from $.01 to $1.00 per barrel. Intermediate values reflected variations in water hauling costs – i.e. distances that the water had to be transported. Commercial water hauling coupled with commercial injection well fees represented the high end of the disposal costs. Evaporation pits with flow lines from the well to the pit were the lowest values provided by respondents. In 2001, none of the operators contacted reported the use of evaporation pits or surface discharge however those water management methods may still be in employed by operators who were not contacted. When operators were contacted in 2001, several reported using commercial trucking and disposal to manage their water. These operators reported that their wells produced little water and that this method made the most sense for them economically. These operators reported a cost of $1.00 - $1.75/bbl. Two other operators in the area reported different produced water management strategies. One reported that all their produced water is pumped via pipeline to their nearby water flood projects. Another reported that they use a combination of company owned evaporation pits and injection wells. Water is pumped from the well sites to the disposal sites. This producer was not familiar with the cost of disposal using these methods.

Las Animas Arch

The Las Animas Arch is located on the eastern side of Colorado. Operators with leases in this basin were contacted in 1997 and in 2001. In 1997, many of the respondents reported using a commercial water hauling service to transport produced water from their wells to a “co-op” disposal well. In this situation, members all pay to share the pipeline and each pays a disposal fee to maintain the disposal well. Disposal costs reported in 1997 were in the range of $.05 - $.45/bbl. The water management scenario appears to have remained much unchanged according to operators who were

contacted in 2001. The co-op system is still in place, but disposal costs have risen to $.60 - $2.10/bbl. This change is attributable in large part to rising costs of commercial transportation. Also, a responding operator reported re-using their water for secondary recovery. He did not provide a cost associated with this water management method. Most operators reported that they do not re-use their water. One operator however, reported that their water is very fresh and they are looking into irrigation as an option in the future.

In terms of capital costs, one operator estimated the cost of converting an old producing well to an injection well to be about $50,000 - depending on the depth of the well. Another estimated that it would cost between $40,000 to $50,000 to convert a well, purchase a tank battery and add a filtration system.

Paradox Basin

The Paradox Basin is located in western Colorado and eastern Utah. This basin was examined in both the 1997 study and the 2001 study. Respondents in 1997 reported that their water was mainly re-injected for secondary recovery projects. Costs reported for this disposal method were $.07 - $.25/bbl. One respondent reported that his company employed a commercial trucking service that hauled his water to a commercial disposal well. He reported that the cost of those services were approximately $2.00/barrel.

In the 2001 study, only one operator reported any economic data. In his situation, the company reinjects their produced water into company owned injection wells for pressure maintenance. This company stores the water in on-site tanks, then pumps the water via pipeline from the well site to the disposal well. This producer estimated the cost of disposal to be about $1.33 per barrel. This figure was determined in part from a calculation based on a $5,000 per month electricity cost to operate his pumps.

Piceance Basin

The Piceance Basin is located in the northwestern corner of Colorado. In the 1997 study, producers reported managing their produced water with either the use of company owned saltwater disposal wells or they re-injected their produced water for secondary recovery. The producers who reported re-using their water for water flood projects estimated their costs to be in the range of $.05 - $.25 per barrel. The operators who reported using company-owned injection wells did not provide economic information on their disposal costs.

In 2001, one operator reported that his company manages their water using a company-owned disposal well at a cost of $.05/bbl. The other company that provided economic information employs a combination of methods to manage their water. Some of their water is pumped via pipeline to a commercial disposal pit for evaporation and some of the water is trucked by a commercial water hauling service to a commercial disposal well. His per barrel costs for disposal were in the range of $.20 - $.25.

Raton Basin

The Raton Basin is located in south central Colorado and northern New Mexico. No disposal economics were provided for this basin, however, one producer with leases

on the Colorado side of the basin reported that his company uses a combination of methods to dispose its produced water. Those methods include the use of injection wells, evaporation pits and surface discharge. They also have several off-site pits which provide livestock water. In addition, this company uses a combination of methods to transport the water from the well site to the disposal site, including pipelines and both commercial and company owned water-hauling trucks. This company also re-uses some of its produced water for "frac" water and a small amount for road spray (when it is available).

San Juan Basin

The San Juan Basin is located in southwestern Colorado and northwestern New Mexico. Information about disposal economics for the Colorado portion of the San Juan Basin will be discussed with New Mexico.

Sand Wash Basin

The Sand Wash Basin is located in northern Colorado and is essentially a southern extension of the Greater Green River Basin (located south of the Washakie Basin in Wyoming). One operator, located at the Hiawatha Field in this basin reported that they pump their water via pipeline to company owned evaporation tanks. No economic data was provided for this method of disposal. Another producer reported using a commercial trucking service as well as a commercial saltwater disposal well. Transportation and disposal fees amounted to about $1.75/bbl for this operator.

DISPOSAL ECONOMICS FOR THE STATE OF UTAH

Central Western Overthrust

The Central Western Overthrust (CWO) is located in both northern Utah and southwestern Wyoming. Many of the operators in this basin have leases on both sides of the state line and provided information that was relevant for the management of their water in both states. The CWO was discussed in more detail in the Wyoming section of this paper. No operators with leases only in the Utah portion of the Central Western Overthrust were contacted in 2001. In 1997 one operator with leases in Utah reported the use of a company-owned saltwater disposal well and another reported that their water is used for secondary recovery. Neither operator provided information on their disposal costs.

Paradox Basin

The Paradox Basin encompasses a large portion of the southeastern corner of the state as well as several counties in Colorado. The Colorado portion of the basin was addressed in a previous section. Operators with leases in the Utah side of the basin were contacted in both the 1997 study and the 2001 study. In 1997, almost all respondents reported that they were re-using their water for secondary recovery, with disposal costs

ranging from $.07 - $.25/bbl. These costs were a reflection of the costs including electricity, chemicals and labor. In 2001, respondents reported that they use a combination of methods to manage their produced water and keep their costs down. In many cases, operators reported that they produced very little water and it was most economic for them to use a commercial water hauler to transport the water to company owned disposal wells. In some cases, pipelines were mentioned as the method to convey the water. None of the operators contacted in 2001 provided economic information.

Uinta Basin

The Uinta Basin is located in eastern Utah and encompasses several large plays including the Altamont, Bluebell and Natural Buttes fields, to name just a few. Operators with leases in this basin were contacted in both 1997 and 2001. In 1997, many operators reported that they managed their produced water using a combination of disposal at both company owned injection wells and commercial disposal wells. These operators estimated their disposal costs to range from $.35 to $1.25/bbl, and included such things as pump maintenance, chemicals, and transportation in their calculations.

Many gas properties in this basin changed ownership during the period between 1997 and 2001. As a result of the changes, the new owners were for the most part unable to provide economic information on their disposal costs. One operator reported that they are re-using all of their water for secondary recovery. He reported that their process includes pumping the water to a tank, where the water is separated out. It is then pumped to a gathering system where it is treated with a filtration system, then re-injected back into the well for secondary recovery. He estimated the cost of this process to be about $.05/bbl. Another operator reported that their produced water is pumped via pipeline to company owned disposal wells or re-used for drilling. He was not able to provide information on the cost of this method of disposal. One other operator reported that they use a commercial water hauling service that transports the water to a commercial disposal site. He estimated the cost of disposal to be about $1.00/bbl using this method.

DISPOSAL ECONOMICS FOR THE SAN JUAN BASIN

The San Juan Basin is located in southwestern Colorado and northwestern New Mexico. Interestingly, there were significant differences in the methods operators on each side of the state line used to manage produced water. These differences are described below.

Operators with Leases in Colorado

Operators with producing gas leases at the Ignacio Blanco Field in the Colorado portion of the San Juan Basin were contacted in both 1997 and 2001. In 1997, operators reported that they managed their produced water by using one or more of the following disposal methods: company-owned disposal wells; secondary recovery; fresh water disposal wells; a commercial disposal service; or evaporation pits. Costs for produced water disposal (including any fees or transportation) ranged from $0.04 to $1.88/bbl. An

operator who used a company-owned fresh water disposal well reported the lowest per barrel cost ($0.04/bbl). Economic data was not provide by the operators who reported using evaporation pits, although that cost has traditionally been very low. Midrange values reflected variations in whether or not the disposal well was company owned or commercially operated and whether a pipeline or commercial trucking service was used to transport the water. The highest values were always reported for commercial trucking coupled with a commercial disposal service.

In 2001 fewer operators were contacted for this part of the basin. Operators who were contacted reported the use of company owned disposal wells coupled with either pipeline systems or commercial water hauling services. One operator reported that his company's disposal costs were in the range of $0.30 to $1.50/bbl.

Operators with Leases in New Mexico

Operators with leases in this area reported that they mainly manage their produced water by employing a commercial water hauling service to transport their water to a commercial disposal service. In 1997, operators reported that it cost between $1.39 - $3.75/bbl to use this method. Some operators reported that they re-used their produced water for secondary recovery projects. The range of responses for disposal costs using that method was $1.00 - 2.10/bbl. Other operators reported the use of evaporation pits, but did not provide a disposal cost for that method. Midrange values were expressed for the use of company owned disposal wells coupled with the use of a commercial trucking service or the use of pipelines to convey the water to the disposal site. Higher costs in this area were often reported as the result of remote well locations coupled with longer trucking distances (time equals money). Some of the lowest disposal costs were provided by operators who disposed their water in company owned "fresh-water" disposal wells. Unfortunately when their low disposal fees were coupled with commercial water hauling, the cost rose to the middle of the ranges described above. One company reported a midrange disposal cost of $1.80/bbl. This value reflected the cost of disposal at a "partner-owned" disposal well coupled with the cost of commercial water hauling.

In 2001, operators also reported using a variety of methods, alone and in combination, to address their produced water disposal needs. The methods described by operators with leases in this area focussed on the use of both commercial and company-owned disposal wells and active and passive evaporation in pits and/or tanks. The water was conveyed either by commercial trucking service or pipeline, depending on the well location. By using different combinations of these methods, producers could best manage their disposal costs. Commercial disposal costs (transportation and disposal fees) were reported in the range of $.50/bbl to $4.00/bbl. The low end is a reflection of shorter hauling distances from well site to disposal site. Many mid-range values were reported.

Several operators with leases in this area provided capital costs associated with produced water disposal. The costs provided by respondents for converting an old producing well to a disposal well were reported in the range of $100,000 to $600,000. In one case, an operator reported that his company had paid as much as $1.5 million to convert a very deep well in that region. Another operator reported that when his company evaluated the pros and cons of converting a well from production to disposal, they figure how many barrels the well would have to take to give the company a 15%

return on their investment. He remarked that capital costs can vary significantly from well to well.

CONCLUSIONS

Operators who responded to the telephone surveys reported that water is managed in many ways and at varying costs to their companies. Most operators indicated that they evaluated several alternatives before identifying the most economical way to dispose their produced water in any given gas basin. They said they consider many factors before developing their disposal strategies. They review water disposal regulations i.e. what disposal methods are acceptable in each state. They examine subsurface conditions and evaluate the cost of drilling their own disposal wells versus the cost of paying for commercial disposal. They explore all their options, including new technologies, when they research their options. And, they communicate with interested stakeholders and other producers who have experience with water disposal in the state. They get "a handle" on their produced water disposal costs before they move forward. A good water management strategy helps producers to save money.

TABLES

Table 1. Produced Water Volumes by Basin and County for the State of Wyoming (2000 Production Data)

Basin Name	Volume of Water (barrels)	Counties Included in Estimate
Powder River Basin	819,143,314	Campbell, Sheridan, Johnson, Natrona
Big Horn Basin	814,681,576	Park, Hot Springs, Big Horn, Washakie
Wind River Basin	124,350,205	Fremont
Greater Green River Basin	92,758,028	Sweetwater, Carbon, Sublette
Central Western Overthrust	4,599,935	Lincoln, Uinta
Other Counties	50,149,217	Albany, Crook, Converse, Laramie, Niobrara, Weston
Total Water Reported in 2000	1,905,682,275	

Table 2. Produced Water Volumes by Basin and County for the State of Colorado (2000 Production Data)

Basin Name	Volume of Water (barrels)	Counties Included in Estimate
Piceance Basin	107,069,727	Moffat, Rio Blanco
Denver Basin	41,134,251	Larimer, Logan, Morgan, Washington, Weld
San Juan Basin (CO only)	24,779,891	La Plata
Raton Basin (CO only)	59,763,544	Huerfano, Las Animas
Las Animas Arch	9,950,296	Cheyenne, Kiowa, Yuma
Paradox Basin	1,135,072	Montezuma
Other Counties	12,327,797	Adams, Arapahoe, Archuleta, Baca, Bent, Boulder, Denver, Dolores, Elbert, Garfield, Jackson, Kit Carson, Larimer, Lincoln, Mesa, Prowers, Route, San Miguel, Sedgewick, Yuma
Total Water Reported in 2000	256,160,578	

Table 3. Produced Water Volumes by Basin and County for the State of Utah (2000 Production Data)*

Basin Name	Volume of Water (barrels)	Counties Included in Estimate
Central Western Overthrust	7,146,338	Summit
Uinta Basin	42,535,495	Uintah, Carbon, Duchesne
Paradox Basin	47,087,973	San Juan, Emory
Other Counties		Other Counties Were Not Analyzed for Water Production
Total Water Reported in 2000 for Basins Listed Above	96,769,806	

*Production volumes are downloadable from the Utah Department of Natural Resources website. Volumes reported in this table are a summary of well production reports from the database.[3]

Table 4. Produced Water Volumes by Basin and County for the State of New Mexico (2000 Production Data).*

Basin Name	Volume of Water (barrels)	Counties Included in Estimate
Raton Basin	2,116,433	Colfax
San Juan Basin	22,125,324	McKinley, Rio Arriba, San Juan, Sandoval
Other Counties		Other Counties Were Not Analyzed for Water Production
Total Water Reported in 2000 for Basins Listed Above	24,241,757	

*Production volumes are downloadable from the New Mexico Institute of Mining and Technology website. Volumes reported in this table are a summary of well production reports from the database.[4]

FIGURES

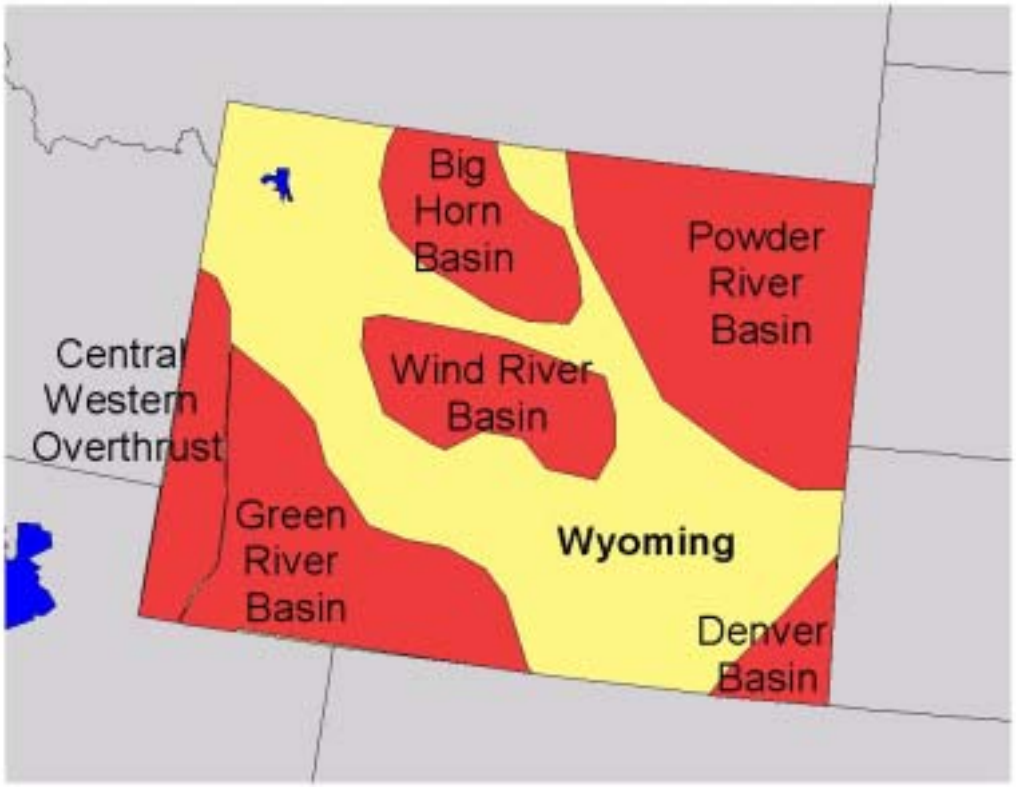

Figure 1. Map of gas producing basins in Wyoming that are included in the GTI study.

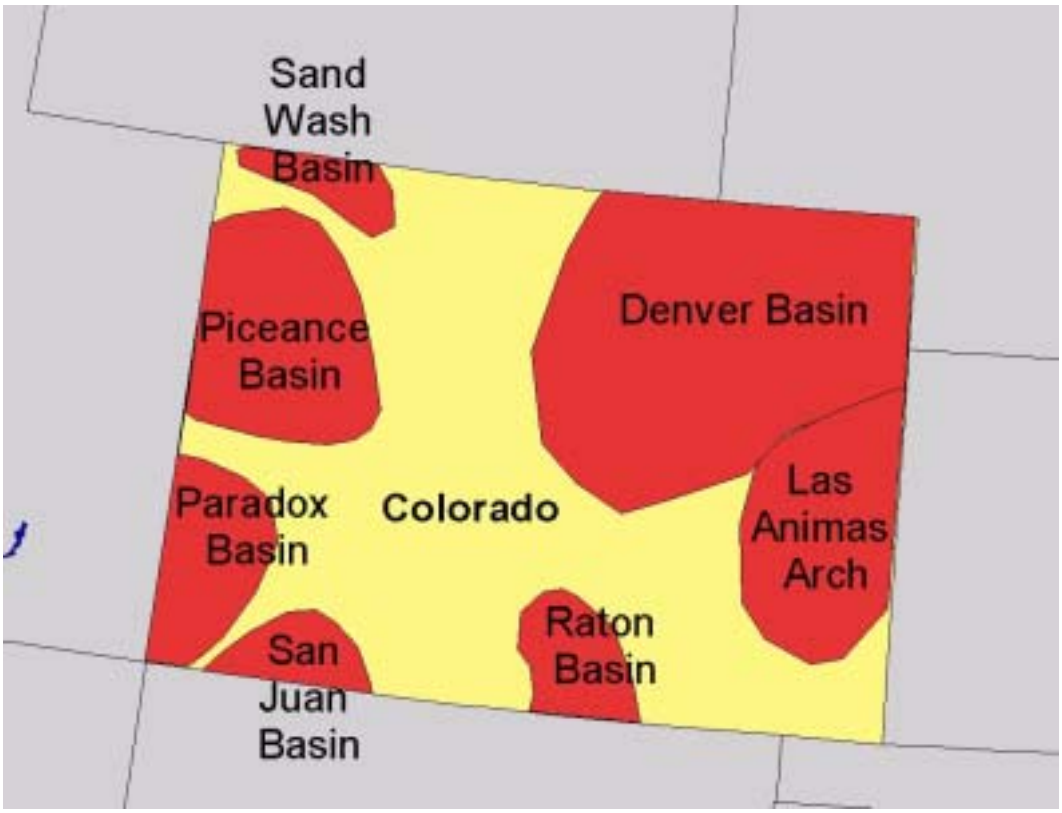

Figure 2. Map of gas producing basins in Colorado that are included in the GTI study.

Figure 3. Map of gas producing basins in Utah that are included in the GTI study.

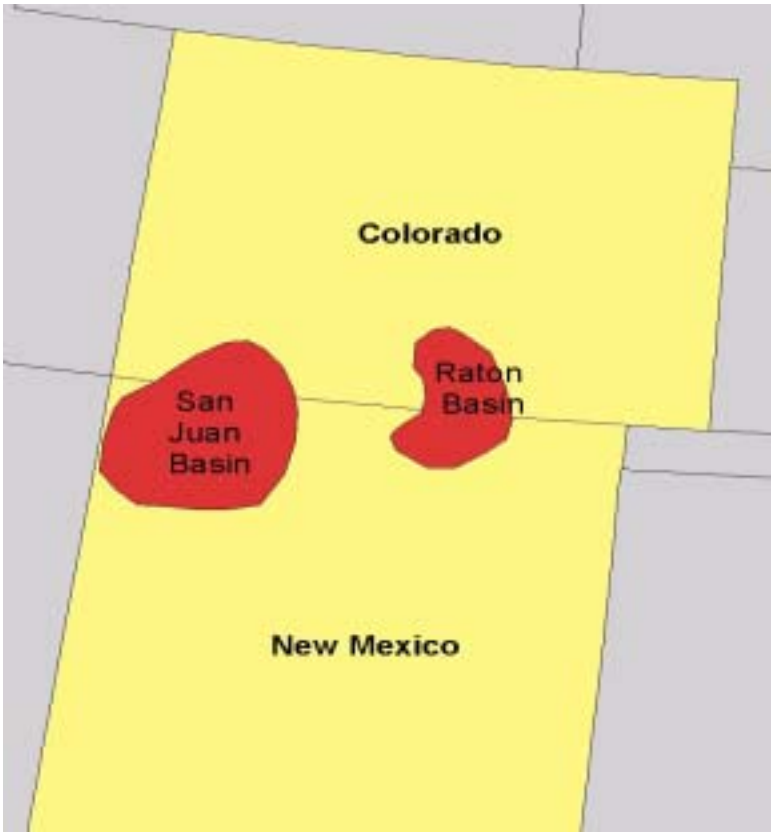

Figure 4. Map locating the San Juan Basin and the Raton Basin in New Mexico and Colorado.

[1] The Wyoming Oil and Gas Conservation Commission website is located at http://wogcc.state.wy.us.

[2] The Colorado Oil and Gas Conservation Commission website is located at http://oil-gas.state.co.us

[3] The Utah Department of Natural Resources - Division of Oil, Gas and Mining website is located at http://www.dogm.nr.state.ut.us/oilgas

[4] The New Mexico Institute of Mining and Technology website is located at http://octane.nmt.edu.