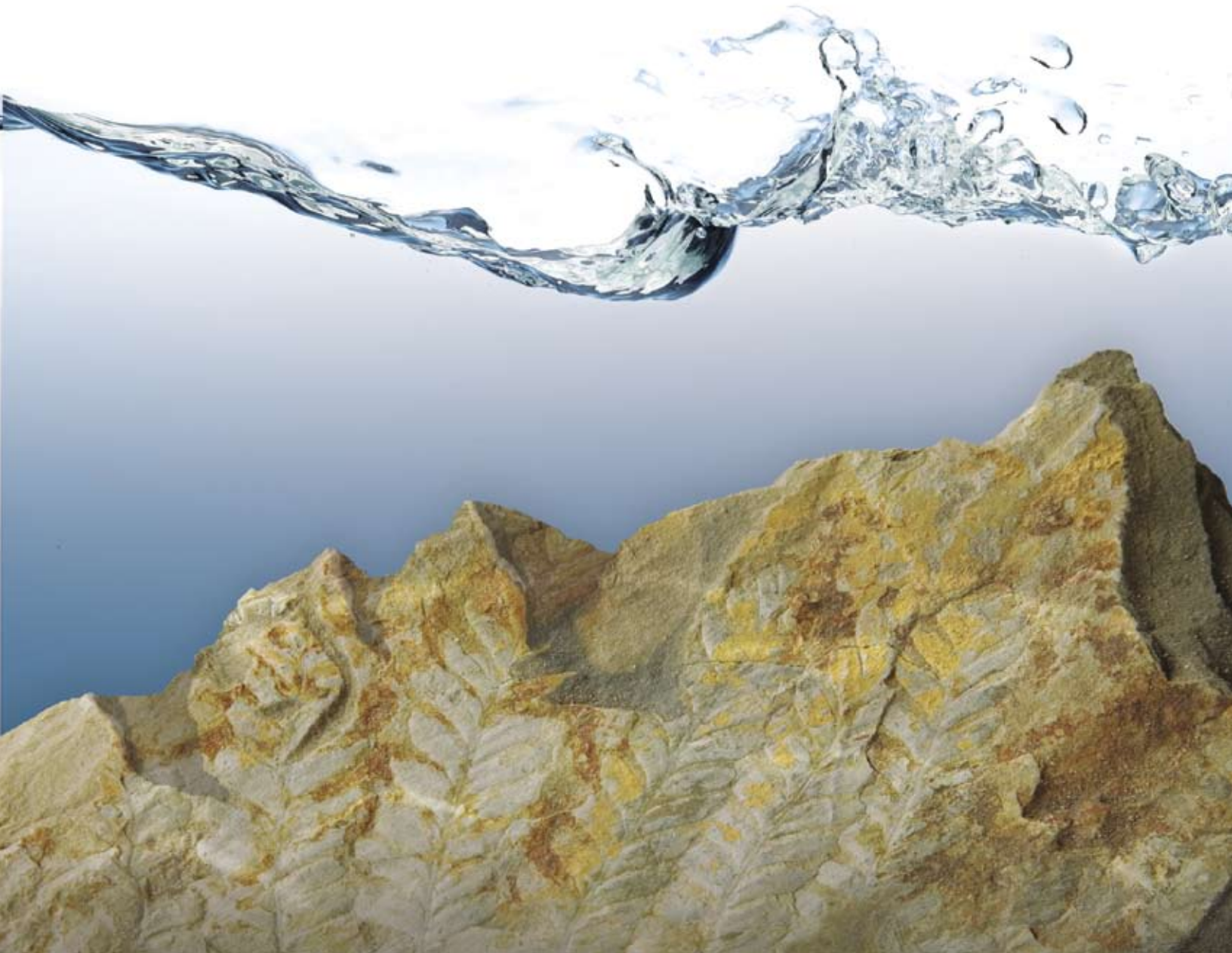
WATER ON THE ROCKS

Oil Shale Water Rights in Colorado

WESTERN RESOURCE ADVOCATES



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About Western Resource Advocates
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WATER ON THE ROCKS: *Oil Shale Water Rights in Colorado*

FOREWORD

WHY THIS WATER AND OIL SHALE ANALYSIS MATTERS

KARIN P. SHELDON
Executive Director
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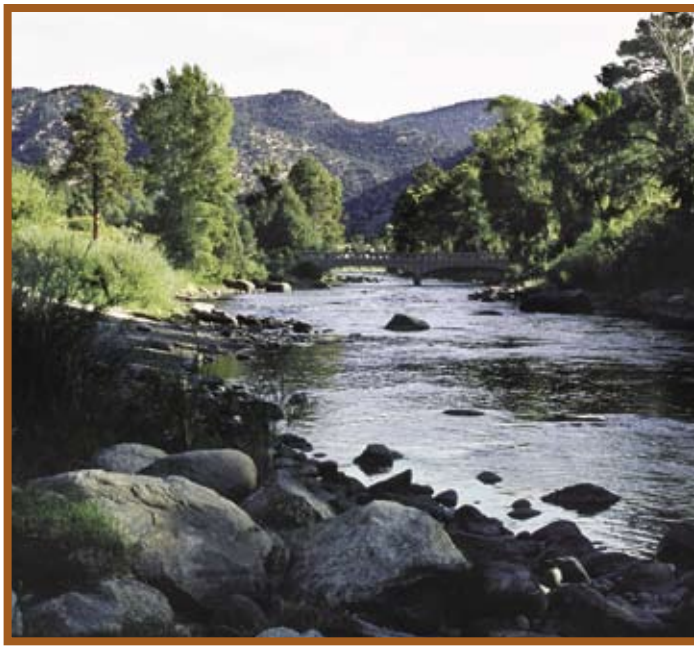
Since the early 1900s, the dream of tapping vast oil shale reserves has drawn energy companies to western Colorado. That dream has proven elusive, for while small quantities of oil have been released after heating shale, commercial production technology remains undeveloped. Past development attempts have failed because of a number of technical, economic, and environmental challenges that have yet to be overcome, despite the billions of dollars invested by both government and industry.

Some members of Congress and a few oil companies suggest the oil shale puzzle may soon be solved. Should this prove to be the case, western Colorado will witness, as Colorado Governor Bill Ritter cautions, "the largest industrial development in the State's history — with enormous implications for all of Northwest Colorado and for the State itself."[1] Oil shale development would bring significant change in western economies, communities, and ways of life. One of the most significant aspects of such change would be in the use of water.



Oil shale development would have tremendous impacts on current and future uses of water — Colorado's most precious natural resource. Water is the lifeblood of the West. It's the foundation of western economies and communities, the basis of political divisions, and often the cause of conflict. Battles over water often pit Front Range cities, such as Denver and Colorado Springs, against West Slope communities, such as Rifle and Grand Junction. Renewed efforts to develop a commercial oil shale industry could once again fan the flames that fuel such battles.

Initial analyses by the RAND Corporation and the U.S. Departments of Energy and the Interior conclude that significant amounts of water will be required to both extract oil from shale and power the extraction processes. Large quantities of water will also be needed to support major infrastructure development and the influx of new workers. It would be folly to discount the crucial link between oil shale development and water resources, ignoring the fact that the arid Rocky Mountain Region is defined by the scarcity of water. Westerners understand this link — and our leaders understand the vital importance of examining potential oil shale development within the context of increasing competition for dwindling water supplies.

It is undisputed that oil shale development will stress limited water resources. The question for elected officials and other community leaders are how, when, where, and to what extent. In a May 2008 letter to Congress, Hamlet J. "Chips" Barry III, manager of the Denver Water Board, stated that "development of oil shale in Colorado could significantly affect the [Front Range Water Users] Council's ability to serve existing customers and the future growth projected for the Front Range of Colorado."[2] That conclusion is significant. What is unclear, however, are the specific impacts on Colorado water and the timing of such impacts.

In order to more fully understand the conflict Barry identifies, Western Resources Advocates (WRA) engaged Larry MacDonnell to investigate the extent of water rights in Colorado held by oil companies, individuals, and water providers that could be used for oil shale development. Entitled "Water on the Rocks: Oil Shale Water Rights in Colorado," this report frames critically important issues vital to the future of Colorado and the West.

BACKGROUND AND KEY FINDINGS

In a 2008 environmental analysis covering oil shale development, the Department of the Interior's Bureau of Land Management (BLM) concluded that oil shale development would likely transform communities in western Colorado from agricultural-based to industrial economies. While noting the likelihood of this fundamental shift, the BLM largely ignored the potentially staggering ramifications.

For northwest Colorado, the fundamental change the BLM forecasts is troubling. Several analyses have already kicked off the public debate. Recently, the Associated Governments of Northwest Colorado teamed with the Colorado Department of Local Affairs to evaluate the socioeconomic impacts of energy development in a four-county region. Their report, which was issued in February 2008, projects a $1.3 billion shortfall in the monies local governments will need to support critical infrastructure upgrades required by oil and natural gas development and oil shale development.

Another study, commissioned by water providers in northwestern Colorado, estimates the growth in water demand needed to support increased extraction and production of energy in four sectors in northwest Colorado, including natural gas, coal, uranium, and oil shale.[3] That report concludes water demands for oil shale could be as much as 378,000 acre-feet per year, an amount that is approximately 25% more than the city of Denver uses annually.[4]

This report fills in another critical piece of the puzzle. It identifies water rights held by energy companies and water providers that could support oil shale development. The report:

- Projects water requirements associated with oil shale development.
- Identifies all major water rights currently owned by energy companies that could be used for oil shale development in Colorado, as well as conditional rights that could be exercised in the future.
- Analyzes legal and hydrological issues of the Colorado River Basin affecting future development of Colorado's allocation under the 1922 Colorado River Compact and subsequent 1948 Upper Basin Compact.
- Explains how the Upper Colorado River Endangered Fish Recovery Program affects and limits additional consumptive uses of water in the mainstem Colorado River.

To illustrate the scope and potential impacts of building new water reservoirs and pipelines, plus shifting existing agricultural rights to oil shale, Geneva Mixon, a Colorado-based cartographer, mapped these rights.

The report's key findings include the following:

1. Energy companies and water supply districts have established conditional water rights associated with more than 200 separate structures (e.g., reservoirs and pipelines) in the Colorado River and White River Basins that potentially could be developed to support oil shale production. Most of these conditional rights were established in the 1950s and 1960s.
2. Collectively, with these rights, energy companies have the right to divert annually more than 10,000 cubic feet per second (cfs) — or 7.24 million acre-feet (af) — of water and store more than 1.7 million af, enough storage to meet the annual needs of 8-10 million Colorado residents.
3. Energy companies have acquired rights in more than 100 existing irrigation ditches in the Colorado River and White River Basins. The flow associated with these rights total 650 cfs. Diverting scarce water for oil shale and other energy development would likely eliminate much of the existing irrigated agriculture in northwest Colorado.
4. The Upper Colorado River Endangered Fish Recovery Program and 1922 Colorado River Compact limit the amount of water Colorado has available for development. As the state edges closer to these limitations, large-scale oil shale and other development projects become mutually exclusive.
5. Large-scale oil shale development would affect existing uses established under more junior water rights, either by curtailment and/or through decreased water availability. Because of potential limits imposed by the 1922 Colorado River Compact, rights junior to 1922 but senior to the oil shale rights could become subject to a call if oil shale resulted in an over-development of Colorado's compact entitlement. A call would potentially limit other planned water development projects, which propose to rely on water from Colorado's West Slope. Those development projects include plans to transfer additional water to Colorado's Front Range cities.

WRA'S CONCLUSIONS FROM THIS REPORT AND OTHER ANALYSES

This report frames a vitally important issue — the nature and extent of water rights that could support oil shale development. By design, however, the report generally does not examine broader issues of the nexus of oil shale and water, and the potential impacts on local economies, the environment, and other water users. Nor does it address the critical issue of climate change and the potential impacts on water availability.

The report's findings are all the more significant when viewed in the larger socioeconomic context of oil shale development. By synthesizing this report and other analyses of potential energy development in Colorado, Utah, and Wyoming, WRA has reached the five conclusions described below on important questions facing the region.

Conclusion #1: ***Commercial oil shale development would transform western Colorado communities.***

> "Water is likely to be transferred from traditional agricultural uses to industrial uses, resulting in the loss of traditional irrigated agriculture. Changes may also result in an increase in dryland agriculture, and depending on scale it may also result in a transition from traditional agriculture based community to a more urbanized lifestyle."[5]
>
> *— Bureau of Land Management, 2008*

> "If commercialization progresses, the oil shale industry has the potential to expand very rapidly – very likely overwhelming the capacity of local governments to deal with growth requirements."[6]
>
> *– Associated Governments of Northwest Colorado, 2008*

First, as this "Water on the Rocks" report makes clear, water for oil shale will partially come at the expense of agricultural use. The vast majority of the agricultural water rights held by oil companies are in Rio Blanco County, an area of the state where the local economy depends heavily on existing agriculture. Many of these water rights, which date back to the late 1800s and early 1900s, are owned by oil companies and are now being leased back to ranches. So, for now, most of the water still remains in irrigation.

However, as this report cautions — and as the BLM notes through its environmental analyses — should commercial oil shale development take off, oil companies would transfer water currently used for agriculture to oil shale production. Thousands of acres historically irrigated would be taken out of agriculture, resulting in a dramatic transformation of land use and associated water uses in the region from an agricultural to an industrial landscape. As witnessed in the Arkansas Basin in Colorado, once a critical mass of farmers (or, in the case of the Piceance Basin, ranchers) sell their lands and associated water rights, it is hard for the agriculture community to sustain itself. The infrastructure that supported the local economy — suppliers, producers, and landowners — shifts to a new economy, and with it the impetus and ability to sustain an agriculture economy. Such changes signal a marked difference in the socioeconomic fabric of agricultural-based communities — the transformation the BLM forecasts.

Anticipated changes in populations necessary to support large-scale industrial development add to the changing uses of water. With rapid industrialization comes the ripple effect of increased populations and related infrastructure needs. The amount of water associated with changing demographics is significant. According to a recent report prepared for the Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee, full-scale oil shale production (which the BLM estimates could occur from 2036-2050) will require an additional 21,100 af of water to accommodate municipal use resulting from the additional 100,000 workers and their families who will move to the area.[7]

Estimated Oil Shale Water Demands

Source of Water Demand	Annual Quantity (af)
Direct demand (1.55 million barrels per day)	112,675
Electric power	244,535
Increased population	21,100
Total	**378,310**

A second impact resulting from oil shale development that requires careful examination is the development of senior conditional water rights. While these rights have not yet been exercised, they have priority dates that are senior to many developed water rights on which Colorado's economy depends today. As MacDonnell discovered through his extensive research of the hundreds of conditional water rights held by energy companies, many of these rights date back to the 1950s. Once oil companies begin using these rights for oil shale development, other users whose rights are junior to oil shale rights could see use of their rights curtailed. This report provides some key examples of development scenarios that show the extent of such displacements.

One example is ski towns in western Colorado. Many of Colorado's premier destination resorts were developed in the 1950s and 1960s, the same period that oil companies were establishing initial water rights for oil shale. Once sleepy towns in the Colorado River Basin, these commu-

nities now sustain substantial year-round populations, recreation, and numerous second homes. As this report notes, much of the water used to serve these communities depends on rights that are junior to oil shale rights. These towns are a core component of a diversified economy that could, along with agriculture, be undermined by oil shale development. Impacts would not be limited to existing uses, as oil shale development would likewise threaten future municipal, recreational, and other development projects on Colorado's West Slope.

Conclusion #2: ***Oil shale development in western Colorado would affect Colorado's Front Range communities and must be thoroughly evaluated and understood.***

> "The prospects of oil shale proceeding to high-level development and the prospects of developing water for Front Range growth are mutually exclusive so there has to be a balancing act."[8]
>
> *— Colorado River Water Conservation District, 2008*

Front Range water providers, such as the Denver Water Board and the Northern Colorado Water Conservancy District, agree with the Colorado River Water Conservation District on one key conclusion — oil shale development will stress and/or compromise future water projects as well as existing projects that are subject to calls from senior in-basin rights and compact curtailment throughout Colorado.

Denver Water and other Front Range water providers divert several hundred thousand acre-feet of water annually out of the Colorado River Basin. Much of this water is senior to conditional water rights established for oil shale development and thus is less likely affected by such development. However, oil shale could trigger a compact call that could lead to curtailment of any post-1922 water uses. Because of increasing needs on Colorado's Front Range, plans are in place to boost water deliveries to Denver and other cities by enlarging existing transbasin diversions and developing new projects. For some of these new projects, water utilities would rely on a combination of both older, pre-oil shale rights and newer junior rights.

For instance, Denver Water's Williams Fork project holds a conditional water right for the Darling Creek Enlargement that is junior to a collection of conditional rights for oil shale. Similarly, the refill right for Williams Fork Reservoir is junior to oil shale conditional rights held by oil companies, as is the proposed Straight Creek Collection System for Roberts Tunnel. Under Colorado water law, senior rights must be fulfilled prior to junior rights. During dry years, junior rights may only be partially met, if at all.

Similarly, the Northern Colorado Water Conservancy District's Windy Gap Reservoir has a 1967 priority date. While this project currently only diverts small amounts of water from the Colorado River Basin, water providers have encountered difficulties in diverting water because their rights are relatively junior. Efforts are underway to "firm" the yield from this project by improving the delivery and reliability of the existing supply with an additional Front Range reservoir. However, substantial development of senior rights for oil shale development would make this task much harder to achieve.

To some outside of the West, these conflicts may appear minor in relation to the need to increase domestic oil production. To those of us in this arid region, how such conflicts are resolved bears directly on Colorado's economic prosperity, future growth, and environmental protection.

Conclusion #3: ***Oil shale will accelerate climate change and will further stress water availability.***

> "Production of unconventional fuels (oil shale, coal to liquids, heavy oil) produces more CO_2 than is produced when using conventional petroleum."[9]
>
> *— U. S. Department of Energy, 2007*

Photo courtesy of The Story Group

Climate change exacerbates and potentially eclipses all other foreseeable stresses on the environment in the region. In February 2007, the Intergovernmental Panel on Climate Change (IPCC) declared: "Warming of the climate system is unequivocal…" and "Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG [greenhouse gas] concentrations."[10]

Oil shale development poses serious climate threats. Producing oil from shale will likely result in the generation of huge quantities of greenhouse gas emissions. Transportation fuels derived from oil shale will be highly energy-intensive and have a carbon footprint greater than both conventional fuels and cleaner fuel alternatives.

Throughout the western United States, climate change is projected to further reduce water availability. In general, these transformations will result from changes in temperature, precipitation, and evapotranspiration. The challenge facing allocation and use of western water is determining the impacts in future years on water availability as temperatures rise and supplies decrease. While the specific impacts are hard to predict, scientists of all disciplines are sounding the alarm. Here is what we do know:

1. <u>The West is getting hotter.</u>
   In a recent, comprehensive assessment, researchers found that 46 out of 49 global circulation model simulations project a more arid southwestern U.S. in future years, with droughts becoming the norm.[11] Climate models project Colorado's average temperature will warm 1.5 to 3.5°F by 2025, relative to the 1950-1999 baseline, and 2.5 to 5.5°F by 2050.[12]

2. <u>The West is getting drier.</u>
   In the arid and semi-arid West, global warming is already having serious consequences for the region's scarce water supplies. As with much of the West, Colorado has a snowfall-dependent water system, deriving 70% of its water supply from snowmelt. Recent hydrologic studies of the Upper Colorado River Basin project multi-model average decreases in runoff ranging from 6% to 20% by 2050 compared to the 20th century average.[13] Relative to the 1950-2000 baseline, evaporation is projected to exceed precipitation by 1.24 inches in the period 2021-2040.[14] This difference compares to that of the Dust Bowl years.[15]

3. Droughts will increase.
   As global warming continues, the IPCC predicts more intense and longer droughts, as characterized by the severe drought that began in the western United States in 1999 and continues today. Moreover, whereas past droughts have been caused by natural variability in ocean and atmospheric circulation (e.g., La Niña events), climatologists predict future drying will be caused by an overall warming. Normal climatic variability will further stimulate additional, increasingly severe, droughts.

4. Streamflows will change.
   Throughout the 20th century, much of the United States has experienced higher streamflow and precipitation, with a corresponding decrease in the duration and severity of drought. The notable exception is the West and Southwest. With drought comes a trend toward reduced mountain snowpack and earlier spring snowmelt runoff, both of which affect water availability and quantity.[16]

5. Ecosystems will be disrupted and wildlife will be affected.
   The IPCC also concluded that recent warming is already strongly affecting ecosystems and wildlife. Glaciers are melting and forests across the West have suffered as warming has extended the range of some damaging insects, such as the mountain pine beetle. Warming is also disrupting the natural timing of seasons and leading to loss of wildlife, including diminished fishing and hunting opportunities in the West.[17]

Importantly, federal officials project oil shale production would not reach full capacity before 2050, the same time that climatologists believe runoff in the Colorado River Basin will have dropped by 6-20% over 20th century levels. The convergence of events would further stress water availability, compounding the challenges and conflicts MacDonnell identifies, including constraints associated with the Upper Colorado River Endangered Fish Recovery Program and allocations under the 1922 Colorado River Compact.

Conclusion #4: ***Water needs must be quantified and supply sources identified before committing to commercial oil shale leasing.***

> "We need to be thoughtful about our approach, especially in light of the magnitude of such development. In fact, if the Department of the Interior were to authorize a commercial oil shale industry in Colorado, the development would constitute the largest industrial development in the State's history — with enormous implications for all of Northwest Colorado and for the State itself."[18]
>
> *— Colorado Governor Bill Ritter, Jr., 2008*

Future municipal development, power production, instream flows for federally endangered fish, and other types of energy development are expected to rely on water from the Colorado River. However, as a result of anticipated changes in climate, population, and changing land uses both within and outside the Colorado River Basin, the margin of uncertainty regarding water availability is troubling.

Estimates of water needed to directly support oil shale development also vary by 400%. According to the RAND Corporation, 1 to 3 barrels of water would be needed for construction, operation, and production for every barrel of oil produced via in-situ methods;[19] 2.6 to 4 barrels of water would be needed for every barrel of oil produced via retort.[20] When electricity demand is added, these estimates jump to 5 barrels of water for every barrel of oil produced. Water used for refining (called "upgrading") further increases the water demands. These margins are significant, especially when the BLM estimates peg potential oil shale development at 2 million barrels per day.

Bruce Lytle, a hydrologist who has evaluated water needs associated with oil shale development, underscores the significance of this margin of uncertainty. He points out that the BLM's analysis of water needed is deficient, noting the BLM's analysis:

- Does not adequately evaluate site-specific water supplies in river basins where oil development may occur.
- Fails to assess impacts from oil shale development in forcing the retirement of agricultural water rights and the dry-up of agricultural lands.
- Does not sufficiently address water rights issues related to hydraulic interconnection of aquifers, permanent changes to surface and groundwater systems, water quality, and mitigation of impacts related to either surface or groundwater supply development.

These conclusions present important warnings to policy makers, especially when coupled with the "Water on the Rocks" report's findings regarding (a) likely elimination of most of the existing irrigated agriculture in northwestern Colorado, (b) constraints associated with the Upper Colorado River Endangered Fish Recovery Program and obligations under the 1922 Colorado River Compact, and (c) impacts on junior water rights throughout Colorado.

These facts are the reason, we believe, why Denver Water and other water providers warned Congress that oil shale development could significantly affect their "ability to serve existing customers and the future growth projected for the Front Range of Colorado."[21]

As long as there is ample water to appropriate, there is little need or incentive for parties to collaborate. That was the case during the failed oil shale development program of the early 1980s, when water was a secondary concern. Since that time, Colorado has experienced a population explosion, which has increased competition for water and decreased water availability.

As Colorado begins to push up against Colorado River Compact allocations and endangered fish recovery goals and agreements, it is vital that stakeholders collaborate to address competing needs. Planning must be integrated to ensure development is consistent with other projects. As a first step in this process, companies seeking to develop oil shale must quantify their water needs and identify supply sources. Without such information, regional planning cannot be accomplished — and regional planning is increasingly necessary as supplies become further stressed.

Conclusion #5: ***Energy demands must be quantified and sources identified before committing to commercial oil shale leasing.***

> "In addition to the emissions associated with the operations themselves, extraction of oil from shale could consume immense quantities of electricity. This would necessitate the building of new power plants, which could further contribute air emissions."[22]
>
> *— Bureau of Land Management, 2008*

> "We do not know the amount of energy that will be needed to process shale oil, the sources or locations of necessary power plants, the impacts such energy production would have on regional air quality and visibility, or the greenhouse gas implications."[23]
>
> *— Colorado Governor Bill Ritter, Jr., 2008*

The BLM estimates that a 100,000-barrel-per-day (bpd) oil shale operation using in-situ conversion technology would likely require 1,200 megawatts (MW) of electricity. That amount of energy roughly equates to the amount needed to serve a city of 500,000. To produce one million barrels of shale oil per day would require 10 new power plants and 5 new coal mines.

In addition to the water required to extract the resource, water would also be needed to power the extraction process. Because oil shale technologies remain in their infancy, it is difficult to ascertain how much energy development would be required or the source of such energy.[24] Nevertheless, the Colorado River Water Conservation District estimates that the BLM's goal of full-scale oil shale development (2 million barrels per day) could require as much as 244,532,000 af of water to power oil shale development.[25] One of the critical policy issues Congress and federal officials must ask is whether the huge volumes of energy required to produce shale is an appropriate use of such power. A closely linked question is whether the associated water needs are an appropriate use of increasingly limited water supplies.

Water need projections for power generation are based on the BLM's assumptions that oil companies will use coal-fired power plants to power oil shale operations. In addition to the vast water requirements, these plants will be a major source of air pollution, which damages human health and the environment. They likewise will use dwindling water supplies and impact (and, in some cases, curtail) junior water users throughout the state.

Before diverting limited water supplies to support 20th century technologies, federal, state, and local leaders must engage in a robust public dialogue on broader energy policy — and must determine whether to promote old technologies or pursue new ones. WRA supports the latter and thus questions using limited water supplies to generate huge amounts of power for oil shale development.

WRA's final conclusion: Develop the information necessary to make informed decisions.

> "Currently, there is no oil shale industry and the oil shale extractive technology is still in its rudimentary stages; as such, commercial oil shale production does not exist anywhere in the world."[26]
>
> *— Bureau of Land Management, 2008*

> "The lack of a domestic oil shale industry makes it speculative to project the demand for oil shale leases, the technical capability to develop the resource, and the economics of producing shale oil."[27]
>
> *— Bureau of Land Management, 2008*

Oil shale development is fraught with uncertainty. While this report sheds light on the nexus between oil shale development and water, the unknowns are still paramount. The BLM acknowledges a 400% range of uncertainty for the amount of water needed to support oil shale development. Uncertainties regarding water availability and water requirements also include:

- Sequencing of development projects
- Rate of consumption
- Power generation needs
- Competition for shared resources
- Impacts of perfecting conditional water rights on junior users
- Impacts of climate change

Photo courtesy of The Story Group

This report makes clear that the link between oil shale and water is complex. Whether changes faced by communities will be incremental or seismic is difficult to predict. Nevertheless, while the specific impacts are difficult to quantify, the BLM's prediction that western Colorado will transition from an agricultural society to an industrial society is well-grounded.

Before we rush headlong into a commercial leasing program, it is wise to remember Spanish philosopher George Santayana's counsel: "Those who cannot remember the past are condemned to repeat it." In May 1982, as world oil prices plummeted, Exxon Oil pulled out of its oil shale Colony Project in Parachute, Colorado, leaving 2,000 people without work. The promise of energy independence turned bust overnight. Government subsidies were not enough to save this faltering industry as the technological obstacles and many costs proved too powerful a force.

Governmental officials at the local, state, and federal level continue to warn policy makers in Washington, D.C. that the knowledge base is simply not there to make informed decisions. Colorado cannot afford to again compromise its strong and diversified economy, but that's what certain lawmakers are asking us to do. By gambling on oil shale and failing, the state could once again be driven into an economic and social recession.

WRA opposes development of oil shale resources in the West unless and until industry and government demonstrate that proven technologies can develop oil shale without unacceptable environmental, climate, economic, or social costs. The industry has barely begun to address that challenge.

One of the significant differences in Colorado today, when compared to 1982, is water availability. In 1982, water was a secondary concern. Now, because of a number of factors — including significant increases in population, an energy boom, and development of the state's recreational economy — water resources and related environmental values are increasingly stressed. Water is central to oil shale development — but it is also critical to Colorado's economic, social, and environmental foundation.

As the Obama Administration takes its seat in Washington, D.C., it is time for elected officials and administration officials at the federal, state, and local level to comprehensively review the federal government's oil shale policy. Front and center must be a hard look at the water requirements and the opportunities and constraints posed by large-scale commercial leasing.

This is a time of great challenge and opportunity in the West. The Colorado Plateau and neighboring Rocky Mountain states are changing dramatically. The Interior West is still a place of spectacular landscapes that support vital ecosystems, important wildlife habitat, and large areas of undeveloped land. But it is also a region characterized by accelerating growth. While the environmental challenges facing the region are huge, the opportunities to address and resolve them are huge as well. The public is increasingly aware of the need for new energy policies and practices, for careful management and conservation of water, and for stewardship of irreplaceable public land resources. Oil shale development runs counter to these needs.

EXECUTIVE SUMMARY

Colorado's oil shale deposits are once again the focus of potential development, intensifying the need to quantify the potential impacts to already limited water supplies. Development would require the use of large quantities of water — perhaps as much as 3-4 barrels of water for each barrel of shale oil for direct use, plus additional water for indirect demands, such as electricity generation and an increased population. Given the magnitude of development the U.S. Department of the Interior's Bureau of Land Management (BLM) projects is one-day feasible, as much as 378,000 acre-feet of water could be required annually to support oil shale development, more than the Denver Metro area uses each year.

The possible development and use of substantial water for oil shale production raise important considerations for Colorado because of their potential to adversely affect some existing water uses and many expected future water uses. Companies with an interest in oil shale development own enormous portfolios of water rights. While there is great uncertainty with respect to the manner in which these rights will be developed and used, the consequences of such development are unquestionable.

Among the many likely changes in the use of Colorado water resulting from oil shale development are changes in existing irrigated agriculture, limitations on existing and planned water development for the Front Range and the West Slope, and likely limitations on other water development for new uses on the West Slope. While these general impacts are relatively easy to project, it is harder to identify the exact development scenarios and the resulting impacts on a given water right or a specific project.

This report helps frame these and other issues central to the many technical and policy questions posed by oil shale development. The report:

- Projects water requirements associated with oil shale development.
- Identifies all major water rights currently owned by energy companies that could be used for oil shale development in Colorado, as well as conditional rights that could be exercised in the future. Rights are grouped by basin, source, point of diversion, and diversion amount.
- Analyzes legal and hydrological issues of the Colorado River Basin that affect future development of Colorado's allocation under the 1922 Colorado River Compact and subsequent 1948 Upper Basin Compact.
- Explains how the Upper Colorado River Endangered Fish Recovery Program affects and limits additional consumptive uses of water in the mainstem Colorado River.

In order to meet the significant water demands associated with oil shale development, oil companies as well as water supply districts have secured hundreds o f water rights through western Colorado. They have established conditional water associated with more than 200 separate proposed structures, such as reservoirs and pipelines in the Colorado and White River Basins, which could potentially be developed in support of oil shale production. Many of these rights

were established in the 1950s and 1960s, and collectively would enable the direct diversion of more than 10,000 cubic feet per second (cfs) of water and the storage of more than 1.7 million acre-feet (af). In addition, energy companies have acquired full or partial ownership of more than 100 existing irrigation ditches with decreed rights to divert more than 650 cfs in the two basins in proximity to the shale deposits.

ExxonMobil owns the most rights: 49 conditional claims and ownership in 48 irrigation ditches. Most of its rights are located in the White River Basin. Shell holds 31 conditional rights in the two basins and has purchased ownership in 5 irrigation ditches. It is now in the process of securing rights on the Yampa River. Chevron holds 28 conditional rights and ownership in 24 irrigation ditches, all located in the Colorado River Basin. Its Unocal subsidiary owns absolute rights to another 48 wells and springs, as well as ownership in 13 ditches in this basin. OXY USA holds conditional rights for 22 proposed structures in the Colorado River Basin. Tosco holds 17 conditional rights and ownership in 14 ditches in the White River Basin. The Colorado River Water Conservation District holds conditional claims to store over 900,000 af of water at locations in the two basins that could serve oil shale development.

In addition to quantifying water rights, the report raises a number of important issues that could disrupt traditional uses of water in Colorado:

1. **Impacts on agriculture:** Energy companies own large portions of the water rights historically used to irrigate lands in the region. Many of these rights date back to the late 1800s and early 1900s. As pre-Colorado River Compact rights, these diversions would not be affected by a call placed against the Upper Basin states. Additionally, most of the associated water still remains in irrigation use as energy companies lease back the water to ranchers. Should oil shale development move beyond the research phase, many, if not all, of these rights would be changed in use, and the lands historically irrigated would be taken out of agriculture. The result would be a dramatic transformation of land and water uses in these areas.

2. **Impacts on junior users:** A second and less obvious outcome of oil shale development would be the displacement of some existing uses by new oil-shale-related uses with senior priorities. Conditional water rights for oil shale development date back to the 1950s. Should these rights be placed into use, they would be senior to all existing uses from the same source of water with subsequent priority dates, thereby affecting rights used both in western Colorado and in Colorado's Front Range. Development would also affect some existing uses established under more junior water rights and would potentially limit much other planned water development from sources on Colorado's West Slope — including plans to take additional water to the Front Range.

3. **Restrictions under the 1922 Colorado River Compact:** An important uncertainty facing future water development in western Colorado is the legal availability of water for development under the 1922 Colorado River Compact and associated laws and requirements. Water development could be constrained by obligations under the compact, as increased consumption would also increase the risk of "call" by the Lower Colorado Basin states against the Upper Basin.

4. **Impacts on endangered fish:** The ultimate extent of new water development is also subject to constraints associated with the Upper Colorado River Endangered Fish Recovery Program. At issue is the continued survival of four species of fish found only in this basin. The U.S. Fish and Wildlife Service has determined that additional depletions of the Colorado River Basin's water would jeopardize the continued existence of these species and any new water development —whether for oil shale or otherwise — must satisfy substantial program requirements intended to protect and recover them.

SECTION I

INTRODUCTION

The oil shale deposits located in Colorado's Piceance Basin are perhaps the richest in the world. An estimated one-half trillion barrels of oil are considered potentially recoverable.[28] Their existence has long been known, but despite periodic experimental attempts, their recovery has not yet been demonstrated to be economically feasible. Interest in oil shale has heightened once again as oil prices have reached record levels in recent years.

The Piceance Basin is located in northwest Colorado, as shown in *Figure 1*. The portion of greatest interest for oil shale development is bounded on the north by the White River, on the east by the Grand Hogback, on the south by the Roan Cliffs and the Colorado River, and on the west by Cathedral Bluffs and Douglas Creek. This area is situated primarily within Garfield and Rio Blanco counties. Most of the land in the north and east is federally owned, while lands in the south are largely private (see *Figure 2*). It is a rugged and lightly populated area, with irrigated agriculture in the creek bottoms and grazing on much of the uplands. Development of the area's substantial natural gas deposits has increased sharply in recent years. The area also contains important wildlife resources, including native and introduced trout, greater sage grouse, elk, and mule deer.

Oil shale development requires an extensive amount of water. According to the Bureau of Land Management, water would be used directly in mining and drilling operations, as well as for cooling equipment, controlling dust, cooling processed shale after retorting, wetting processed shale prior to disposal, fire control, revegetation, and on-site human uses.[29] In-situ operations would

Photo courtesy of The Story Group

Figure 1. *Location of the White and Colorado River Basins and the Piceance Basin Oil Shale Deposits*

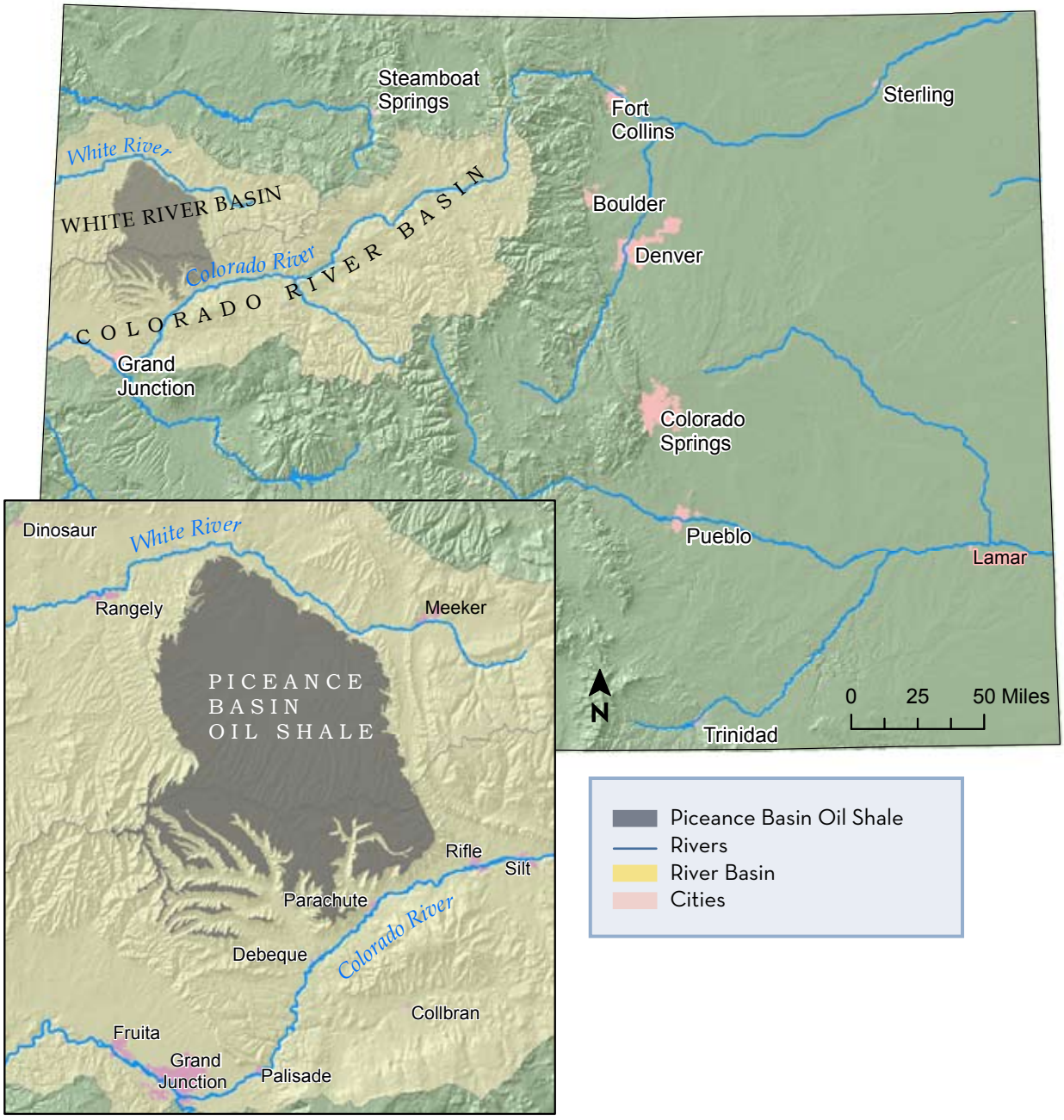
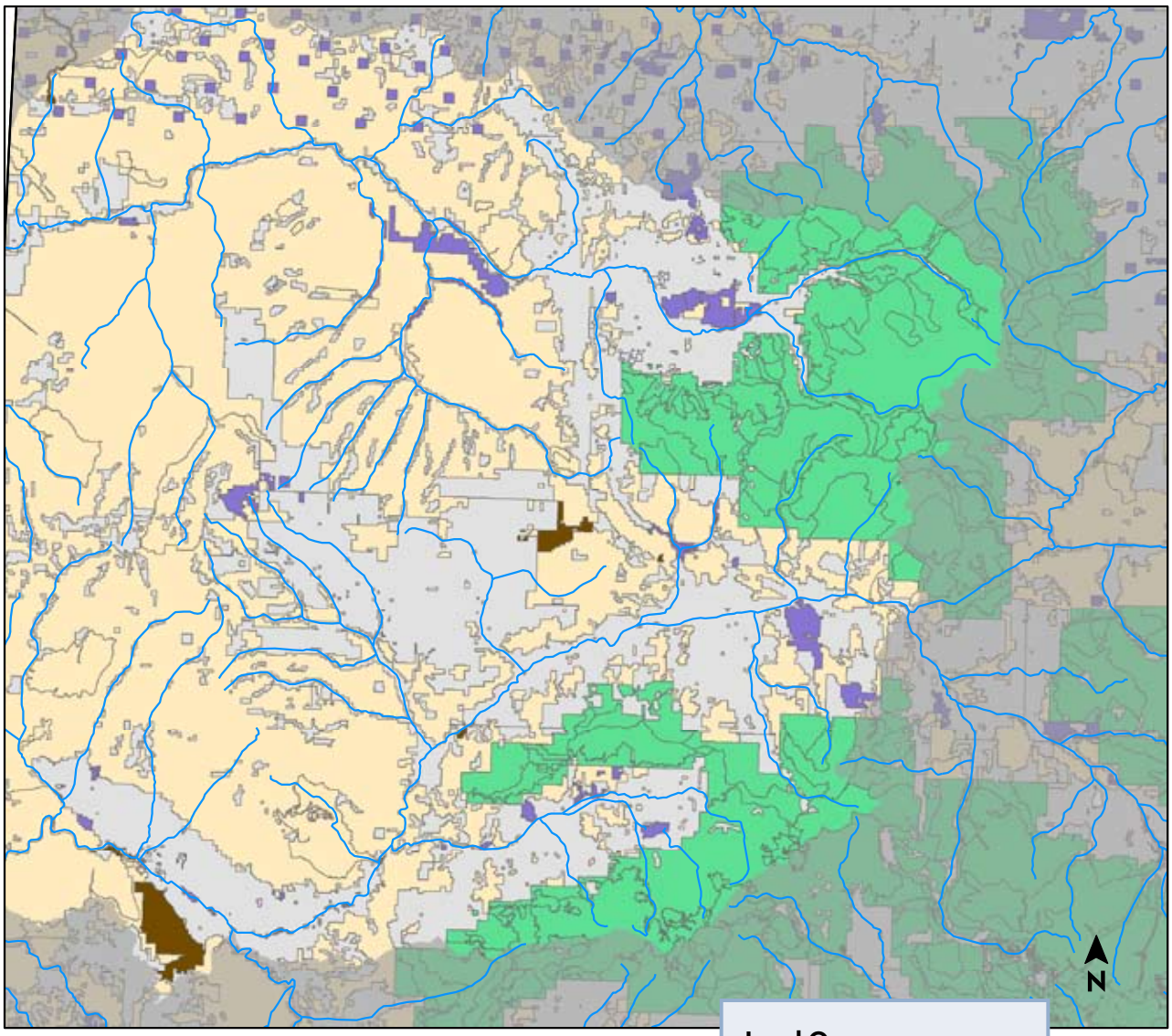


Figure 2. *Land Ownership in the White and Western Colorado River Basin*



Data Source: Theobald, D.M., G. Wilcox, S.E. Linn, N. Peterson, and M. Lineal. 2008. Colorado Ownership, Management, and Protection v7 database. Human Dimensions of Natural Resources and Natural Resource Ecology Lab, Colorado State University, Fort Collins, CO. 15 September. www.nrel.colostate.edu/projects/comap

use water for "hydrofracturing, steam generation, water flooding, quenching of kerogen products at producer holes, cooling of productive zones in the subsurface, cooling of equipment, and rinsing of oil shale after the extraction cycle."[30] Water would also be needed for indirect demands, including power generation and municipal needs resulting from the increased local population.

In anticipation of commercial-scale oil shale development, potential oil shale developers and local water districts filed for conditional water rights to secure the rights to develop significant quantities of water. Many of these rights date back to the 1950s. They also purchased existing agricultural water rights. This report provides a detailed examination of the extent and nature of these rights.

The report begins with a look at the anticipated water demands associated with oil shale development. It then summarizes water rights — both conditional rights and acquired irrigation rights — that could be used to support oil shale development. A more detailed look at these rights is provided next according to their ownership. Finally, the report considers some implications for other water users and water uses should these water rights be exercised for oil shale production.

WATER FOR OIL SHALE DEVELOPMENT

Water has long been identified as a critical component of oil shale development. A 2006 report produced by Argonne National Laboratory compared previous estimates of water requirements, focusing only on direct requirements and not assuming local refining of the oil.[31] These estimates are reproduced in *Table 1.*

Table 1.
Estimates of Water Requirements for Development of Oil Shale

Source	Oil Production (bpd)	Water Required (af/year)	Water Requirement Scaled to 100,000-bpd Oil Production (af/year)
Prien (1954)	1,000,000	227,000 diverted82,500 consumed	22,700 diverted 8,250 consumed
Cameron and Jones (1959)	1,250,000	252,000 diverted 159,000 consumed	20,000 diverted 8,250 consumed
Ely (1968)	2,000,000	500,000	25,000
U.S. Department of the Interior (1968)	1,000,000	145,000 diverted 61,000-96,000 consumed	14,500 diverted 6,100-9,600 consumed
U.S. Department of the Interior (1973a)	50,000 underground mine	8,700	17,400
	100,000 surface mine	16,800	16,800
	50,000 in-situ methods	4,400	8,800
	400,000 technology mix	65,000	16,300
	1,000,000 technology mix	155,000	15,500
McDonald (1980)	1,500,000	200,000	13,300
RAND (2005)	No specific value given; assume 3 barrels of water per 1 barrel of oil		14,125

Source: J.A. Veil and M.G. Puder, Potential Ground Water and Surface Water Impacts from Oil Shale and Tar Sands Energy-Production Operations, Argonne National Laboratory.

Clearly, the estimates vary somewhat. The early studies did not consider an in-situ production process. Some studies only consider amounts of water diverted, not consumed. In general, though, the assumptions respecting quantities of water required for mining and retorting are in the same range.

The most recent government estimates are contained in the September 2008 *Final Oil Shale and Tar Sands Programmatic Environmental Impact Statement (PEIS).* The U.S. Department of the Interior's Bureau of Land Management (BLM) assumes 1 to 3 barrels of water would be needed for every barrel of oil produced using an in-situ method and 2.6 to 4 barrels of water would be needed for every barrel of oil produced using the mining and surface retort

method.[32] Based on these water-to-oil ratios, the BLM estimates annual water consumption for a 200,000-bpd in-situ project would be 18,600 to 34,600 af per year. For production of 50,000 bpd using underground mining with surface retort, the BLM estimates water consumption of 4,900 to 7,400 af per year. Scaling this production up to 200,000 bpd, water consumption would be 19,600 to 29,600 af per year — somewhat less than would be required for the same production level using in-situ methods.

In a study recently prepared for the Colorado and Yampa/White River Roundtable Committees by URS, Inc., *Energy Development Water Needs Assessment*, analysts determined the annual water demand (not consumption) for a 50,000-bpd mine and retort to be 6,920 af annually, while a 50,000-bpd in-situ facility would require 3,576 af annually (not including water for electric power).[33] Assuming a long-term production mix of 1.5 million bpd from in-situ methods and 50,000 bpd using a surface retort, the report estimates direct water demands of 112,675 af per year. The report then goes on to estimate indirect water demands. Assuming a population increase of about 94,000 associated with production of 1.55 million bpd, the report estimates human water demands of 21,100 af annually.[34] The largest single demand for water would come from the electric power production needed primarily in support of in-situ processing, an estimated 242,535 af of water annually.

Table 2.
Summary of Estimated Oil Shale Water Demands

Source of Water Demand	Annual Quantity (af)
Direct demand (1.55 million bpd)	112,675
Electric power	244,535
Increased population	21,100
Total	**378,310**

Source: URS, Inc., Energy Development Water Needs Assessment

Thus, an oil shale industry in Colorado that produces 1.5 million bpd by in-situ means and another 50,000 bpd using the mine/retort method would require 378,310 af of water annually for direct and indirect uses.[35] Using a factor of 0.76 to convert demand for process water into consumption and 0.35 to convert other uses,[36] total annual consumption of water in support of oil shale development would be 280,439 af.

CONDITIONAL WATER RIGHTS

Under Colorado law, an appropriation of water is established at the time the appropriator's intent to divert and use water is made clear through overt actions that place others on notice of the intent. The date the intent is manifested is the appropriation date. The right is regarded as conditional, however, until water is physically controlled and placed to beneficial use. Holders of conditional water rights must file an application with the water court to obtain a decree determining that a conditional right has been established and fixing its priority date. Holders are obligated to pursue development of the appropriation with reasonable diligence and must demonstrate that diligence to the water court every six years until water is actually placed to beneficial use.

Every appropriation is given a name for the structure proposed to be built to control and divert water. The location of the structure is identified, including the source from which water will be diverted. For appropriations intended to directly divert water, a maximum rate of flow described in cubic feet per second is identified. For appropriations to store water, the expected capacity of the facility is stated as a volume of water, described in acre-feet (an acre-foot of water is approximately 326,000 gallons of water). The intended general purpose (or purposes) of use (e.g., municipal or industrial) also is identified.

SECTION III

WATER RIGHTS FOR OIL SHALE

Oil shale production and its associated requirements would represent a major new demand for water in Colorado. While some of this water would probably come from retirement of existing uses, most would come from new projects that would capture flows of water in the two primary rivers of the regions, the Colorado River and the White River, and move them to the places of use. This section summarizes the water rights that have been established in anticipation of serving oil shale production and the existing rights that have been purchased.[37]

As described below, oil companies have acquired agricultural rights and taken initial steps to secure other water rights (conditional rights). In order to reach large-scale commercial production of oil shale, companies would need to use both rights.

A. CONDITIONAL WATER RIGHTS

Companies interested in oil shale development have established conditional water rights (see sidebar) associated with more than 200 proposed structures, such as a diversion or storage dam in the Colorado River and White River Basins, dating back more than 50 years.[38] *Figures 3* and *4* provide an overview of the general location of these conditional rights. A chronological description of their development is provided in *Appendix A*. Tables listing these rights for each basin according to their priority can be found in *Appendix B*.

Companies first established conditional claims in the Colorado River Basin, as early attention focused on oil shale deposits in the Parachute Creek area. Several of the largest early conditional rights envision pumping water through pipelines from the Colorado River for use in the Parachute Creek and Roan Creek watersheds. Subsequent conditional rights added proposed storage reservoirs.

As more information about the quality of deposits in the Piceance Basin to the north became available in the 1950s and 1960s, individuals and companies began to establish conditional appropriations in the White River Basin. The richest oil shale deposits in the Piceance are located on the high plateau that separates the mainstem Colorado River and White River Basins. Unlike

in the Colorado River, there are multiple reservoirs proposed for construction on the North and South Forks as well as on the mainstem White River. Pipelines and pumps are proposed to lift the water from the White River into the Piceance watershed. *Figures 5* and *6* display the location of conditional water rights in this basin.

There are approximately 105 separate proposed structures with associated conditional water rights that could be used for oil shale development in the Colorado River Basin. These rights are for a mixture of both direct diversion and storage rights. In addition, there are 114 proposed structures with conditional rights in the White River Basin. These conditional structures include proposed reservoirs, pipelines (most with pumps), ditches, wells, and springs. These rights would enable a total direct diversion of approximately 5,000 cfs in the Colorado River Basin and nearly 5,700 cfs in the White River Basin. They would provide for total storage of approximately 735,000 af of water in the Colorado River Basin and over 1 million af in the White River Basin.

This information is summarized in the following tables and detailed in *Appendix B*.

Table 3.
Summary of Conditionally Decreed Structures – Colorado River Basin

Proposed Structures by Type	Total Conditionally Decreed Quantities of Water
Reservoirs: 27	736,770.6 af
Pumps and pipelines: 23	1,515.6 cfs
Ditches: 6	3,472.3 cfs
Wells: 5	1.36 cfs
Springs: 44	6.76 cfs
Total structures: 105	**Total quantities: 4,996.02 cfs 736,770.6 af**

Table 4.
Summary of Conditionally Decreed Structures – White River Basin

Proposed Structures by Type	Total Conditionally Decreed Quantities of Water
Reservoirs: 34	1,186,625.8 af
Pumps and pipelines: 33	4,274 cfs
Ditches: 24	1,363 cfs
Wells: 12	54.02 cfs
Springs: 11	2.45 cfs
Total structures: 114	**Total quantities: 5693.47 cfs 1,186,625.8 af**

B. AGRICULTURAL WATER RIGHTS

In addition to establishing conditional water rights, energy companies have been actively purchasing existing agricultural ditch rights in both basins. *Figure 7* shows the location of these ditches in the Colorado River Basin, and *Figure 8* shows their location in the White River Basin. *Appendix C* contains tables listing these rights. Acquisition of ditches provides control of water with senior priorities, especially important on the flow-limited tributaries in which they are located. In many cases, ownership of the ditches is shared by two or more energy companies. For the most part, the water associated with these ditches remains in irrigation use. Shifting the use to energy production or other purposes requires petitioning the Colorado water court

to change the use of the water. Among other requirements, the water right holder must demonstrate that a different use will not injure other existing rights.

As shown in *Table 5*, 57 irrigation ditches in the Colorado River Basin are now owned in whole or in part by energy companies, with decreed absolute rights to divert approximately 470 cfs of water. According to state records, average diversions under these rights are approximately 50,000 af of water per year.

Another 57 ditches in the White River Basin are now owned by energy companies. In many cases, companies have acquired only partial ownership of a ditch (less than 100% of total ditch shares). Sometimes several energy companies share in the ownership of the same ditch. The decreed absolute diversion rates associated with these ditches total approximately 200 cfs. The total annual volume of water diverted under these rights, on average, is approximately 19,000 af.

Table 5.
Summary of Irrigation Ditches Owned by Energy Companies

No. of Ditches	Decreed Diversion Rate	Average Volume Diverted Annually
Colorado: 57	468.55 cfs	50,293 af
White: 57	207.94 cfs	19,193 af

In sum, conditional water rights that could potentially be developed to provide water for oil shale development include storage rights to nearly 2,000,000 af of water and rights to divert more than 10,000 cfs of water in the two basins.[39] In addition, more than 100 irrigation ditches in the area of potential oil shale development now are owned by energy companies. Collectively, these ditches hold absolute rights to divert approximately 675 cfs of water.

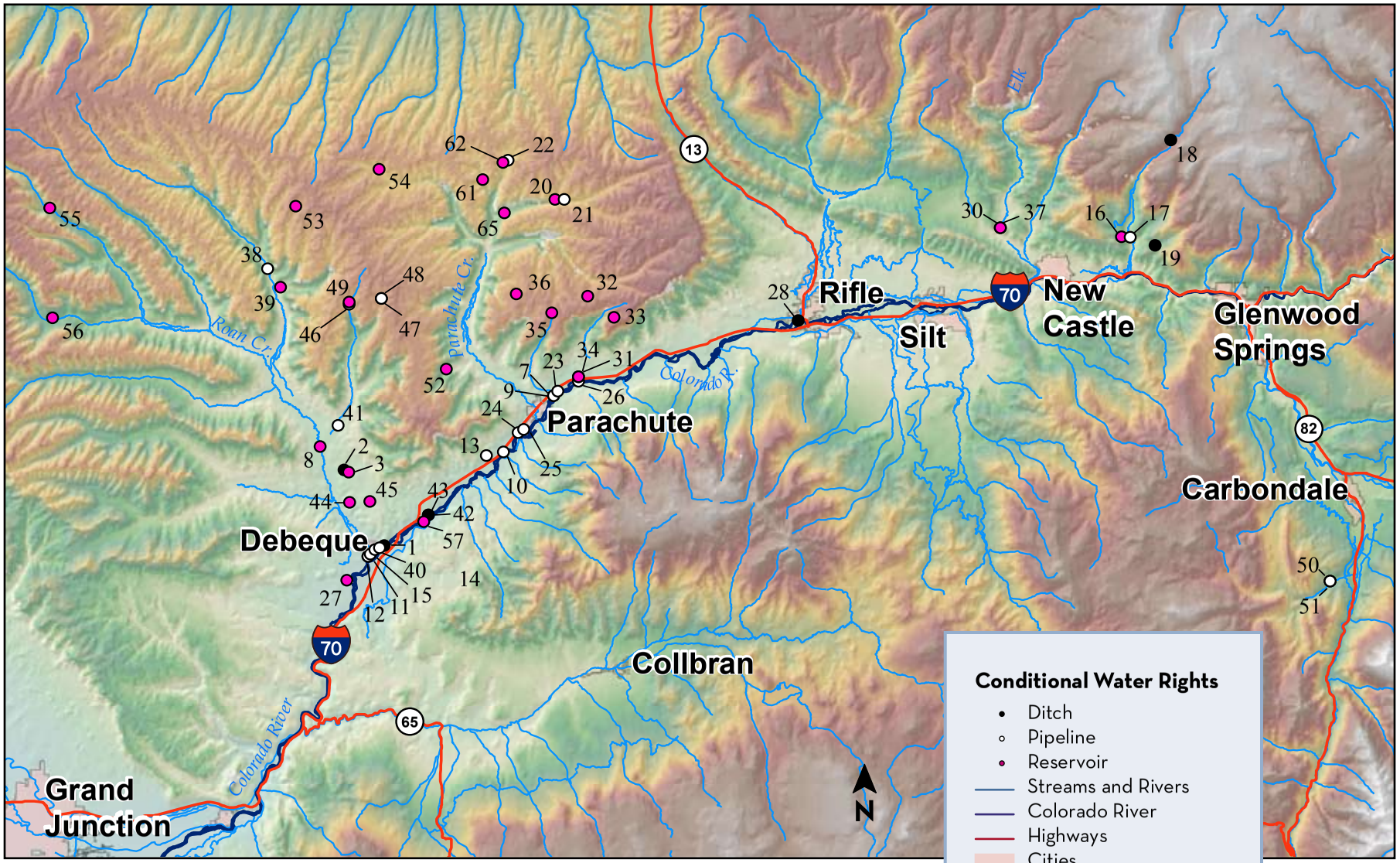
A NOTE ON OIL SHALE PRODUCTION TECHNOLOGIES

Oil shale can be mined using one of two methods: underground mining, using the room-and-pillar method, or surface mining. After mining, the oil shale is transported to a facility for retorting, a heating process that separates the oil fractions of oil shale from the mineral fraction. (The vessel in which retorting takes place is known as a retort.) After retorting, the oil must be upgraded by further processing before it can be sent to a refinery, and the spent shale must be disposed of.

Shell Oil is currently developing an in-situ conversion process (ICP). The process involves heating underground oil shale, using electric heaters placed in deep vertical holes drilled through a section of oil shale. The volume of oil shale is heated over a period of two to three years, until it reaches 650-700°F, at which point oil is released from the shale. The released product is gathered in collection wells positioned within the heated zone.

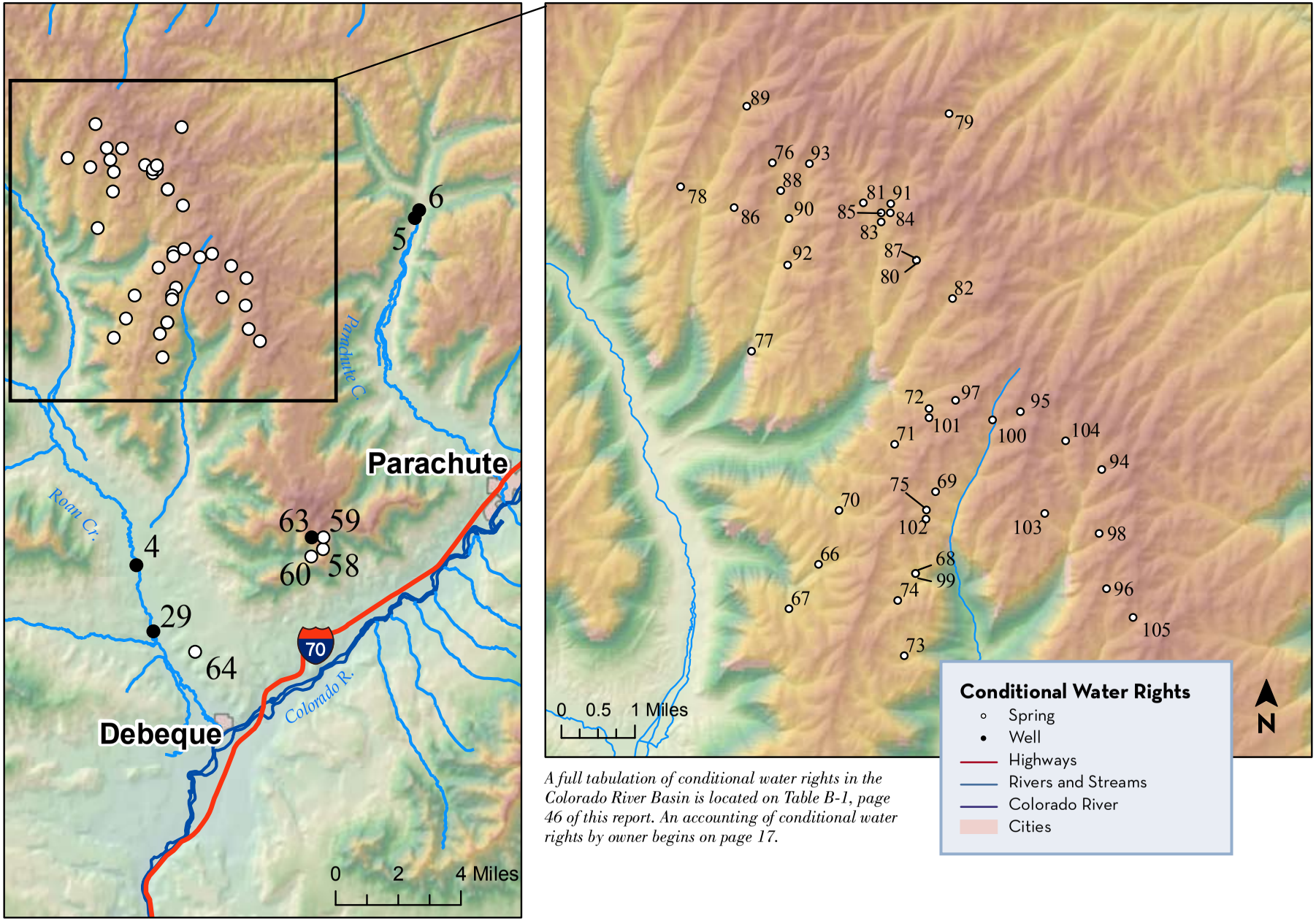
Source: Oil Shale & Tar Sands Programmatic EIS Information Center Web site, available at http://ostseis.anl.gov/guide/oilshale/index.cfm.

Figure 3. *Conditional Water Rights (Ditches, Pipelines, Reservoirs) for Oil Shale Development in the Colorado River Basin*



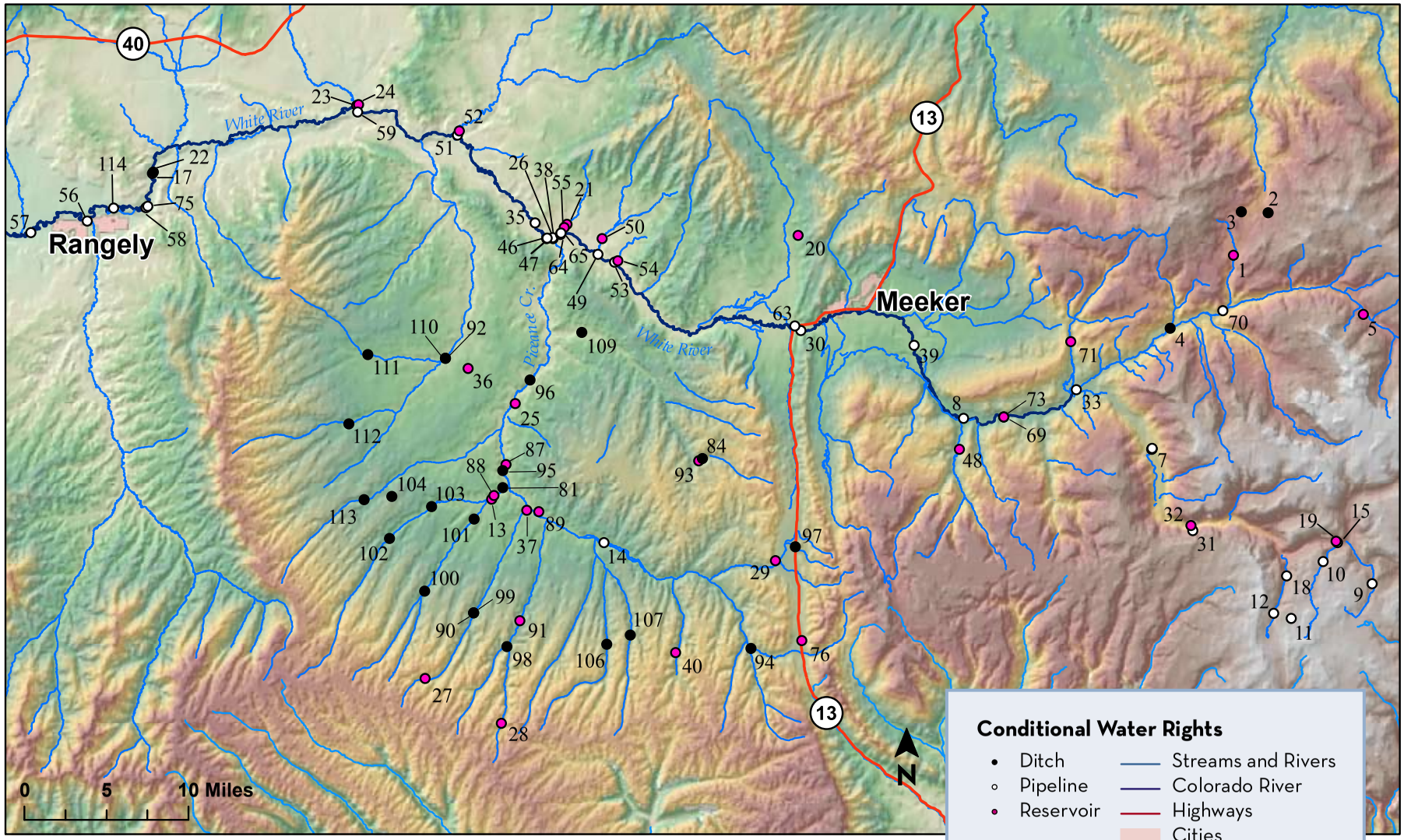
A full tabulation of conditional water rights in the Colorado River Basin is located on Table B-1, page 46 of this report.
An accounting of conditional water rights by owner begins on page 17.

Figure 4. *Conditional Water Rights (Springs and Wells) for Oil Shale Development in the Colorado River Basin*



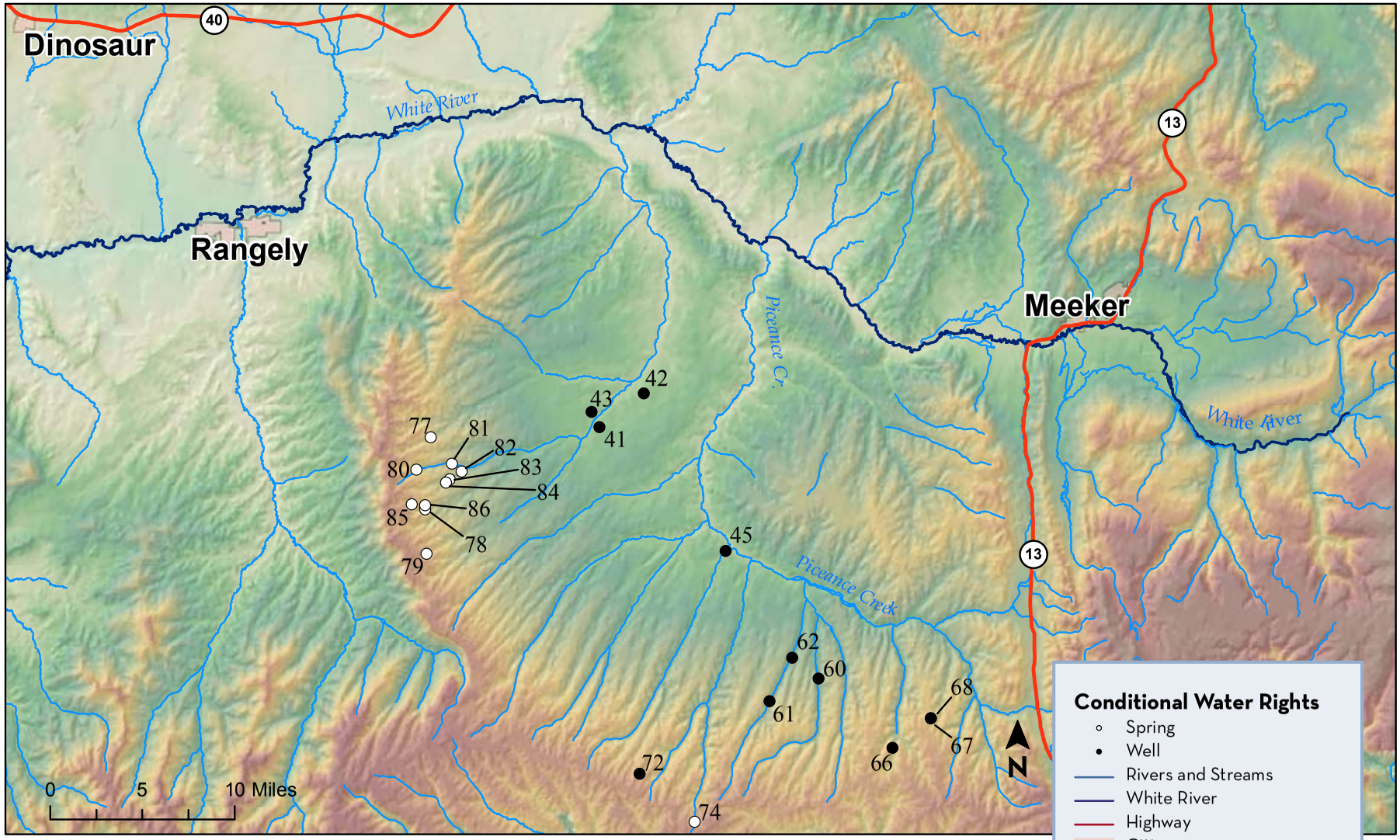
A full tabulation of conditional water rights in the Colorado River Basin is located on Table B-1, page 46 of this report. An accounting of conditional water rights by owner begins on page 17.

Figure 5. *Conditional Water Rights (Ditches, Pipelines, and Reservoirs) for Oil Shale Development in the White River Basin*



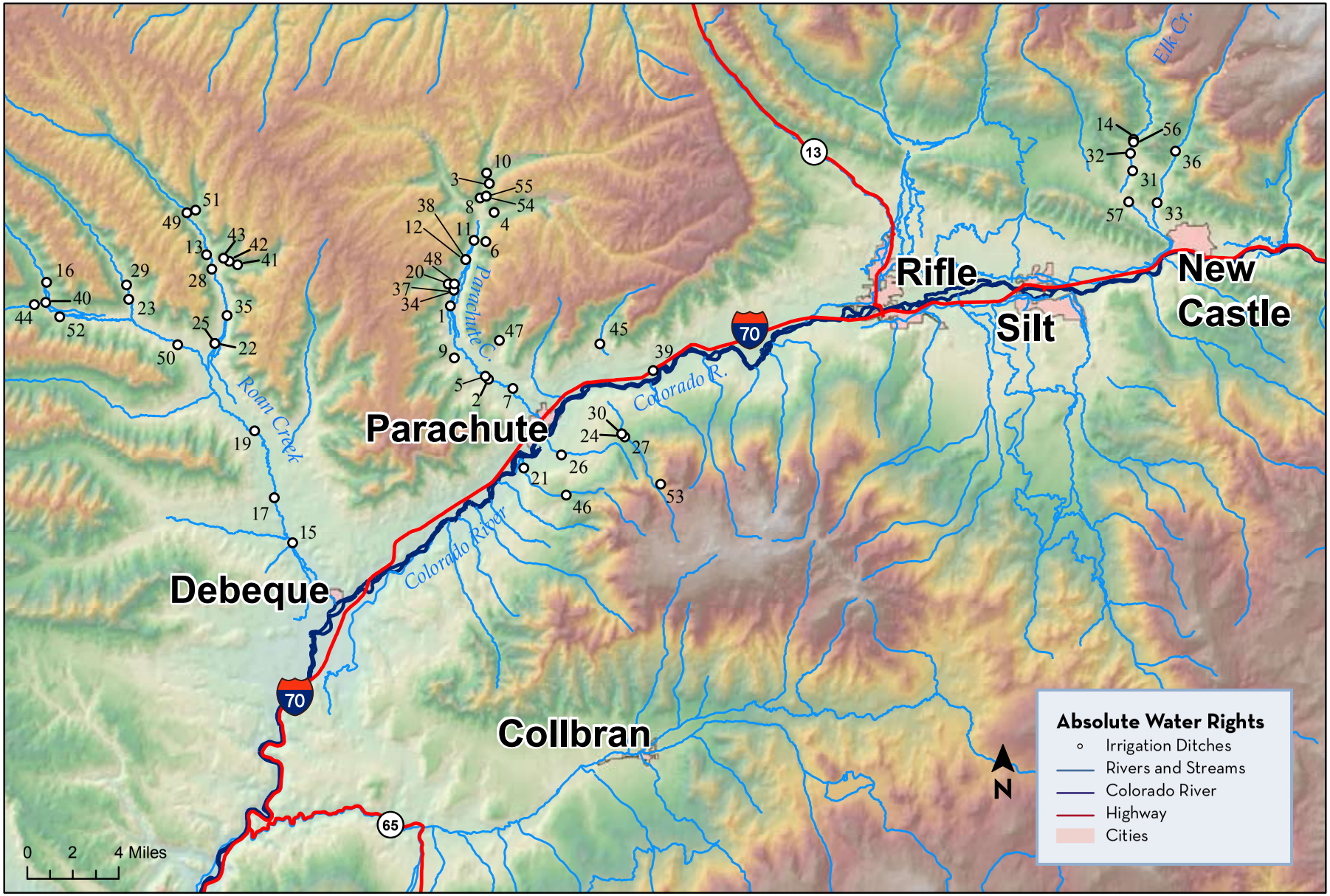
A full tabulation of conditional water rights in the White River Basin is located on Table B-2, page 50 of this report.
An accounting of conditional water rights by owner begins on page 26.

Figure 6. *Conditional Water Rights (Springs and Wells) for Oil Shale Development in the White River Basin*



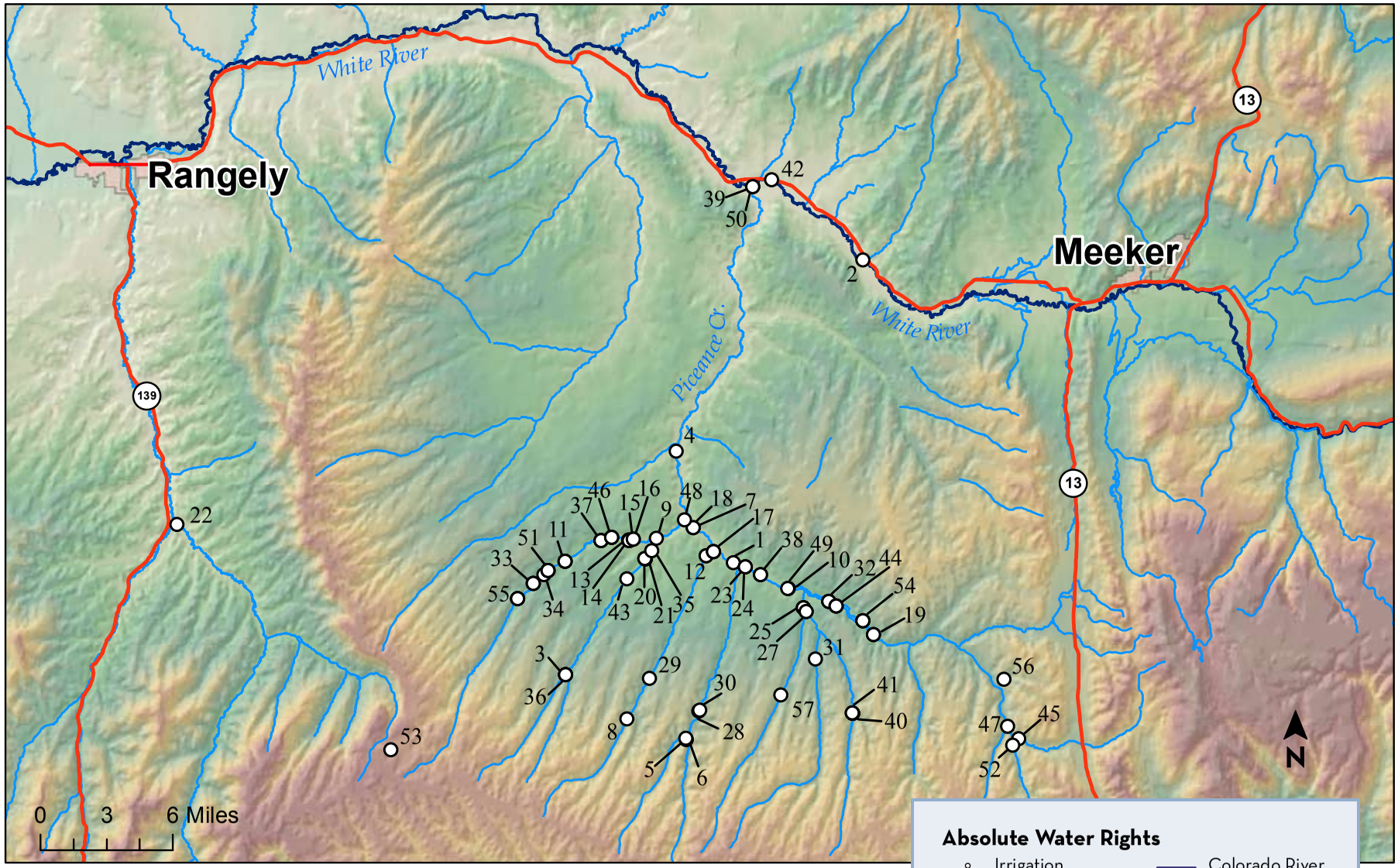
A full tabulation of conditional water rights in the White River Basin is located on Table B-2, page 50 of this report.
An accounting of conditional water rights by owner begins on page 26.

Figure 7. *Absolute Water Rights (Irrigation Ditches) for Oil Shale Development in the Colorado River Basin*



A full tabulation of absolute ditch water rights in the Colorado River Basin is located on Table C-1, page 55 of this report.
An accounting of absolute water rights by owner begins on page 18.

Figure 8. *Absolute Water Rights (Irrigation Ditches) for Oil Shale Development in the White River Basin*



A full tabulation of absolute ditch water rights in the White River Basin is located on Table C-2, page 57 of this report. An accounting of absolute water rights by owner begins on page 29.

SECTION IV

A CLOSER LOOK AT WATER RIGHTS FOR OIL SHALE

This section explores the portfolio of conditional and absolute rights owned by entities either historically or currently involved in oil shale development or by water suppliers that could provide water for oil shale development. The water rights are summarized in separate tables for conditional rights and, if applicable, for absolute rights. Locations of the proposed or existing structures are shown on maps for each basin. The discussion is organized by river basin.

For a complete list of all owners of conditional rights in both river basins, see *Appendix B*; for a complete list of all owners of absolute rights in both river basins, see *Appendixes C* and *D*.

A. COLORADO RIVER BASIN

1. Chevron Texaco

Chevron Texaco holds the rights to develop 28 conditionally decreed structures in the Colorado River Basin. These rights include 6 proposed reservoirs with a total storage capacity of over 100,000 af. Most of this storage would be located in the Roan Creek watershed. The rights also include 3 proposed pipelines with the decreed conditional right to pump approximately 300 cfs from the Colorado River.

Table 6.
Chevron Texaco – Conditional Water Rights – Colorado River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
4	Galyean Well	Well	Roan Creek	0.5	0	5/15/1948
8	Roan Creek Reservoir	Reservoir	Roan Creek	0	71,300	1/7/1950
9	Dragert Pump Plant & Pl	Pump	Colorado River	194	0	1/7/1950
11	Getty Pipeline	Pump	Colorado River	56	0	9/3/1950
14	Pacific Oil Co Pl No 1	Pump	Colorado River	57.25	0	6/9/1953
27	Virginia Mesa Reservoir	Reservoir	Colorado River	0	50.52	7/18/1957
44	Getty Reservoir No 2	Reservoir	Roan Creek	0	2,0670.2	5/17/1965
45	Getty Reservoir No 1	Reservoir	Roan Creek	0	2,543.9	5/17/1965
53	Getty-Sleepy Gulch Res	Reservoir	Clear Creek	0	6,538	6/27/1967
54	Getty W Fk Parachute Cr	Reservoir	Parachute Creek	0	4,658	6/27/1967
76	Getty Spring 15b	Spring	Clear Creek	0.027	0	7/1/1983
77	Getty Spring 17a	Spring	Clear Creek	0.007	0	7/1/1983
78	Getty Spring 20a	Spring	Clear Creek	0.037	0	7/1/1983
79	Getty Spring 1b	Spring	Parachute Creek	0.097	0	7/1/1983
80	Getty Spring 10a	Spring	Clear Creek	0.787	0	7/1/1983
81	Getty Spring 12c	Spring	Clear Creek	0.027	0	7/1/1983
82	Getty Spring 09a	Spring	Clear Creek	0.327	0	7/1/1983
83	Getty Spring 11e	Spring	Clear Creek	0.007	0	7/1/1983
84	Getty Spring 11b	Spring	Clear Creek	0.027	0	7/1/1983
85	Getty Spring 11c	Spring	Clear Creek	0.027	0	7/1/1983
86	Getty Spring 19a	Spring	Clear Creek	0.007	0	7/1/1983
87	Getty Spring 10b	Spring	Clear Creek	0.017	0	7/1/1983
88	Getty Spring 15a	Spring	Clear Creek	0.047	0	7/1/1983
89	Getty Spring 18a	Spring	Clear Creek	0.637	0	7/1/1983
90	Getty Spring 14e	Spring	Clear Creek	0.027	0	7/1/1983
91	Getty Spring 11a	Spring	Clear Creek	0.187	0	7/1/1983
92	Getty Spring 16b	Spring	Clear Creek	0.057	0	7/1/1983
93	Getty Spring 14a	Spring	Clear Creek	0.127	0	7/1/1983
	Total structures: 28			**Total: 310.23 cfs**	**Total: 105,760.62 af**	

Chevron Texaco also owns 24 irrigation ditches, with the decreed right to divert approximately 265 cfs. These ditches are located both in the Parachute Creek and Roan Creek watersheds. The following table lists these rights.

Table 7.
Chevron Texaco – Absolute Water Rights – Colorado River Basin

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date
11	Granlee Ditch	Parachute Creek	12.69	1,690	5/17/1883
12	Benson and: Barnett Ditch	Parachute Creek	8.51	1,187	5/17/1883
13	Newton Ditch	Clear Creek	3.1	1,143	7/1/1883
15	Reservoir Ditch	Roan Creek	37.4	5,459	2/28/1884
16	Upper Roan Creek Ditch	Carr Creek	14.25	1,155	8/10/1884
17	Roan Creek No 3 Ditch	Roan Creek	7.4	1,762	10/13/1884
19	Creek and: Newman Ditch	Roan Creek	33	3,318	11/15/1884
20	Garden Gulch Ditch	Parachute Creek	5.25	314	4/15/1885
22	Himebaugh Ditch	Clear Creek	6.93	840	5/15/1885
23	Cannon Ditch	Brush Creek	11.65	1,387	6/3/1885
25	Clear Creek Ditch	Clear Creek	50.43	3,439	4/9/1886
28	Carr and: Himebaugh Ditch	Clear Creek	8.9	705	4/22/1887
29	Cannon Highline Ditch	Brush Creek	4.34	455	5/10/1887
34	Purdy Ditch	Parachute Creek	6.15	814	4/5/1890
35	Gibler Ditch	Clear Creek	4.52	404	10/1/1890
37	Jangle Ditch	Parachute Creek	12.97	1,521	11/12/1891
38	Benson and: Barnett Ditch	Parachute Creek	8.51	1,187	11/12/1891
40	Flume Ditch	Carr Creek	4.35	455	4/1/1895
44	Carlisle Ditch	Roan Creek	4.35	183	4/1/1900
48	Garden Gulch No 2 Ditch	Parachute Creek	1.33	175	5/1/1903
49	H A Newton Ditch	Clear Creek	2.86	97	5/15/1907
50	New Hobo Ditch	Roan Creek	11.56	566	6/6/1908
51	Parkes Ditch	Clear Creek	3.7	169	5/5/1908
52	Longseth No 1 Ditch	Roan Creek	1.67	143	5/3/1910
	Total structures: 24		**Total: 265.82 cfs**	**Total: 28,568 af**	

2. Colorado River Water Conservation District

The Colorado River Water Conservation District (CRWCD) is a special governmental district established under Colorado law to protect and develop water resources of the Colorado River Basin on Colorado's West Slope. It owns conditional water rights for 9 structures that could potentially be developed to provide water for uses that include oil shale development as well as to meet other water demands in the region. Included are 3 conditional reservoirs with the decreed capacity to store slightly less than 500,000 af. These rights are listed below.

Table 8.
CRWCD – Conditional Water Rights – Colorado River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
1	Kobe Canal	Ditch	Colorado River	48.3	0	6/30/1936
2	Mt Logan Canal	Ditch	Roan Creek	75	0	6/30/1936
3	Mt Logan Dam & Reservoir	Reservoir	Roan Creek	0	10,000	6/30/1936
16	Flattops Proj Bearwl Res	Reservoir	Canyon Creek	0	96,488.9	6/28/1954
17	Flattops Proj Bearwl Con	Pipeline	Canyon Creek	200	0	6/28/1954
18	Flattops Proj Bench Flum	Ditch	Canyon Creek	254	0	6/28/1954
19	Flattops Proj Poss Coll1	Ditch	Canyon Creek	175	0	6/28/1954
28	Bluestone Project	Ditch	Colorado River	220	0	3/27/1958
42	Una Reservoir	Reservoir	Colorado River	0	369,460	3/16/1965 (includes refill right with a 1981 priority)
	Total structures: 9			**Total: 972.3 cfs**	**Total: 475,948.9 af**	

3. Exxon Mobil Corporation

Exxon Mobil Corporation (ExxonMobil) owns conditional water rights to develop 16 structures in the Colorado River Basin (see *Table 9*). Its rights are concentrated in the Parachute Creek watershed and the adjacent Colorado River. It also owns rights that would enable development on Main Elk Creek, an upstream tributary to the Colorado River. Collectively, these conditional rights would enable diversion of over 300 cfs and storage of approximately 45,000 af.

In addition, ExxonMobil has acquired ownership of 17 irrigation ditches in the Colorado River Basin, including several in Main Elk Creek. In total, these ditches are decreed to divert approximately 73 cfs. This information is displayed in *Table 10*. Exxon also holds contracts for 6,000 af of water stored in Ruedi Reservoir.

Table 9.
ExxonMobil – Conditional Rights – Colorado River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
10	Hayward & Wyatt Pl	Pipeline	Colorado River	12.725	0	2/2/1950
20	East Middle Fork Res	Reservoir	Parachute Creek	0	130.558	9/17/1954
21	Dow E Middle Fork Pl	Pipeline	Parachute Creek	13.54	0	10/19/1954
22	Dow Middle Fk Pipeline	Pipeline	Parachute Creek	1.088	0	10/20/1954
23	Dow Pump Plant And Pl	Pump	Colorado River	187.11	0	1/24/1955
30	Main Elk Wheeler G Pl	Pipeline	Main Elk Creek	40	0	6/19/1963
31	Mahaffey Pump P & Pl	Pump	Colorado River	60	0	6/19/1963
32	Sheep Trail H Term Res	Reservoir	Parachute Creek	0	160	6/19/1963
33	Cottonwood G Term Res	Reservoir	Cottonwood G.	0	160	6/19/1963
34	Mahaffey Terminal Res	Reservoir	Colorado River	0	160	6/19/1963
35	Allenwater Cr Term Res	Reservoir	Colorado River	0	160	6/19/1963
36	Rulison Gulch Term Res	Reservoir	Parachute Creek	0	160	6/19/1963
37	Main Elk Reservoir	Reservoir	Main Elk Creek	0	34,922	6/19/1963
61	Davis Gulch Reservoir	Reservoir	Parachute Creek	0	1,194	9/30/1974
62	Middle Fork Reservoir	Reservoir	Parachute Creek	0	1,470.002	9/30/1974
65	Lower E Middle Fork Res	Reservoir	Parachute Creek	0	6,200	2/2/1982
	Total structures: 16			**Total: 314.46 cfs**	**Total: 44,716.56 af**	

Table 10.
ExxonMobil – Absolute Water Rights – Colorado River Basin

Map Location	Structure Name	Water Source	Quantity (cfs)	Avg. Vol. Div. (af)	Appropriation Date
14	C O & C P Pierson Ditch	Main Elk Creek	5	1,001	2/15/1884
21	Dry Creek Ditch	Dry Creek (West)	2.02	52	4/23/1885
24	R F Ditch	Battlement Creek	9.855	538	11/25/1885
26	Werhonig Ditch	Monument Gulch	0.2	0	7/15/1886
27	Dobey Ditch	Battlement Creek	5.975	354	3/7/1887
30	Shutt Ditch	Battlement Creek	6	267	5/11/1887
31	Trout Ditch	Main Elk Creek	3.5	557	2/5/1888
32	Benson Pierson Nelson	Main Elk Creek	4	646	2/5/1888
33	Oak Grove Ditch	East Elk Creek	3	747	2/20/1890
36	Red Glen Highline Ditch	East Elk Creek	8	1,643	11/20/1890
39	Rulison Miller Ditch	Colorado River	4.1	453	12/8/1891
45	Jensen Ditch	Cottonwood Gulch	8.8	396	4/15/1901
46	Number One Ditch	Dry Creek (West)	3.86	153	5/1/1901
53	Hayward Spring Ditch	Battlement Creek	0.75	6	8/31/1912
54	Ryden No 2 Ditch	Main Elk Creek	1.76	279	4/6/1912
56	Ryden No 1 Ditch	Main Elk Creek	5.5	716	4/7/1915
57	W E Ditch	Main Elk Creek	1	458	7/1/1917
	Total structures: 17		**Total: 73.32 cfs**	**Total: 8,266 af**	

4. The Oil Shale Corporation

The Oil Shale Corporation (Tosco) owns rights to 2 proposed reservoirs: the Trail Gulch Reservoir, to be sited on Roan Creek, and Trail Gulch Reservoir Alternative Point, to be located on Carr Creek. The particulars of these rights are presented in the following table.

Table 11.
Tosco – Conditional Water Rights – Colorado River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
55	Trail Gulch Res Alt Pt	Reservoir	Carr Creek	0	950.79	9/23/1967
56	Trail Gulch Reservoir	Reservoir	Roan Creek	0	5,669.21	9/23/1967
	Total structures: 2			**Total: 0 cfs**	**Total: 6,620 af**	

5. OXY USA

OXY USA, formerly Occidental Oil Company, purchased Cities Service in the early 1980s. OXY's Colorado River Basin conditional rights are concentrated in the Roan Creek area. In total, OXY owns rights that would enable it to develop 22 structures, providing for direct diversion of almost 124 cfs and storage of approximately 1,000 af. These rights are summarized in the following table.

Table 12.
OXY – Conditional Water Rights – Colorado River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
12	Cities Service Pl and Pp	Pump	Colorado River	100	0	8/2/1951
46	Conn Creek Pipeline	Pipeline	Conn Creek	10	0	8/25/1966
47	Cascade Canyon Res	Reservoir	Conn Creek	0	619.47	8/25/1966
48	Cascade Canyon Pipeline	Pipeline	Conn Creek	10	0	8/25/1966
49	Conn Creek Reservoir	Reservoir	Conn Creek	0	422.75	8/25/1966
58	Logan Wash Mine	Spring	Roan Creek	0.11	0	9/1/1972
59	Lw-27 Well	Spring	Roan Creek	0.11	0	3/30/1973
60	Logan Wash Mine No 3-C	Spring	Roan Creek	0.11	0	2/1/1974
63	Ww-1 Well	Well	Roan Creek	0.165	0	11/22/1974
64	Logan Wash Pump No 1	Spring	Roan Creek	2.9	0	10/30/1979
94	Cities Service Spg 41	Spring	Conn Creek	0.03	0	7/19/1983
95	Cities Service Spg 17	Spring	Conn Creek	0.05	0	7/19/1983
96	Cities Service Spg 39	Spring	Conn Creek	0.09	0	7/19/1983
97	Cities Service Spg 07	Spring	Clear Creek	0.12	0	7/19/1983
98	Cities Service Spg 40	Spring	Conn Creek	0.03	0	7/19/1983
99	Cities Service Spg 13	Spring	Conn Creek	0.05	0	7/19/1983
100	Cities Service Spg 18	Spring	Conn Creek	0.05	0	7/19/1983
101	Cities Service Spg 08	Spring	Clear Creek	0.02	0	7/19/1983
102	Cities Service Spg 11a	Spring	Conn Creek	0.02	0	7/19/1983
103	Cities Service Spg 03	Spring	Conn Creek	0.02	0	7/19/1983
104	Cities Service Spg 22	Spring	Conn Creek	0.05	0	7/19/1983
105	Cities Service Spg 38	Spring	Conn Creek	0.06	0	7/19/1983
	Total structures: 22			**Total: 123.99 cfs**	**Total: 1,042.22 af**	

6. Shell Texaco

Shell Texaco owns the right to develop 14 structures in the Colorado River Basin. These conditional rights include diversion of 250 cfs and storage of over 1,500 af. The following table sets out this information. In addition, Shell Texaco has purchased 3 ditches, with the decreed right to divert approximately 8 cfs. These rights are listed in *Table 14*.

Table 13.
Shell Texaco – Conditional Water Rights – Colorado River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
38	Clear Creek Feeder Pl	Pipeline	Clear Creek	50	0	2/8/1965
39	Deer Park Gulch Res	Reservoir	Clear Creek	0	1533.6	2/8/1965
40	Deer Park Gulch Pmp & Pl	Pump	Colorado River	150	0	2/8/1965
41	Conn Creek Feeder Pl	Pipeline	Conn Creek	50	0	2/8/1965
66	Pacific Spring No 2	Spring	Clear Creek	0.06	0	5/1/1982
67	Pacific Spring No 3	Spring	Clear Creek	0.03	0	5/1/1982
68	Pacific Spring No 9	Spring	Conn Creek	0.04	0	5/1/1982
69	Pacific Spring No 10	Spring	Conn Creek	0.04	0	5/1/1982
70	Pacific Spring No 1	Spring	Clear Creek	0.02	0	5/1/1982
71	Pacific Spring No 7	Spring	Clear Creek	0.06	0	5/1/1982
72	Pacific Spring No 8	Spring	Clear Creek	0.08	0	5/1/1982
73	Pacific Spring No 4	Spring	Conn Creek	0.02	0	5/1/1982
74	Pacific Spring No 5	Spring	Conn Creek	0.07	0	5/1/1982
75	Pacific Spring No 6	Spring	Conn Creek	0.05	0	5/1/1982
	Total structures: 14			**Total: 250.47 cfs**	**Total: 1,533.6 af**	

Table 14.
Shell Texaco – Absolute Water Rights – Colorado River Basin

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date
41	Long Gulch Ditch No 1	Clear Creek	2.24	239	11/20/1897
42	Long Gulch Ditch No 2	Clear Creek	2.98	213	11/11/1899
43	Short Gulch Ditch	Clear Creek	2.76	117	11/1/1899
	Total structures: 3		**Total: 7.98 cfs**	**Total: 569 af**	

7. Union Oil Company of California

The Union Oil Company of California (Unocal) is now part of Chevron. However, there are still numerous structures with water rights listed as owned by Unocal. Virtually all these rights are located in Parachute Creek. The 2 conditional structures, both proposed wells, are shown in *Table 15*. *Table 16* shows the 47 absolute structures, consisting of wells and springs, listed as owned by Unocal. Unocal also owns 13 irrigation ditches, which are shown in *Table 17*. The ditches have a total diversion right of 120 cfs.

Table 15.
Unocal – Conditional Water Rights – Colorado River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
5	Union 76 Water Well No 3	Well	Parachute Creek	0.066	0	2/14/1949
6	Union 76 Water Well No 2	Well	Parachute Creek	0.124	0	2/14/1949
	Total structures: 2			**Total: 0.19 cfs**	**Total: 0 af**	

Table 16.
Unocal – Absolute Water Rights (Wells and Springs) – Colorado River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
1	Nelson Well No 1*	Well	Parachute Creek	0.018	0	5/17/1883
2	Sherwood Well No 1*	Well	Parachute Creek	0.022	0	5/17/1883
3	Sherwood Well No 2*	Well	Parachute Creek	0.018	0	5/17/1883
4	Seep Spring No 1*	Well	Parachute Creek	0.033	0	4/19/1922
5	Seep Spring No 2*	Well	Parachute Creek	0.033	0	4/19/1922
6	Seep Spring No 3*	Well	Parachute Creek	0.033	0	4/19/1922
7	House Log Gulch Sprg No 1*	Spring	Parachute Creek	0.033	0	4/19/1922
8	House Log Gulch Sprg No 2*	Spring	Parachute Creek	0.033	0	4/19/1922
9	House Log Gulch Sprg No 3*	Spring	Parachute Creek	0.033	0	4/19/1922
10	House Log Gulch Sprg No 4*	Spring	Parachute Creek	0.033	0	4/19/1922
11	House Log Gulch Sprg No 5*	Spring	Parachute Creek	0.033	0	4/19/1922
12	Red Spring No 1*	Spring	Parachute Creek	0.033	0	4/22/1922
13	Squire's Spring*	Spring	Parachute Creek	0.033	0	7/21/1922
14	Sheep Gulch Spring*	Spring	Parachute Creek	0.033	0	7/21/1922
15	Calf Spring*	Spring	Parachute Creek	0.033	0	8/9/1922
16	Long Ridge Spring No 1*	Spring	Parachute Creek	0.033	0	9/22/1922
17	Long Ridge Spring No 2*	Spring	Parachute Creek	0.033	0	9/22/1922
18	Long Ridge Spring No 3*	Spring	Parachute Creek	0.033	0	9/22/1922
19	Long Ridge Spring No 4*	Spring	Parachute Creek	0.033	0	9/22/1922
20	Long Ridge Spring No 5*	Spring	Parachute Creek	0.033	0	9/22/1922
21	Feather Springs*	Spring	Parachute Creek	0.033	0	11/10/1922
22	Grassy Spring*	Spring	Parachute Creek	0.033	0	11/27/1922
23	Hidden Spring*	Spring	Parachute Creek	0.033	0	7/11/1924
24	Cottonwood Spring No 1*	Spring	Cottonwood Ck	0.05	0	11/8/1940

Table 16. *(cont'd)*

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
25	Union 76 Water Well No 4*	Well	Parachute Creek	1.114	0	2/14/1949
26	Union 76 Water Well No 1*	Well	Parachute Creek	0.52	0	2/14/1949
27	Union 76 Water Well No1a*	Well	Parachute Creek	0.52	0	2/14/1949
28	Union 76 Water Well No 3*	Well	Parachute Creek	1.048	0	2/14/1949
29	Union 76 Water Well No 2*	Well	Parachute Creek	0.99	0	2/14/1949
30	Union 76 Water Well No 5*	Well	Parachute Creek	1.114	0	2/14/1949
31	Union 76 Water Well No 6*	Well	Parachute Creek	0.722	0	2/14/1949
32	Parkhurst Cabin Spg No 1*	Spring	Parachute Creek	0.033	0	3/22/1951
33	Parkhurst Cabin Spg No 2*	Spring	Parachute Creek	0.033	0	3/22/1951
34	Helm Gulch Spring No 1*	Spring	Parachute Creek	0.033	0	3/27/1952
35	Helm Gulch Spring No 2*	Spring	Parachute Creek	0.033	0	3/27/1952
36	Lone Tree Spring*	Spring	Parachute Creek	0.033	0	1/20/1954
37	Pete Spring*	Spring	Parachute Creek	0.033	0	5/31/1955
38	Wagon Spring*	Spring	Parachute Creek	0.033	0	6/2/1966
39	Light Gulch Spring No 1*	Spring	Parachute Creek	0.033	0	6/2/1966
40	Light Gulch Spring No 2*	Spring	Parachute Creek	0.033	0	6/2/1966
41	Cabin Spring*	Spring	Parachute Creek	0.066	0	6/2/1966
42	Cottonwood Spring No 2*	Spring	Cottonwood Ck	0.01	0	5/1/1967
43	Corral Spring No 1*	Spring	Parachute Creek	0.03	0	10/7/1986
43	Eisaguirre Spring No 1*	Spring	Parachute Creek	0.02	0	10/10/1986
44	Schutte Spring No 1*	Spring	Parachute Creek	0.033	0	10/10/1986
45	Schutte Spring No 2*	Spring	Parachute Creek	0.033	0	10/10/1986
46	Sage Spring No 2*	Spring	Parachute Creek	0.033	0	10/23/1986
	Total structures: 47			**Total: 7.32 cfs**	**Total: 0 af**	

**Absolute decree*

Table 17.
Unocal – Absolute Water Rights (Ditches) – Colorado River Basin

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date
1	Low Cost Ditch	Parachute Creek	27.94	3,945	5/17/1883
2	Vieweg Ditch	Parachute Creek	1.9	1,287	5/17/1883
3	C C D Ditch	Parachute Creek	2.53	309	5/17/1883
4	East Fork Ditch	Parachute Creek	6.56	243	5/17/1883
5	Parachute Ditch	Parachute Creek	27.22	1,965	5/17/1883
6	Ri Ley Ditch	Parachute Creek	1	106	5/17/1883
7	Cornell Ditch	Parachute Creek	15.675	1,546	5/17/1883
8	Spring Ditch	Parachute Creek	0.12	202	5/17/1883
9	Starkey Gulch Ditch	Parachute Creek	4.32	150	5/17/1883
10	Charley Dere Ditch	Parachute Creek	0.83	350	5/17/1883
18	Atkinson Canal	Roaring Fork River	26.33	2,420	10/20/1884
47	Wheeler Ditch	Parachute Creek	3	183	8/14/1901
55	Ida Dere Ditch	Parachute Creek	3	184	4/1/1914
	Total structures: 13		**Total: 120.43 cfs**	**Total: 12,890 af**	

Photo courtesy of The Story Group

B. WHITE RIVER BASIN

1. Colorado River Water Conservation District

The Colorado River Water Conservation District (CRWCD) holds 9 conditional rights to develop water in the White River Basin. Like the rights held in the Colorado River Basin, these rights could potentially be developed to provide water for uses that include oil shale development as well as to meet other water demands in the region. These rights include 5 proposed reservoir sites with a total storage capacity of nearly 530,000 af and 5 pipelines with the potential right to divert over 1,800 cfs. The conditional rights held by the CRWCD are presented in the following table.

Table 18.
CRWCD – Conditional Water Rights – White River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
15	Flattops Tunnel	Pipeline	South Fork	254	0	10/31/1961
16	Piceance Basin Pl Coll S	Pipeline	South Fork	60	0	10/31/1961
17	Rangely Reservoir	Reservoir	White River	0	131,034.5	10/31/1961
18	Patterson Cr Collect Sys	Pipeline	Patterson Ck	75	0	10/31/1961
19	Rio Blanco Reservoir	Reservoir	South Fork	0	131,034	10/31/1961
20	Strawberry Creek Res	Reservoir	Strawberry Ck	0	75,957	10/31/1961
21	Wray Gulch Dam & Res	Reservoir	Wray Gulch	0	29,374	10/31/1961
22	Douglas Canal	Ditch	White River	620	0	10/31/1961
23	Wolf Ck Res (Crwcd)	Reservoir	White River	0	162,400	7/3/1962
63	Strawberry Creek Pl	Pipeline	White River	400	0	6/16/1972
65	Wray Gulch Pipeline	Pipeline	White River	450	0	7/19/1972
	Total structures: 11			**Total: 1,859 cfs**	**Total: 529,799.5 af**	

2. Exxon Mobil Corporation

The Exxon Mobil Corporation (ExxonMobil) owns conditional water rights associated with 33 structures within the White River Basin. Its 17 proposed reservoirs have a conditionally decreed storage capacity of approximately 161,000 af. Its direct flow rights have a cumulative diversion rate of 1,100 cfs. The package of conditional rights owned by ExxonMobil is presented in the table below.

Table 19.
ExxonMobil – Conditional Water Rights – White River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
7	Stillwater Reservoir	Reservoir	South Fork	0	12,548	5/29/1955
13	Boies Reservoir	Reservoir	Black Sulphur Ck	0	31,020.8	7/10/1961
14	Piceance Canal	Pipeline	Piceance Ck	50	0	7/10/1961
24	Wolf Ck Res	Reservoir	Wolf Ck	0	35,000	7/3/1962
25	Ryan Gulch Reservoir	Reservoir	Piceance Ck	0	22,635.2	12/15/1963
26	White River Pumping Pl	Pipeline	White River	100	0	12/15/1963
27	Jumps Cabin Res	Reservoir	West Hunter Ck	0	7,868.8	5/27/1964
28	Howells Cabin Res	Reservoir	Willow Ck/Pic. Ck	0	8,096	5/27/1964
33	White River Pl No 2	Pipeline	White River	120	0	10/12/1964

Table 19. *(cont'd)*

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
34	South Fork Piceance Pl	Pipeline	South Fork	70	0	5/29/1965
45	Hunter Cr Wells	Well	Hunter Ck	30	0	3/8/1967
46	Superior Oil Term Res	Reservoir	White River	0	800	5/14/1968
47	Superior Oil Pl	Pipeline	White River	24	0	5/14/1968
49	Blacks Gulch Pipeline	Pipeline	White River	100	0	9/1/1968
50	Blacks Gulch Res	Reservoir	Blacks Gulch	0	13,900	9/1/1968
51	Crooked Wash P.L.	Pipeline	White River	100	0	9/1/1968
52	Crooked Wash Res	Reservoir	Crooked Wash	0	11,800	9/1/1968
53	Kellog Gulch P.L.	Pipeline	White River	100	0	9/1/1968
54	Kellogg Gulch Res	Reservoir	Kellogg Gulch	0	3,700	9/1/1968
55	Wray Gulch Res	Reservoir	Wray Gulch	0	13,500	9/1/1968
56	Superior Pumpback Pl 1	Pump	White River	12	0	10/5/1968
57	Superior Pumpback Pl 2	Pump	White River	12	0	10/5/1968
58	Superior Pumpback Pl 3-1	Pump	White River	12	0	10/5/1968
59	Wolf Ck Pl	Pipeline	White River	70	0	9/30/1971
64	Wray Gulch Pipeline	Pipeline	White River	100	0	7/19/1972
75	Mobil Pump Station Pl	Pump	White River	200	0	5/4/1984
87	Exxon Love Ranch Res	Reservoir	Piceance Ck	0	30	11/17/1998
88	Exxon Boies Bl.Sulp Res	Reservoir	Black Sulphur Ck	0	50	11/17/1998
89	Exxon B&M Res	Reservoir	Piceance Ck	0	50	11/17/1998
90	Exxon Hunter Creek Res	Reservoir	Hunter Ck	0	30	11/17/1998
91	Exxon Willow Creek Res	Reservoir	Willow Ck/ Pic. Ck	0	30	11/17/1998
92	Exxon Yellow Creek Res	Reservoir	Yellow Ck	0	30	11/17/1998
93	Exxon Dry Creek Res	Reservoir	Trib.-Piceance Ck	0	20	11/17/1998
	Total structures: 33			**Total: 1,100 cfs**	**Total: 161,108.8 af**	

In addition, ExxonMobil has acquired either full or partial ownership in 31 irrigation ditches in the White River Basin. These ditches provide for decreed rights to divert approximately 88 cfs. Information about these ditches is displayed in the following table.

Table 20.
ExxonMobil – Absolute Water Rights – White River Basin

Map Location	StructureName	Water Source	Quantity (cfs)	Avg. Vol. Div. (af)	Appropriation Date
1	P & L Ditch	Piceance Ck	0.5	144	6/1/1883
3	Mckee Ditch	Black Sulphur Ck	3	303	5/10/1884
5	Willow Creek Ditch No 2	East Willow Ck	1.2	294	9/29/1884
6	Willow Creek Ditch No 3	East Willow Ck	1.2	230	9/29/1884
7	M H M German Cons D	Piceance Ck	17.54	880	10/22/1884
8	Gilmor Ditch	Hunter Ck	1.5	320	5/10/1886
9	Boies Ditch	Black Sulphur Ck	2	363	10/16/1886
11	D D Taylor Ditch*	Black Sulphur Ck	2	418	4/5/1887
13	Black Eagle D No 1*	Black Sulphur Ck	5.95	321	4/16/1887
14	Black Eagle D No 2*	Black Sulphur Ck	5.95	276	4/16/1887
15	Black Eagle Alt Pt 1	Black Sulphur Ck	0	92	4/16/1887
16	Black Eagle Alt Pt 2	Black Sulphur Ck	0	85	4/16/1887
18	M H And M Ditch	Piceance Ck	17.54	880	4/18/1887
20	O I See Ditch*	Fawn Ck	1.2	225	4/27/1887
21	No Name Ditch*	Fawn Ck	0.4	173	5/1/1887
22	Decker Irrigation Ditch	East Douglas Ck	2.8	94	5/6/1887
23	Belot Moffat Ditch	Piceance Ck	11.6	1,304	5/10/1887
28	Taylor Ditch	Willow Ck/Pic Ck	2	279	5/09/1888
29	Hunter Ditch	Hunter Ck	1	267	5/15/1888
30	Ebler Ditch	Willow Ck/Pic Ck	1	170	5/20/1888
33	Schweizer Ditch*	Black Sulphur Ck	2.6	437	9/30/1888
34	Schweizer Ditch Alt Pt	Black Sulphur Ck	0	110	9/30/1888
35	Hutchinson Spring Ditch	Fawn Ck	0.5	159	7/18/1889
36	Mcgee Ditch*	Fawn Ck	1.16	270	5/1/1890
37	J W Bainbrick D No 1&2*	Black Sulphur Ck	0.86	181	7/1/1893
43	N & L Ditch	Fawn Ck	1	271	5/1/1901
46	Bainbrick Mikkelsen 1&2*	Black Sulphur Ck	0.375	264	5/1/1904
48	Milo Ditch	Black Sulphur Ck	0.3	36	5/1/1911
51	Desert Ditch*	Black Sulphur Ck	1.43	182	6/12/1914
53	Edmund Pauls Ditch	Sulphur Ck	0.1	11	7/21/1915
55	Duckett Ditch*	Black Sulphur Ck	1.2	242	6/10/1918
	Total structures: 31		**Total: 87.91 cfs**	**Total: 9,281 af**	

**Joint ownership*

3. Shell Frontier

Shell Frontier owns conditional rights associated with 16 structures in the White River Basin. Two large proposed reservoirs would store approximately 145,000 af. Shell holds conditional direct diversion rights that would allow diversion of over 625 cfs. These rights are listed in *Table 21*. Shell also owns 2 irrigation ditches in the basin; these rights are listed in *Table 22*.

Table 21.
Shell Frontier – Conditional Water Rights – White River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
6	Stillwater Power Plant	Pipeline	South Fork	300	0	5/29/1955
29	Fourteen Mile Res 1	Reservoir	Fourteen M. Ck	0	60,000	6/24/1964
30	White R Fourteen M. Ck Pl	Pipeline	White River	200	0	9/12/1964
31	South Fork Pipeline	Pipeline	South Fork	100	0	9/14/1964
32	South Fork Reservoir	Reservoir	South Fork	0	85,342	9/14/1964
77	Swepi Spring 1	Spring	Duck Ck	0.367	0	6/13/1988
78	Swepi Spring 10	Spring	Spruce Gulch	0.489	0	6/13/1988
79	Swepi Spring 13	Spring	Stake Springs Ck	0.222	0	6/13/1988
80	Swepi Spring 2	Spring	Water Gulch	0.233	0	6/13/1988
81	Swepi Spring 3	Spring	Water Gulch	0.178	0	6/13/1988
82	Swepi Spring 5	Spring	Water Gulch	0.044	0	6/13/1988
83	Swepi Spring 6	Spring	Corral Gulch	0.178	0	6/13/1988
84	Swepi Spring 7	Spring	Corral Gulch	0.078	0	6/13/1988
85	Swepi Spring 8	Spring	Spruce Gulch	0.011	0	6/13/1988
86	Swepi Spring 9	Spring	Spruce Gulch	0.011	0	6/13/1988
114	Shell Pumping Plant	Pump	White River	25	0	1/1/1999
	Total structures: 16			**Total: 626.81 cfs**	**Total: 145,342 af**	

Table 22.
Shell Frontier – Absolute Rights – White River Basin

Map Location	Structure name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div.	Appropriation Date
2	Calhoun Ditch	White River	8.17	285	8/25/1883
32	Rye Grass Ditch*	Piceance Ck	0	0	6/5/1888
	Total structures: 2		**Total: 8.17 cfs**	**Total: 285 af**	

**Joint ownership*

4. The Oil Shale Corporation

The Oil Shale Corporation (Tosco) owns a substantial portfolio of water rights in the White River Basin. As listed in *Table 23*, these rights include conditional claims to 17 structures. There are 3 proposed reservoirs with conditional rights to store approximately 95,000 af, as well as conditional rights to divert a total of 244 cfs. In addition, Tosco has established either partial or total ownership of rights in 14 existing ditches that cumulatively hold absolute rights to divert 73 cfs; *Table 24* lists these rights.

Table 23.
Tosco – Conditional Rights – White River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
8	Miller Creek Pump Pl	Pump	White River	100	0	5/26/1957
9	Ertl Pipeline Hg 1	Pipeline	Buck Ck	15	0	5/26/1957
10	Ertl Pipeline Hg 2	Pipeline	Wagon Wheel Ck	1	0	5/26/1957
11	Ertl Pipeline Hg 3	Pipeline	Patterson Ck	7	0	5/26/1957
12	Ertl Pipeline Hg 4	Pipeline	Patterson Ck	7	0	5/26/1957
37	Hunter Ck Res	Reservoir	Hunter Ck	0	24,362	2/28/1967
38	Ohio Ertl Pl	Pipeline	White River	55	0	2/28/1967
39	Story G Parachute Pl	Pipeline	White River	55	0	2/28/1967
40	Story Gulch Res	Reservoir	Story Gulch	0	25,000	2/28/1967
48	Miller Ck Res	Reservoir	Miller Ck	0	45,900	7/18/1968
60	Tg 71-5 Well	Well	Stewart Gulch	1.111	0	11/29/1971
61	Tg 71-4 Well	Well	Stewart Gulch	0.888	0	12/3/1971
62	Tg 71-3 Well	Well	Stewart Gulch	0.444	0	12/13/1971
66	Liberty Bell Well No 12	Well	Story Gulch	0.888	0	12/5/1972
67	Camp Bird Well 12	Well	Trib-Piceance Ck	0.444	0	9/6/1973
68	Camp Bird Well 12a	Well	Trib-Piceance Ck	0.444	0	9/6/1973
72	Ohio Well No 41	Well	West Willow Ck	0.044	0	8/22/1977
	Total structures: 17			**Total: 244.26 cfs**	**Total: 95,262 af**	

Table 24.
Tosco – Absolute Water Rights – White River Basin

Map Location	Structure Name	Water Source	Quantity. Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date
10	Emily Ditch*	Piceance Ck	5.85	794	11/05/1886
12	Last Chance Ditch*	Hunter Ck	1.4	294	4/13/1887
17	Robert Mckee Ditch*	Piceance Ck	6.33	1,235	4/18/1887
19	Oldland Ditch 1*	Piceance Ck	13.8	1,000	4/27/1887
25	Jessup Ditch 1*	Stewart Gulch	1.2	204	6/16/1887
26	Blue Grass Ditch*	Stewart Gulch	0.6	262	7/11/1887
27	Jessup Ditch 2*	Stewart Gulch	0.6	134	4/14/1888
32	Rye Grass Ditch*	Piceance Ck	8.2	901	6/5/1888
38	Gardenheir Ditch*	Piceance Ck	2.04	350	3/5/1895
40	E Stewart Gulch D No 1*	East Stewart Gulch	0.6	46	11/1/1899
41	E Stewart Gulch D No 2*	East Stewart Gulch	0.6	35	10/15/1900
44	Oldland Ditch 3*	Piceance Ck	1.4	199	5/15/1902
50	Forney Corcoran Ditch	White River	11.47	0	5/10/1913
54	Oldland Ditch 2*	Piceance Ck	18.94	660	5/1/1917
	Total structures: 14		**Total: 73.03 cfs**	**Total: 6,114 af**	

**Joint ownership*

5. Yellow Jacket Water Conservancy District

The Yellow Jacket Water Conservancy District (WCD) owns 9 conditional water rights in the White River Basin that could potentially provide water in support of oil shale development. Included are 4 reservoir storage rights with total capacity of almost 250,000 af, 2 pipelines with diversion rights of 1,000 cfs, and 3 ditches with diversion rights of 700 cfs. These rights are listed below.

Table 25.
Yellow Jacket WCD – Conditional Water Rights – White River Basin

Map Location	Structure Name	Structure Type	Water Source	Quantity (cfs)	Quantity (af)	Appropriation Date
1	Lost Park Reservoir	Reservoir	Lost Ck	0	33,541	11/9/1953
2	Lost Park Feeder Canal 1	Ditch	Trib-North Fk	100	0	11/9/1953
3	Lost Park Feeder Canal 2	Ditch	Trib-North Fk	100	0	11/9/1953
4	Yellow Jacket Canal	Ditch	North Fork	500	0	11/9/1953
5	Ripple Creek Reservoir	Reservoir	North Fork	0	27,992	11/19/1953
69	Colo White R Hydro Plant	Pipeline	White River	500	0	9/6/1973
70	North Fork Fdr Conduit	Pipeline	North Fork	500	0	10/7/1976
71	Sawmill Mountain Res	Reservoir	Big Beaver Ck	0	80,000	10/7/1976
73	Colo White R Res	Reservoir	White River	0	105,000	11/17/1981
	Total structures: 9			**Total: 1,700 cfs**	**Total: 246,533 af**	

SECTION V

KEY IMPLICATIONS OF AND LIMITATIONS ON WATER DEVELOPMENT FOR OIL SHALE

The possible development and use of substantial amounts of water for oil shale production raises important considerations for Colorado because of the potential to adversely affect some existing water uses and many expected future water uses. Companies with an interest in oil shale development own enormous portfolios of water rights. While there is great uncertainty with respect to the manner in which these rights will be developed and used, the consequences of such development are unquestionable.

Among the many likely changes in the use of Colorado water resulting from oil shale development are changes in existing irrigated agriculture, limitations on existing and planned water development for the Front Range and the West Slope, and likely limitations on other water development for new uses on the West Slope. While these general impacts are relatively easy to project, it is harder to identify the exact development scenarios and the resulting impacts on a given water right or a specific project. This uncertainty largely stems from not knowing which water rights will be used or which storage and delivery systems will be utilized (including which ones will be built).

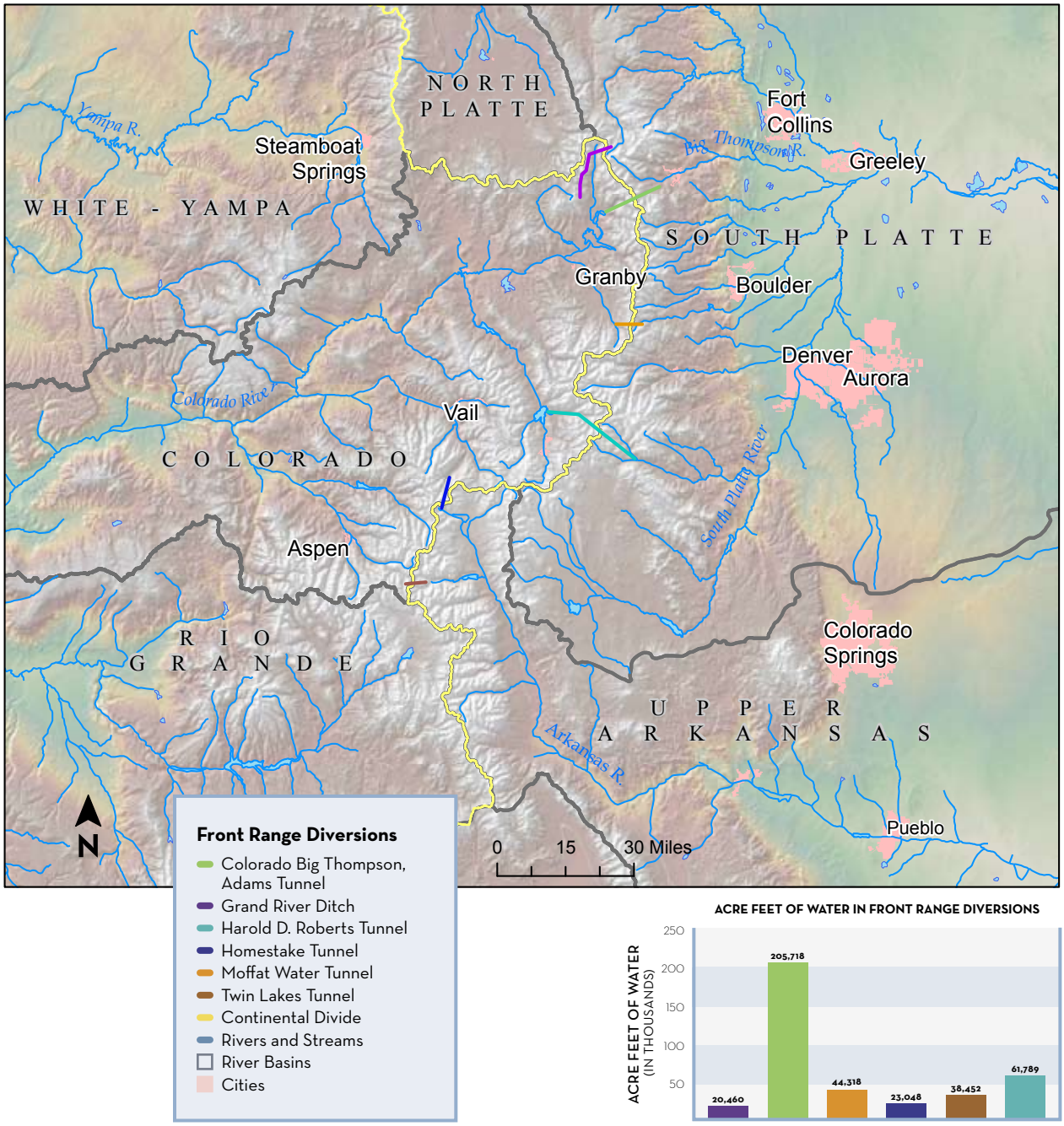
A. OIL SHALE AND EXISTING WATER USES

Perhaps the most immediately evident effect on existing water uses from potential oil shale development would be the shift of water from irrigated agriculture in the area to industrial uses. Energy companies own large portions of the water rights historically used to irrigate lands in the region. Many of these rights date back to the late 1800s and early 1900s. As pre-Colorado River Compact rights, these diversions would not be affected by a call placed against the Upper Basin. Most of the associated water still remains in irrigation use as energy companies lease back the water to ranchers. Should oil shale development move beyond the research phase, many, if not all, of these rights would be changed in use, and the lands historically irrigated would be taken out of agriculture. The result would be a dramatic transformation of land and water uses in these areas.

A second, less obvious outcome of oil shale development would be the displacement of some existing uses by new oil shale-related uses with senior priorities. As mentioned earlier in this report, conditional rights for oil shale development date back to the 1950s. Should these rights be placed into use, they would be senior to all existing uses from the same source of water with subsequent priority dates, thereby affecting rights used both in western Colorado and in Colorado's Front Range.

Front Range water providers divert several hundred thousand acre-feet of water annually out of the Colorado River Basin for both urban and agricultural use. Most of the existing transbasin diversions occur under water rights senior to conditional rights established for oil shale development. Plans to enlarge these diversions and to develop new projects, however, are more likely to

Figure 9. *Major Diversions to the Front Range of Colorado*



have priority dates junior to some of the oil shale rights. Should these oil shale rights be developed, they will have to be satisfied before the more junior transbasin rights. (See *Figure 9*)

West Slope communities have grown considerably since the 1950s. The headwaters towns in the Colorado River Basin now support substantial year-round populations as well as large numbers of second homes. The wintertime, ski-based tourist industry has extended into a year-round tourist and business economy. Much of the water supply that has been developed to serve this population depends on water rights with relatively recent appropriation dates.

Appendix E shows the relative priorities of selected oil shale and non-oil shale conditional water rights in the Colorado River Basin. As illustrated, there are significant oil shale rights senior to these other rights. For example, as-yet-undeveloped elements of the Homestake Project that would provide additional water to Colorado Springs and Aurora hold a priority junior to several

large downstream rights for oil shale on the Colorado River. Denver Water's Williams Fork project, for example, holds a conditional claim for the Darling Creek Enlargement decreed to divert 90 cfs that is junior to conditional rights for oil shale. Those rights collectively have the decreed right to divert over 950 cfs from the Colorado River downstream of Williams Fork. Its refill right for Williams Fork Reservoir would also be junior to these oil shale conditionals, as would its proposed Straight Creek Collection System for Roberts Tunnel. Even more junior are its conditional rights to the Piney River Unit.

Likewise, the Colorado River Water Conservation District holds the conditional water rights associated with the proposed Wolcott Reservoir, to be located in the Eagle River Basin. This project is intended to store water from the Eagle River watershed as well as from the Colorado River. Wolford Mountain Reservoir is also an important junior right, providing critical water for both the Western Slope and Denver Water.

Finally, the Northern Colorado Water Conservancy District's Windy Gap Reservoir has a 1967 priority date.[40] While presently only used to divert modest amounts of water from the Colorado River Basin, this project has already encountered difficulties because of its relatively junior priority. While efforts are presently underway to improve the yield from this project, substantial new downstream development of senior rights for oil shale development would make this task much harder to achieve.

B. OIL SHALE AND THE COLORADO RIVER COMPACT

Still another important uncertainty facing future water development in western Colorado is the legal availability of water for development under the Colorado River Compact and associated laws and requirements. Under the terms of the 1922 Colorado River Compact, the four Upper Basin states (Colorado, New Mexico, Utah, and Wyoming) were thought to be entitled to consume 7.5 million af of basin water annually. Based on this assumption, in 1948 the Upper Basin states apportioned use of their share; under that agreement, Colorado was given 3.8 million af (51.75% of the Upper Basin share). However, as explained below, Colorado's rights are in actuality less than this amount.

In 1988 and again in 2007, the Bureau of Reclamation produced hydrologic determinations that make clear the Upper Basin states cannot expect to consume the allocated 7.5 million af.[41] The actual amount remains uncertain, but the 2007 analysis indicated a maximum consumption of about 5.75 million af per year. Using this assumption, Colorado would be entitled to consume just under 3 million af annually.

In a very thoughtful analysis of the state of Colorado's Colorado River entitlement, Eric Kuhn of the Colorado River Water Conservation District reviewed the hydrologic determinations and, using the Bureau of Reclamation's 2007 model, developed his own estimate. The primary difference between his assessment and Bureau of Reclamation's was his extension of the hydrology back to 1800 based on paleoclimatic data.[42] (The extended record had an average annual flow of 14.23 million af.) With this longer and somewhat drier record, he estimated that the Upper Basin entitlement would be 5.25 million af and that Colorado's share would be 2.69 million af.

Kuhn also evaluated how much water Colorado now uses under its entitlement and, based on data of the Colorado River Water Conservation Board, concluded that average use for the period 1988 to 2004 was 2.11 million af. Using his assumptions and calculations, it would appear that Colorado has roughly 580,000 af remaining in its development account.

However, Kuhn takes his analysis one step further by suggesting that a longer paleo-record reveals extended dry periods and droughts. Climate modeling projects warmer and drier conditions for the Colorado River Basin and elsewhere in the Interior West that are likely to affect both supply and demand.[43] With this in mind, Kuhn produced a table, reproduced below, of development risk levels for the state's remaining Colorado River water. The risk is of compact curtailment based on an assumption about the likely future of available supplies.

Table 26.
Risk Levels of Remaining Supply of Colorado River Water

Risk Level	Available Development (af)
Little or No Risk	Up to 150,000
Moderate Risk	150,000 to 300,000
High Risk	300,000 to 600,000
Extreme Risk	More than 600,000

Based on Kuhn's analysis, there is a high risk of Colorado having its use of Colorado River water curtailed by the Colorado River Compact if full-scale development (1.5 million bpd) of oil shale were to occur. That conclusion, importantly, does not account for other planned developments within Colorado, which would further stress water availability under the Colorado River Compact.

Because of the increasing possibility of water shortages in the basin that will force curtailment of some existing uses, the state of Colorado has funded a study to examine more closely the assumptions underlying the state's remaining developable water. Getting a more reliable estimate of existing depletions is important, but more critical is an evaluation of expected physical water availability in the Upper and Lower Basins to meet demands. Evidence of warming temperatures in large parts of the basin suggests the likelihood that there will be less water available for use and that needs for water will increase, independent of the normal demand increases associated with population growth.

Since all the major rivers on the West Slope are tributary to the Colorado River Basin, depletions in any one of these rivers will limit the ability to develop and use water from the others. Each of these regions of the state anticipates growth with its associated needs for water. And, as mentioned, there are active plans for development of water for use on Colorado's Front Range.[44] Should oil shale develop in the manner the BLM projects, competition for water on Colorado's West Slope will be intense.

A key issue is the effect of over-development of the compact entitlement on all post-compact water rights, including rights senior to oil shale. Transmountain diversions would be among the first to be restricted in the event of a compact call. The risk that over-development by juniors would result in curtailment of senior rights under the compact's 10-year delivery accounting procedure is one of the important issues identified by Eric Kuhn. The resulting demand for pre-1922 irrigation rights to use for compact replacement would have even more serious implications for the agricultural economy on the West Slope.

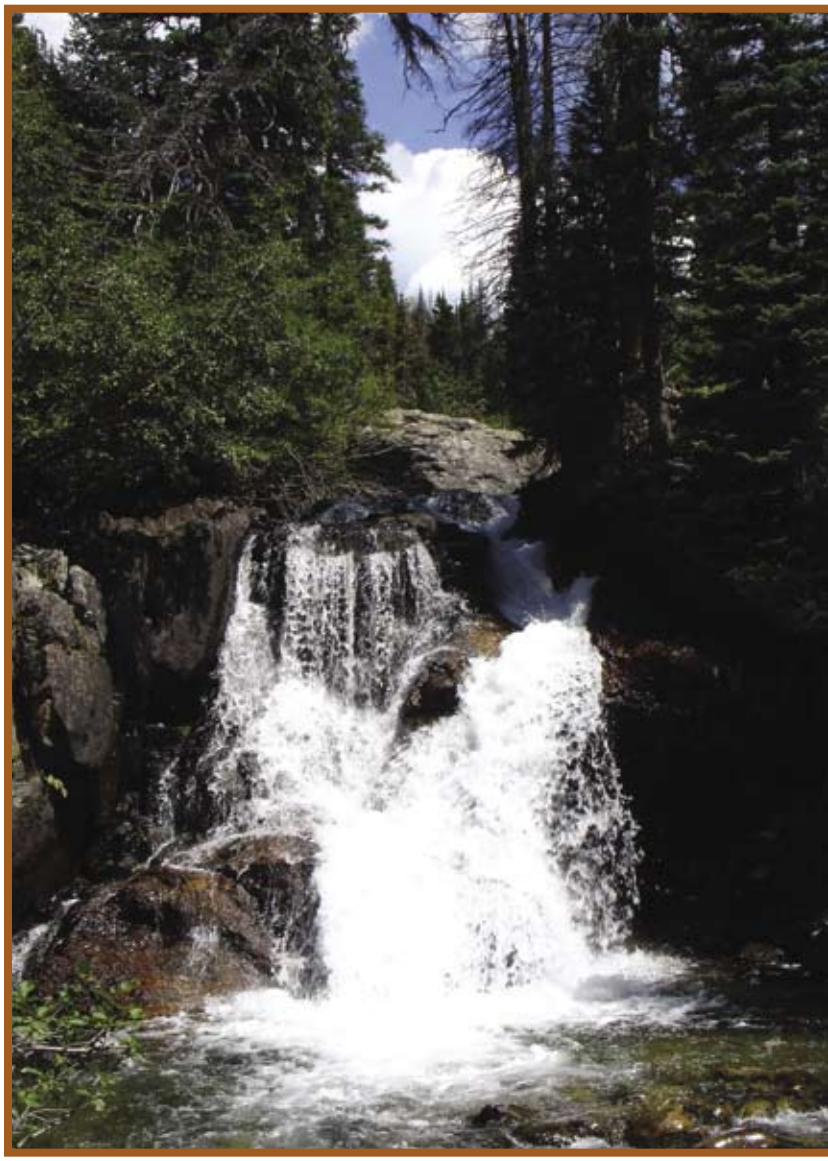
C. OIL SHALE AND THE UPPER COLORADO RIVER RECOVERY PROGRAM

Beginning in the 1970s, the U.S. Fish and Wildlife Service (USFWS) began reviewing proposed federal actions related to additional water development in the upper Colorado River Basin under the Endangered Species Act. At issue was the continued survival of four species of fish found only in this basin. USFWS had determined that additional depletions of the basin's water would jeopardize their continued existence. Concern for survival of these species continues today, and any new water development — whether for oil shale or otherwise—must satisfy substantial program requirements intended to protect and recover these species. This section describes these requirements and their significance for further development of water in Colorado's portion of the Upper Basin.

If the Colorado River's endangered fish (Colorado River pikeminnow, humpback chub, bonytail, and razorback sucker) are ever to be restored, it will be in the upper reaches of the Colorado River Basin, where there is still some remaining habitat. Oil shale development in Colorado, were it to occur on even a modest scale, would find itself in competition for some of the very

same water that is currently dedicated to recovery of the fish. Two of the most important basins for the native fish in Colorado — the mainstem of the Colorado River and the White River — are the very ones in which oil shale development is most likely to occur and in which, as described above, energy companies hold extensive water rights.

Under the late 1980s Upper Colorado River Endangered Fish Recovery Implementation Program (RIP), an agreement among the states of Colorado, Wyoming, and Utah, federal agencies, water users, and environmentalists, the parties assumed that the native fish could be recovered while allowing states to develop water to which they were entitled under the Colorado River Compact and the Upper Colorado River Compact. The RIP is designed to make compact entitlement development possible, but within specific parameters and not at all places in the basin.



1. Colorado River

The mainstem Colorado River from Rifle, Colorado, to Lake Powell, Utah, supports populations of humpback chub and Colorado pikeminnow, and is recognized as important to the recovery of all four endangered fishes. Relatively large and healthy humpback chub populations occur at Black Rocks and Westwater Canyon near the Utah-Colorado state line. A smaller humpback chub population occurs in Cataract Canyon, and some of the last wild bonytail were collected in this river reach. All life stages of Colorado pikeminnow occur in the section of river from Palisade, Colorado, downstream to Lake Powell. Razorback sucker populations, while present in the mainstem, have declined precipitously in the past 20 years.

In 1992, Colorado filed an application in state water court for a 581-cfs instream-flow right in the 15-Mile Reach (Colorado River upstream of the Gunnison River confluence and downstream of Debeque and Parachute, the locations of almost all of the oil shale sites). A final decree was issued in 1997. A programmatic biological opinion (PBO) for this reach was completed in December 1999, which requires additional deliveries of water and restricts future depletions. The future depletions-restriction limits are up to two 60,000 acre-feet increments, the second of which depends on the status of the native fish (i.e., the adult pikeminnow population, estimated to be approximately 870, must reach 1,100).[45] Even the first depletion increment of 60,000 af depends on the condition of the native fish. If the population estimate of pikeminnow declines, no additional depletions against this increment are allowed.[46] Two projects now under environmental review — the Windy Gap Firming Project of the Northern Colorado Water Conservancy District and the Moffat System expansion of Denver Water — would take 50,000 af of the first increment, leaving at most only 10,000 af.

The instream-flow requirements of the 15-Mile Reach PBO illustrate the complexities of the recovery program and the way in which depletion limits are intertwined with the water needs of the endangered fish. In addition to the depletion limits, there are also provisions for increased

flows for the 15-Mile Reach in the PBO. The Bureau of Reclamation has made available 5,000 af of water annually, plus an additional 5,000 af in four of every five years, from Ruedi Reservoir (on the Fryingpan River) to augment flows during July, August, and September. In addition, water is available from the lease of 10,825 af per year of water from Ruedi Reservoir and permanent commitment of 10,825 af per year from Front Range and West Slope water users. By 2009, the Colorado River Water Conservation District and Denver Water must have a plan in place to permanently provide the 10,825 af that is now delivered from existing reservoirs. Additional water is being provided through a memorandum of agreement with CRWCD for delivery of up to 6,000 af of water from Wolford Mountain Reservoir.

Other sources of water for the 15-Mile Reach include implementation of the Grand Valley Water Management Project that creates a pool of water for the fish in Green Mountain Reservoir. Water users are also exploring ways to increase participation in the expanded coordinated reservoir operations as recommended in the PBO. Superimposing oil shale development at almost any scale on top of this complex agreement is a challenge. The development of senior conditional rights by energy companies may affect the RIP's success through additional depletions. Additionally, depending on USFWS' success in recovering these fish populations, junior rights may be seriously constrained by the PBO.

In the Colorado River, all oil shale development would take place in areas north of Debeque and Parachute, primarily within the Roan Creek and Parachute Creek watersheds. In that case, all the development would be upstream of the 15-Mile Reach, a stretch of the river managed, in part, under the PBO described above. Because the first increment of 60,000 af is, for all practical purposes, spoken for by Denver's Moffat expansion and Northern's Windy Gap Firming Project, only the second increment might be available.[47]

2. White River

Adult Colorado pikeminnow occupy the White River downstream of Taylor Draw Dam near Rangely, Colorado, in relatively high numbers. Adult Colorado pikeminnow in the White River spawn in the Green and Yampa Rivers. Juvenile and sub-adult Colorado pikeminnow also utilize the White River on a year-round basis. Incidental captures of razorback sucker have been recorded in the lower White River.

Interim flow recommendations for the White River were completed in 2004 and are now under USFWS review for possible refinement. This review involves the addition of peak flows to the base flow targets in the 2004 recommendations. Instream-flow filings are on hold pending re-evaluation of how flows will be legally protected in Colorado, but with their protection, whatever form it may take, future depletions will be constrained. When the flow recommendations are available and their review complete, the USFWS RIP office plans to initiate a PBO process that will, among other things, establish depletion limits on the White River in both Colorado and Utah. If the PBO is structured like its neighbor on the Colorado River, oil shale development may likewise face major constraints.

If, in the White River Basin, USFWS were to employ a PBO structured around development increments coupled with habitat restoration activities (i.e., like the 15-Mile Reach PBO), then it is very likely that, in the near future, the White River will also face depletion limits that will be tied to the status of endangered native fish in the basin and that will put constraints on oil shale development capacity.

SECTION VI

CONCLUSION

The prospect of tapping Colorado's enormous deposits of oil shale has tantalized the energy industry for many years. Oil companies have established a large number of conditional water rights in both the Colorado River and White River Basins, proposing the use of pipelines, pumps, springs, wells, and reservoirs to be able to obtain the necessary water. In addition, they and others have acquired a large number of agricultural irrigation ditches in the area for the purpose of shifting the use of the associated water to industrial and other purposes as needed. The result is the accumulation of the rights to use a large share of the water available in that portion of western Colorado.

Companies have pursued obtaining rights largely independently, based on their own needs and interests.[48] Some conditional claims are directly overlapping, such as plans to build dams at essentially the same location. The feasibility of developing some claims is questionable because of their location in sensitive areas, cost, physical availability of sufficient water, or other reasons. In short, even if oil shale production goes forward, many of these conditional rights will never be developed.

Beyond the many issues associated with actual development of existing conditional rights for oil shale use, there are the matters of the ability to develop water under the Upper Colorado Endangered Fishes Recovery Program and the Colorado River Compact. There are unresolved questions about the amount of water that will be available for any new consumptive use. The prospect of substantial water demands associated with oil shale development simply further complicates an already complex future.

Almost certainly, irrigated agriculture in the Piceance Basin would diminish sharply. Flow regimes in the various rivers and creeks would be altered, sometimes dramatically, as dams are constructed to capture peak flows, and flows are pumped into storage. Effects on local fisheries will be a concern as will effects on water quality.

Perhaps even more significant are the potential effects on some existing and all planned water uses, not only in the mainstem Colorado River and White River Basins, but also in the Yampa and San Juan River Basins, and even on the Front Range. Colorado is approaching a zero-sum game in which new depletions for oil shale would displace some existing uses and could well preclude or make more difficult other future uses, dependent on the manner and speed of development. Many of the conditional rights have priorities dating back to the 1950s and 1960s. Their seniority suggests that, if they are developed, they will use up much of Colorado's remaining share of basin water. Such an outcome would obviously have important consequences for the state.

APPENDIX A

CHRONOLOGICAL DEVELOPMENT OF CONDITIONAL WATER RIGHTS FOR OIL SHALE DEVELOPMENT

A. DEVELOPMENT IN THE COLORADO RIVER BASIN

The earliest oil shale conditional water right is the Pumping Pipeline of the Union Oil Company of California. It has a 1949 appropriation date. This pipeline is conditionally decreed for diversion of 118.5 cubic feet per second (cfs) from the Colorado River. It is now owned by EnCana Oil and Gas. The following year, the Pacific Oil Company (now Chevron) established the Dragert Pumping Plant and Pipeline, intended to divert 94 cfs from the Colorado River.

In 1951, the Cities Service Pipeline and Pumping Plant conditionally appropriated 100 cfs further downstream on the Colorado, and Getty Oil established the Pumping Pipeline of the Pacific Western Oil Corporation with a diversion of 56 cfs. OXY now owns the Cities Service Pipeline, while Chevron owns the Pumping Pipeline of the Pacific Western Oil Corporation. Also that year, the Eaton Shale Company established the Eaton Pumping Plant and Pipeline, with a diversion decreed for 100 cfs. This right is now owned by Chevron. This early flurry of activity anticipated direct diversions from the Colorado, using pumps to lift the water through pipelines to the ultimate point of use.

In 1953, the Pacific Oil Company established the Pacific Oil Company Pipeline and Pumping Plant No. 1 and No. 2. There are 2 separate appropriations for No. 1: 57.25 and 114.5 cfs; the diversion rate for No. 2 is 28.63 cfs. Chevron now owns the 57.25 portion of No. 1; Shell Frontier owns No. 2.

In 1954 and 1955, Dow Chemical Company established 3 conditional rights: the Dow Pumping Plant and Pipeline with the right to divert 178 cfs from the Colorado River; the Dow East Middle Fork Pipeline with the right to divert 20 cfs from the East Middle Fork of Parachute Creek; and the Dow Middle Fork Pipeline with the right to divert 10 cfs from the Middle Fork of Parachute Creek. Dow also established 3 decreed reservoirs in the Parachute Creek watershed: Davis Gulch with a decreed capacity of 204 acre-feet (af); East Middle Fork with a capacity of 130 af; and Middle Fork with a capacity of 171 af. ExxonMobil now owns these rights.

In 1956, Sinclair Oil established the Sinclair Oil & Gas Co. Pumping Plant and Pipeline, with the conditional right to divert 33 cfs from the Colorado. This right is now owned by the Puckett Land Company. The Oil Shale Corporation established the Oil Shale Corporation Pipeline and Pumping Plant, with a diversion from the Colorado of 100 cfs. Also that year, Rea Eaton established the Eaton Pipeline No. 1 and No. 2, each with a diversion of 10 cfs from the Colorado River. No. 1 is now owned by the Puckett Land Company; No. 2 is owned by the Battlement Mesa Metro District.

The Shale Pumps and Pipeline, established in 1959, provides for diversion of 11.11 cfs from the Colorado River. This right is now owned by Frac Tech Services.

Attention then shifted further downstream and in the adjacent Roan Creek watershed. The Colorado River Water Conservation District established several water rights with appropriation

dates relating back to 1936 involving the water of Roan Creek. The Kobe Canal would divert 50 cfs from the Colorado River. The Mt. Logan Dam and Reservoir provides for storage of 10,000 af of Roan Creek water in an off-channel location. The Roan Creek Feeder Canal is decreed for 75 cfs from Roan Creek. The Mt. Logan Canal would carry water from the dam at a rate of 40 cfs.

In 1965, Sohio established rights to 4 structures in this watershed. Deer Park Gulch Pumping Pipeline would take 150 cfs of Colorado River water and store it in Deer Park Gulch Reservoir, decreed for a capacity of 1533.6 af. The Clear Creek Feeder Canal and the Conn Creek Feeder Canal are each decreed for a diversion rate of 50 cfs. Shell now owns the Deer Park Pipeline, the Deer Park Gulch Reservoir, the Clear Creek Feeder Canal, and the Conn Creek Feeder Canal.

Also in 1965, Getty Oil established a conditional right for Getty Reservoir No. 1, located on an unnamed tributary to Roan Creek, with a storage capacity of 2,543.9 af and Getty Reservoir No. 2, also located on an unnamed tributary to Roan Creek, with a capacity of 20,670.2 af. In addition, Getty established the Cascade Creek Pipeline that would divert 10 cfs from Cascade, which is a tributary to Conn Creek, also tributary to Roan Creek. Getty established Cascade Canyon Reservoir, to be located on Cascade Creek with a capacity of 619.47 af. The Colorado River, through the Cities Service Pipeline, was decreed as an alternate source of supply for this reservoir. Finally, Cities Service established the Conn Creek Pipeline to take up to 10 cfs from Conn Creek as well as Conn Creek Reservoir, with a capacity of 422.75 af. The Colorado River is also an alternate source of supply for this reservoir. Getty Reservoirs 1 and 2 have been abandoned. OXY USA now owns the rights to Cascade Canyon Reservoir, Cascade Creek Pipeline, Conn Creek Pipeline, and Conn Creek Reservoir.

In that same year, an individual established rights to Roan Creek Reservoir. Subsequently, Getty purchased the rights to Long Point Reservoir, which were senior, and transferred these rights to Roan Creek Reservoir. This reservoir holds a 1961 priority for 12,397 af of storage. The right is now owned by Chevron Texaco.

In 1967, Getty established the Getty-Sleepy Gulch Reservoir, with a capacity of 6,538 af. Sleepy Gulch is tributary to Roan Creek. Getty also established Trail Gulch Reservoir in Roan Creek, with a capacity of 5,669.21 af. Sleepy Gulch is now owned by Texaco, while The Oil Shale Corporation owns Trail Gulch.

Occidental (now OXY USA) established the Logan Wash Pump No. 1 in Roan Creek with a 1979 priority date. This right is decreed for 1.1 cfs absolute and 2.9 cfs conditional.

The Main Elk Reservoir was established with a 1963 priority date on Main Elk Creek above the Town of New Castle, with a capacity of 34,922 af. Also established was the Main Elk Wheeler G Pipeline with a decreed rate of diversion of 40 cfs from Main Elk Creek. These rights are now owned by Exxon.

Even further upstream are the Deep Creek Reservoir and Deep Creek Pipeline, established by ARCO with a 1966 priority date. The reservoir had a decreed capacity of 14,557 af, and the pipeline was decreed for a diversion rate of 33 cfs. These rights have been abandoned.

The Roan Plateau Pumping Pipeline, decreed to divert 100 cfs from the Colorado River, has a 1964 appropriation date. It is owned by Humble Oil Company (Exxon). Humble Oil established the Humble Division Forebay Pump with a 1966 appropriation date, providing for the storage of 8,582 af of Colorado River water. This right has been abandoned.

Chevron established Parachute Creek Reservoir with an appropriation date of 1966 and a capacity of 33,733 af. Water is to come primarily from the Colorado River via the Eaton Pumping Plant and Pipeline, the Dragert Pumping Plant and Pipeline, and the Pumping Pipeline of the Union Oil Company of California.

ARCO then established the Starkey Gulch Reservoir and the South Starkey Gulch Reservoir, on tributaries to Parachute Creek, with 1967 priority dates. South Starkey has a decreed capacity of 5,541 af, and Starkey has a decreed capacity of 7,360 af. In addition to storing legally available water from Starkey Gulch, the reservoirs were decreed to store water appropriated under other rights from the Colorado River, Deep Creek, and Thompson Creek. South Starkey is now owned by Chevron. Starkey is owned by the Puckett Land Company.

Getty established the Getty West Fork of Parachute Creek Reservoir, with a decreed capacity of 4,658 af, also with a 1967 appropriation date. Water is to come primarily from the Colorado River via the Pumping Pipeline of the Pacific Western Oil Corporation. This right is now owned by Chevron Texaco.

The Colony Development Corporation and ARCO obtained a decree for the enlargement of Davis Gulch Reservoir in Parachute Creek by an additional 996 af, to a total capacity of 1,200 af, with a 1974 appropriation date. They also obtained an enlargement of Middle Fork Reservoir by 1438.4 af. Exxon now owns these rights.

Photo courtesy of The Story Group

In 1982, Exxon established the Lower East Middle Fork Reservoir in Parachute Creek, with a decreed capacity of 6,200 af. The water is to come primarily from the Colorado River via the Dow Pumping Plant and Pipeline.

Also in 1982, Exxon established 5 additional storage rights, each for 160 af: the Mahaffey Terminal Reservoir and the Allenwater Creek Terminal Reservoir, both in the Colorado River; the Rulison Gulch Terminal Reservoir and the Sheep Trail H Terminal Reservoir in Parachute Creek; and the Cottonwood G Terminal Reservoir in Cottonwood Gulch. Exxon also established the Mahaffey Pumping Plant and Pipeline, to withdraw 60 cfs from the Colorado River.

In 1983, Getty filed on 11 springs in Parachute Creek, with a collection rate of 1.15 cfs. These rights are now owned by Chevron. Shortly thereafter, Cities Service filed on five springs in Parachute Creek, with a collective rate of 0.22 cfs. OXY USA now owns Cities Service.

Shell holds 10 decrees for springs in Clear and Conn Creeks, tributaries to Roan Creek. The appropriation date is 1982. The collective flow rate for these springs is 0.47 cfs. Getty filed on 17 springs in Clear Creek, with an appropriation date of 1983. Chevron now owns these rights. Cities Service filed shortly thereafter on 13 springs in Clear and Conn Creeks. OXY now owns these rights.

B. DEVELOPMENT IN THE WHITE RIVER BASIN

Initiation of conditional water rights for oil shale in the White River Basin was not far behind that in the Colorado River Basin. Two individuals established rights to Stillwater Reservoir, Stillwater Power Plant, and South Fork-Piceance Pipeline on the South Fork of the White River with a 1955 appropriation date. The reservoir is decreed to store 12,548 af, the power plant 300 cfs, and the pipeline 70 cfs. Exxon now owns the reservoir decree, while Shell owns the power plant and pipeline decrees.

The Yellow Jacket Water Conservancy District initiated plans for the Yellow Jacket Project, located in the North Fork of the White River, in the early 1950s. This project includes Ripple Creek Reservoir on the North Fork, with a decreed capacity of 27,992 af; Lost Park Reservoir on Lost Creek, with a decreed capacity of 33,541 af; Lost Creek Feeder Canals 1 and 2, which would bring water to Lost Park Reservoir, with headgates on tributaries to the Williams Fork River in the Colorado River Basin, both decreed for 100 cfs; and the Yellow Jacket Canal, which would divert water out of the North Fork and carry it 38 miles for distribution to different uses, with a decreed capacity of 500 cfs.

In 1957, the Energy Resources Technology Land Company established claims to water from several tributaries of the South Fork as part of the ERTL Pipeline. Headgate No. 1 is located on Buck Creek; Headgate No. 2 is located on Wagon Wheel Creek; Headgate No. 3 is located on the East Branch of Patterson Creek; and Headgate No. 4 is located on the West Branch of Patterson Creek. The original decree was for 30 cfs. Now Headgate 1 is decreed for 15 cfs, Headgate 2 for 1 cfs, Headgate 3 for 7 cfs, and Headgate 4 for 7 cfs. Tosco now owns these rights.

Also in 1961, the Socony-Mobil Oil Company initiated an appropriation for Boies Reservoir, Piceance Pipeline, and Piceance Canal. The sources of water for Boies Reservoir are Black Sulfur Creek, Fawn Creek, Piceance Creek, and water diverted into Piceance Creek from other drainages. The reservoir is decreed for storage of 31,020.8 af. The canal is decreed for 50 cfs. These rights are now owned by ExxonMobil.

Later that same year, the CRWCD established the Flattops Project. The remaining elements of this project include the Rio Blanco Reservoir, to be constructed on the South Fork, and the Patterson Creek Collection System. The reservoir is decreed for 131,035 af. The collection system is decreed for 75 cfs.

Shortly thereafter, the Moon Lake Electric Association initiated the Moon Lake-Staley Mine Pipeline and Reservoir on the White River. The pipeline is decreed for 125 cfs. In 1964, Moon Lake appropriated an additional 55 cfs for this pipeline, which is now owned by Blue Mountain Energy.

In 1962, the CRWCD initiated an appropriation for the Rangely Project, including a reservoir. Subsequently, CRWCD changed the place of storage for 49,256 af to the Wolf Creek Reservoir, to be located on the White River.

In 1963, the Humble Oil Company established Ryan Gulch Reservoir, to be located on Piceance Creek, with a capacity of 22,635.2 af. Simultaneously, it established the White River Pumping

Pipeline, to withdraw 100 cfs of water from the White River for delivery to Ryan Gulch Reservoir. These rights are now owned by Exxon.

The same two individuals who first initiated an oil shale-related conditional right in the White Basin established the White River Pumping Pipeline in late 1963. The pipeline is decreed to divert 100 cfs from the White River. The owners are Wheeler and Phillips.

In 1964, Humble established an appropriation for Jumps Cabin Reservoir, to be located on West Hunter Creek, with a decreed capacity of 7,868.8 af. Humble is still listed as the owner. At the same time, it established Howells Cabin Reservoir, to be constructed on Willow Creek, a tributary of Piceance Creek, with a decreed capacity of 8,096 af. Also established with the same priority date is Dietz Cabin Reservoir, also to be constructed on Willow Creek, with a decreed capacity of 29,900 af. This right is currently owned by an individual, Pat Johnson. Later in 1964, Humble established the White River Pipeline No. 2, decreed for 120 cfs. Exxon currently owns this right.

Also in 1964, the Fourteen Mile Land Company initiated the Fourteen Mile Reservoir 1, to be located on Fourteen Mile Creek, with a decreed capacity of 85,988 af. In addition to taking water from Twelve Mile, Thirteen Mile, and Fourteen Mile Creeks, all tributaries of Piceance Creek, water is to come from the South Fork of the White River through the South Fork-Piceance Pipeline and from the White River. Shell Frontier currently owns this right. The same company also established the White River-Fourteen Mile Pipeline at this time, with the decreed right to divert 200 cfs from the White River. This right is now owned by Shell Frontier.

Just two days later, the same company established the South Fork Reservoir and the South Fork Pipeline, both located on the South Fork of the White River. The reservoir is decreed for a capacity of 85,342 af. The pipeline is decreed to divert 100 cfs. Both of these rights are now owned by Shell.

In 1967, Mobil Oil Company established appropriations for the Hunter Creek Wells, Nos. 1-30. The source of water is the Parachute Creek member of the Green River Formation. Each well is decreed to withdraw 1 cfs. In a subsequent proceeding, Mobil obtained recognition that the Hunter Creek Wells are part of an integrated water supply system that also includes Boies Reservoir, Piceance Pipeline, and Piceance Canal.

In 1968, the Superior Oil Company established a diversion and storage project that included the Superior Oil Company Pipeline and Terminal Reservoirs and the Superior Oil Company Storage System. The pipeline is decreed to divert 12 cfs from the White River and carry water to 2 terminal reservoirs, with a combined capacity of 800 af. Superior obtained an enlargement, adding an additional 12 cfs in a subsequent filing. The storage system consists of 4 reservoirs and 4 pipelines. Crooked Wash Reservoir is decreed for 11,800 af, Wray Gulch Reservoir for 13,500 af, Blacks Gulch Reservoir for 13,900 af, and Kellog Gulch Reservoir for 3,700 af. Water for these reservoirs would come from the White River through pipelines with the names of the reservoir sites, each decreed for a capacity of 100 cfs. Superior also established the Superior Oil Company Pumpback Pipeline Nos. 1, 2, and 3-1, each decreed for 12 cfs. These rights are now owned by Exxon.

An entity called White River Resources then established the White River-Piceance Pipeline, decreed to carry 100 cfs from the White River to Powell Park Reservoir, to be constructed in the Piceance Basin. The reservoir is decreed for storage of 75,970 af. These rights are now owned by two individuals, Walter Wilson and Thomas Cameron.

The Atlantic Richfield Company initiated the White River Figure Four Pipeline later that same year, with a decreed capacity of 70 cfs to come from the White River. This right is now owned by the Puckett Land Company.

Industrial Resources, Inc. initiated the appropriation for the Wolf Ridge Reservoir and the Wolf Ridge Feeder Pipeline in 1966, but did not obtain an adjudication until 1971. The reservoir has a decreed capacity of 7,379.7 af. The pipeline has a decreed capacity of 100 cfs with its point of diversion on the White River. These rights are now owned by Natural Soda, Inc.

In 1967, the Oil Shale Corporation (Tosco) established the Ohio/Ertl Pipeline and the Story Gulch/Parachute Pipeline, each decreed to divert 55 cfs from the White River. Simultaneously, Tosco established Hunter Creek Reservoir, with a decreed capacity of 24,362 af; Story Gulch Reservoir, with a decreed capacity of 10,200 af; and Miller Creek Reservoir, with a decreed capacity of 22,600 af.

In 1971, two individuals — Winston Wheeler and L.E. Phillips — established two new appropriations: Wolf Creek Reservoir and Wolf Creek Pipeline. The reservoir is decreed for 35,000 af; the pipeline is decreed to divert 70 cfs from the White River. These rights are now owned by Exxon.

In 1972, the CRWCD initiated the Wray Gulch Pipeline, the Wray Gulch Dam and Reservoir, the Strawberry Creek Pipeline, and the Strawberry Creek Dam and Reservoir. The Wray Gulch pipeline is decreed to divert 450 cfs from the White River. The Wray Gulch Reservoir has a decreed capacity of 29,374 af. The Strawberry Creek pipeline has a decreed capacity of 400 cfs, and Strawberry Creek Reservoir has a decreed capacity of 75,957 af. In 1974, the CRWCD obtained a change of right to shift 31,944 af of water from the Rangely Enlargement to Wolf Creek Reservoir. Wolf Creek Reservoir now is decreed to store 81,200 af.

In 1976, the Yellow Jacket WCD established the Sawmill Mountain Reservoir and the North Fork Feeder Conduit. The reservoir is decreed to store 80,000 af; the conduit is decreed to carry 500 cfs of water from the North Fork.

Also in 1976, Tosco established the Miller Creek Reservoir with the right to store 23,300 af of water, including that brought from the White River through the Miller Creek Pipeline with its 100-cfs capacity. In 1979, Tosco established an enlargement of Story Gulch Reservoir from 10,200 af to 25,000 af.

In 1981, the Yellow Jacket WCD established the Colorado White River Reservoir at Warner Point, with a decreed capacity of 105,000 af. It also established the Colorado White River Hydroelectric Plant, decreed for 500 cfs.

In 1984, Mobil established the Mobil Pumping Station and Pipeline, with a decreed capacity of 200 cfs. Its purpose is to exchange water upstream to Taylor Draw as necessary to enable pumping of up to 30 cfs from its Hunter Creek Wells. This right is now owned by Exxon.

APPENDIX B

CONDITIONAL WATER RIGHTS FOR OIL SHALE DEVELOPMENT

Table B-1.
Colorado River Basin – Conditional Rights

Map Location	Structure Name	Water Source	Structure Type	Quantity (cfs)	Quantity (af)	Appropriation Date	Appropriation Owner
1	Kobe Canal	Colorado River	Ditch	48.3	0	6/30/1936	Colorado River Water Cons Dist
2	Mt Logan Canal	Roan Creek	Ditch	75	0	6/30/1936	Colorado River Water Cons Dist
3	Mt Logan Dam & Reservoir	Roan Creek	Reservoir	0	10,000	6/30/1936	Colorado River Water Cons Dist
4	Galyean Well	Roan Creek	Well	0.5	0	5/15/1948	Texaco Inc
5	Union 76 Water Well No 3	Parachute Creek	Well	0.066	0	2/14/1949	Union Oil - American Soda
6	Union 76 Water Well No 2	Parachute Creek	Well	0.124	0	2/14/1949	Union Oil - American Soda
7	Pumping Pl Union Oil Cal	Colorado River	Pipeline	110.16	0	2/14/1949	EnCana Oil & Gas Company
8	Roan Creek Reservoir	Roan Creek	Reservoir	0	71,300	1/7/1950	Chevron Texaco Shale Oil Co
9	Dragert Pump Plant & Pl	Colorado River	Pipeline	194	0	1/7/1950	Chevron Shale Oil Cp
10	Hayward & Wyatt Pl	Colorado River	Pipeline	12.725	0	2/2/1950	Exxon Colony Project
11	Getty Pipeline	Colorado River	Pipeline	56	0	9/3/1950	Chevron Texaco Shale Oil Co
12	Cities Service Pl And Pp	Colorado River	Pipeline	100	0	8/2/1951	OXY USA Wtp Lp
13	Shale Pumps & Pl	Colorado River	Pipeline	11.11	0	10/7/1951	Frac Tech Services
14	Pacific Oil Co Pl No 1	Colorado River	Pipeline	57.25	0	6/9/1953	Chevron Shale Oil
15	Pacific Oil Co Pl No 2	Colorado River	Pipeline	27.63	0	6/9/1953	Shell Frontier Oil & Gas
16	Flattops Proj Bearwl Res	Canyon Creek	Reservoir	0	96,488.9	6/28/1954	Colorado River Water Cons Dist
17	Flattops Proj Bearwl Con	Canyon Creek	Pipeline	200	0	6/28/1954	Colorado River Water Cons Dist
18	Flattops Proj Bench Flum	Canyon Creek	Ditch	254	0	6/28/1954	Colorado River Water Cons Dist
19	Flattops Proj Poss Coll1	Canyon Creek	Ditch	175	0	6/28/1954	Colorado River Water Cons Dist

Table B-1. *(cont'd)*

Map Location	Structure Name	Water Source	Structure Type	Quantity (cfs)	Quantity (af)	Appropriation Date	Appropriation Owner
20	East Middle Fork Res	Parachute Creek	Reservoir	0	130.558	9/17/1954	Exxon Oil Company
21	Dow E Middle Fork Pl	Parachute Creek	Pipeline	13.54	0	10/19/1954	Exxon Mobil Corp
22	Dow Middle Fk Pipeline	Parachute Creek	Pipeline	1.088	0	10/20/1954	Exxon Mobil Corp
23	Dow Pump Plant And Pl	Colorado River	Pipeline	187.11	0	1/24/1955	Exxon Mobil Corp
24	Sinclair Oil & Gas Pump	Colorado River	Pipeline	33	0	11/29/1956	Puckett Land Company
25	Eaton Pipeline No 1	Colorado River	Pipeline	9	0	12/17/1956	Puckett Land Company
26	Oil Shale Corp P & Pl	Colorado River	Pipeline	100	0	12/3/1956	Puckett Land Company
27	Virginia Mesa Reservoir	Colorado River	Reservoir	0	50.52	7/18/1957	Chevron Shale Oil
28	Bluestone Project	Colorado River	Ditch	220	0	3/27/1958	Colorado River Water Cons Dist
29	Letson Well	Roan Creek	Well	0.5	0	9/18/1959	Texaco Inc
30	Main Elk Wheeler G Pl	Main Elk Creek	Pipeline	40	0	6/19/1963	Main Elk Corp & Exxon Mobil
31	Mahaffey Pumping P & Pl	Colorado River	Pipeline	60	0	6/19/1963	Main Elk Corp & Exxon Mobil
32	Sheep Trail H Term Res	Parachute Creek	Reservoir	0	160	6/19/1963	Main Elk Corp/ Mobil
33	Cottonwood G Term Res	Cotton-wood G.	Reservoir	0	160	6/19/1963	Main Elk Corp/ Mobil
34	Mahaffey Terminal Res	Colorado River	Reservoir	0	160	6/19/1963	Main Elk Corp/ Mobil
35	Allenwater Cr Term Res	Colorado River	Reservoir	0	160	6/19/1963	Main Elk Corp/ Mobil
36	Rulison Gulch Term Res	Parachute Creek	Reservoir	0	160	6/19/1963	Main Elk Corp/ Mobil
37	Main Elk Reservoir	Main Elk Creek	Reservoir	0	34,922	6/19/1963	Main Elk Corp/ Mobil
38	Clear Creek Feeder Pl	Clear Creek	Pipeline	50	0	2/8/1965	Shell Frontier Oil & Gas Inc
39	Deer Park Gulch Res	Clear Creek	Reservoir	0	1,533.6	2/8/1965	Shell Frontier Oil & Gas Inc
40	Deer Park Gulch Pmp & Pl	Colorado River	Pipeline	150	0	2/8/1965	Shell Frontier Oil & Gas Inc
41	Conn Creek Feeder Pl	Conn Creek	Pipeline	50	0	2/8/1965	Shell Frontier Oil & Gas Inc
42	Una Reservoir	Colorado River	Reservoir	0	369,460	3/16/1965	Colorado River Water Cons Dist
43	Una Res Power Conduit	Colorado River	Ditch	2700	0	3/16/1965	Colorado River Water Cons Dist
44	Getty Reservoir No 2	Roan Creek	Reservoir	0	20,670.2	5/17/1965	Texaco Inc
45	Getty Reservoir No 1	Roan Creek	Reservoir	0	2,543.9	5/17/1965	Texaco Inc
46	Conn Creek Pipeline	Conn Creek	Pipeline	10	0	8/25/1966	OXY USA Wtp Lp

Table B-1. *(cont'd)*

Map Location	Structure Name	Water Source	Structure Type	Quantity (cfs)	Quantity (af)	Appropriation Date	Appropriation Owner
47	Cascade Canyon Reservoir	Conn Creek	Reservoir	0	619.47	8/25/1966	OXY USA Wtp Lp
48	Cascade Canyon Pipeline	Conn Creek	Pipeline	10	0	8/25/1966	OXY USA Wtp Lp
49	Conn Creek Reservoir	Conn Creek	Reservoir	0	422.75	8/25/1966	OXY USA Wtp Lp
50	Thompson Creek Res	Thomp-son Creek	Reservoir	0	23,893	12/17/1966	Puckett Land Co
51	Thompson Creek Pipeline	Thomp-son Creek	Pipeline	33	0	12/17/1966	Puckett Land Co
52	Starkey Gulch Reservoir	Parachute Creek	Reservoir	0	7,360	2/20/1967	Pucket Land Company
53	Getty-Sleepy Gulch Res	Clear Creek	Reservoir	0	6,538	6/27/1967	Texaco Inc
54	Getty W Fk Parachute Cr	Parachute Creek	Reservoir	0	4,658	6/27/1967	Chevron Texaco Shale Oil Co
55	Trail Gulch Res Alt Pt	Carr Creek	Reservoir	0	950.79	9/23/1967	Oil Shale Corp
56	Trail Gulch Reservoir	Roan Creek	Reservoir	0	5,669.21	9/23/1967	Oil Shale Corp
57	Paradise Reservoir	Colorado River	Reservoir	0	69,895.7	3/23/1968	Pure Cycle
58	Logan Wash Mine	Roan Creek	Spring	0.11	0	9/1/1972	Occidental Shale Oil
59	Lw-27 Well	Roan Creek	Spring	0.11	0	3/30/1973	Occidental Shale Oil
60	Logan Wash Mine No 3-C	Roan Creek	Spring	0.11	0	2/1/1974	Occidental Shale Oil
61	Davis Gulch Reservoir	Parachute Creek	Reservoir	0	1,194	9/30/1974	Exxon Oil Company
62	Middle Fork Reservoir	Parachute Creek	Reservoir	0	1,470	9/30/1974	Exxon Mobil Corp
63	Ww-1 Well	Roan Creek	Well	0.165	0	11/22/1974	Occidental Shale Oil
64	Logan Wash Pump No 1	Roan Creek	Spring	2.9	0	10/30/1979	Occidental Shale Oil
65	Lower E Middle Fork Res	Parachute Creek	Reservoir	0	6,200	2/2/1982	Exxon Oil Company
66	Pacific Spring No 2	Clear Creek	Spring	0.06	0	5/1/1982	Shell Western E & P
67	Pacific Spring No 3	Clear Creek	Spring	0.03	0	5/1/1982	Shell Western E & P
68	Pacific Spring No 9	Conn Creek	Spring	0.04	0	5/1/1982	Shell Western E & P
69	Pacific Spring No 10	Conn Creek	Spring	0.04	0	5/1/1982	Shell Western E & P
70	Pacific Spring No 1	Clear Creek	Spring	0.02	0	5/1/1982	Shell Western E & P
71	Pacific Spring No 7	Clear Creek	Spring	0.06	0	5/1/1982	Shell Western E & P
72	Pacific Spring No 8	Clear Creek	Spring	0.08	0	5/1/1982	Shell Western E & P

Table B-1. *(cont'd)*

Map Location	Structure Name	Water Source	Structure Type	Quantity (cfs)	Quantity (af)	Appropriation Date	Appropriation Owner
73	Pacific Spring No 4	Conn Creek	Spring	0.02	0	5/1/1982	Shell Western E & P
74	Pacific Spring No 5	Conn Creek	Spring	0.07	0	5/1/1982	Shell Western E & P
75	Pacific Spring No 6	Conn Creek	Spring	0.05	0	5/1/1982	Shell Western E & P
76	Getty Spring 15b	Clear Creek	Spring	0.027	0	7/1/1983	Chevron Texaco Shale Oil Co
77	Getty Spring 17a	Clear Creek	Spring	0.007	0	7/1/1983	Chevron Texaco Shale Oil Co
78	Getty Spring 20a	Clear Creek	Spring	0.037	0	7/1/1983	Chevron Texaco Shale Oil Co
79	Getty Spring 1b	Parachute Creek	Spring	0.097	0	7/1/1983	Chevron Texaco Shale Oil Co
80	Getty Spring 10a	Clear Creek	Spring	0.787	0	7/1/1983	Chevron Texaco Shale Oil Co
81	Getty Spring 12c	Clear Creek	Spring	0.027	0	7/1/1983	Chevron Texaco Shale Oil Co
82	Getty Spring 09a	Clear Creek	Spring	0.327	0	7/1/1983	Chevron Texaco Shale Oil Co
83	Getty Spring 11e	Clear Creek	Spring	0.007	0	7/1/1983	Chevron Texaco Shale Oil Co
84	Getty Spring 11b	Clear Creek	Spring	0.027	0	7/1/1983	Chevron Texaco Shale Oil Co
85	Getty Spring 11c	Clear Creek	Spring	0.027	0	7/1/1983	Chevron Texaco Shale Oil Co
86	Getty Spring 19a	Clear Creek	Spring	0.007	0	7/1/1983	Chevron Texaco Shale Oil Co
87	Getty Spring 10b	Clear Creek	Spring	0.017	0	7/1/1983	Chevron Texaco Shale Oil Co
88	Getty Spring 15a	Clear Creek	Spring	0.047	0	7/1/1983	Chevron Texaco Shale Oil Co
89	Getty Spring 18a	Clear Creek	Spring	0.637	0	7/1/1983	Chevron Texaco Shale Oil Co
90	Getty Spring 14e	Clear Creek	Spring	0.027	0	7/1/1983	Chevron Texaco Shale Oil Co
91	Getty Spring 11a	Clear Creek	Spring	0.187	0	7/1/1983	Chevron Texaco Shale Oil Co
92	Getty Spring 16b	Clear Creek	Spring	0.057	0	7/1/1983	Chevron Texaco Shale Oil Co
93	Getty Spring 14a	Clear Creek	Spring	0.127	0	7/1/1983	Chevron Texaco Shale Oil Co
94	Cities Service Spg 41	Conn Creek	Spring	0.03	0	7/19/1983	OXY USA Inc, C/O Legal Div
95	Cities Service Spg 17	Conn Creek	Spring	0.05	0	7/19/1983	OXY USA Inc, Legal Div
96	Cities Service Spg 39	Conn Creek	Spring	0.09	0	7/19/1983	OXY USA Inc, Legal Div
97	Cities Service Spg 07	Clear Creek	Spring	0.12	0	7/19/1983	OXY USA Inc, C/O Legal Div
98	Cities Service Spg 40	Conn Creek	Spring	0.03	0	7/19/1983	OXY USA Inc, C/O Legal Div
99	Cities Service Spg 13	Conn Creek	Spring	0.05	0	7/19/1983	OXY USA Inc, C/O Legal Div

Table B-1. *(cont'd)*

Map Location	Structure Name	Water Source	Structure Type	Quantity (cfs)	Quantity (af)	Appropriation Date	Appropriation Owner
100	Cities Service Spg 18	Conn Creek	Spring	0.05	0	7/19/1983	OXY USA Inc, C/O Legal Div
101	Cities Service Spg 08	Clear Creek	Spring	0.02	0	7/19/1983	OXY USA Inc, C/O Legal Div
102	Cities Service Spg 11a	Conn Creek	Spring	0.02	0	7/19/1983	OXY USA Inc, C/O Legal Div
103	Cities Service Spg 03	Conn Creek	Spring	0.02	0	7/19/1983	OXY USA Inc, C/O Legal Div
104	Cities Service Spg 22	Conn Creek	Spring	0.05	0	7/19/1983	OXY USA Inc, C/O Legal Div
105	Cities Service Spg 38	Conn Creek	Spring	0.06	0	7/19/1983	OXY USA Inc, C/O Legal Div
	Total structures: 105			**Total: 4,996.03 cfs**	**Total: 736,770.6 af**		

Table B-2.
White River Basin – Conditional Rights

Map Location	Structure Name	Water Source	Structure Type	Quantity (cfs)	Quantity (af)	Appropriation Date	Appropriation Owner
1	Lost Park Reservoir	Lost Ck	Reservoir	0	33,541	11/9/1953	Yellow Jacket Water Cons Dist
2	Lost Park Feeder C. 1	Tributar-ies-N. Fk	Ditch	100	0	11/9/1953	Yellow Jacket Water Cons Dist
3	Lost Park Feeder C. 2	Tributar-ies-N. Fk	Ditch	100	0	11/9/1953	Yellow Jacket Water Cons Dist
4	Yellow Jacket Canal	North Fork	Ditch	500	0	11/9/1953	Yellow Jacket Water Cons Dist
5	Ripple Creek Reservoir	North Fork	Reservoir	0	27,992	11/19/1953	Yellow Jacket Water Cons Dist
6	Stillwater Power Plant	South Fork	Pipeline	300	0	5/29/1955	Shell Frontier Oil & Gas Inc
7	Stillwater Reservoir	South Fork	Reservoir	0	12,548	5/29/1955	Exxon Mobil Corporation
8	Miller Creek Pumping Pl	White River	Pipeline	100	0	5/26/1957	Tosco Corporation
9	Ertl Pipeline Hg 1	Buck Ck	Pipeline	15	0	5/26/1957	Tosco Corporation
10	Ertl Pipeline Hg 2	Wagon Wheel Ck	Pipeline	1	0	5/26/1957	Tosco Corporation
11	Ertl Pipeline Hg 3	Patterson Ck	Pipeline	7	0	5/26/1957	Tosco Corporation
12	Ertl Pipeline Hg 4	Patterson Ck	Pipeline	7	0	5/26/1957	Tosco Corporation
13	Boies Reservoir	Black Sulphur Ck	Reservoir	0	31,020.8	7/10/1961	Exxon Mobil Corporation
14	Piceance Canal	Piceance Ck	Pipeline	50	0	7/10/1961	Exxon Mobil Corporation
15	Flattops Tunnel	South Fork	Pipeline	254	0	10/31/1961	Colorado River Water Cons Dist
16	Piceance Basin Pl Coll S	South Fork	Pipeline	60	0	10/31/1961	Colorado River Water Cons Dist

Table B-2. *(cont'd)*

Map Location	Structure Name	Water Source	Structure Type	Quantity (cfs)	Quantity (af)	Appropriation Date	Appropriation Owner
17	Rangely Reservoir	White River	Reservoir	0	131,034.5	10/31/1961	Colorado River Water Cons Dist
18	Patterson Cr Coll. Sys	Patterson Ck	Pipeline	75	0	10/31/1961	Colorado River Water Cons Dist
19	Rio Blanco Reservoir	South Fork	Reservoir	0	131,034.5	10/31/1961	Colorado River Water Cons Dist
20	Strawberry Creek Res	Straw-berry Ck	Reservoir	0	7,5957	10/31/1961	Colorado River Water Cons Dist
21	Wray Gulch Dam & Res	Wray Gulch	Reservoir	0	2,9374	10/31/1961	Colorado River Water Cons Dist
22	Douglas Canal	White River	Ditch	620	0	7/3/1962	Colorado River Water Cons Dist
23	Wolf Ck Res(Crwcd)	White River	Reservoir	0	162,400	7/3/1962	Colorado River Water Cons Dist
24	Wolf Ck Res	Wolf Ck	Reservoir	0	35,000	7/3/1962	Exxon Mobil Corporation
25	Ryan Gulch Reservoir	Piceance Ck	Reservoir	0	22,635.2	12/15/1963	Exxon Mobil Corporation
26	White River Pumping Pl	White River	Pipeline	100	0	12/15/1963	Exxon Mobil Corporation
27	Jumps Cabin Res	West Hunter Ck	Reservoir	0	7,868.8	5/27/1964	Humble Oil Company
28	Howells Cabin Res	Willow Ck/Pic. Ck	Reservoir	0	8,096	5/27/1964	?
29	Fourteen Mile Res 1	Fourteen Mile Ck	Reservoir	0	60,000	6/24/1964	Shell Frontier Oil & Gas Inc
30	White R. Fourteen M. Pl	White River	Pipeline	200	0	9/12/1964	Shell Frontier Oil & Gas Inc
31	South Fork Pipeline	South Fork	Pipeline	100	0	9/14/1964	Shell Frontier Oil & Gas Inc
32	South Fork Reservoir	South Fork	Reservoir	0	8,5342	9/14/1964	Shell Frontier Oil & Gas Inc
33	White River Pl No 2	White River	Pipeline	120	0	10/12/1964	Exxon Mobil Corporation
34	South Fork Piceance Pl	South Fork	Pipeline	70	0	5/29/1965	Exxon Mobil Corporation
35	Wolf Ridge Feeder Pl	White River	Pipeline	100	0	11/19/1966	Ehs Manager, Natural Soda Inc
36	Wolf Ridge Res	Yellow Ck	Reservoir	0	7,380	11/19/1966	Ehs Manager, Natural Soda Inc
37	Hunter Ck Res	Hunter Ck	Reservoir	0	24,362	2/28/1967	Tosco Corporation
38	Ohio Ertl Pl	White River	Pipeline	55	0	2/28/1967	Tosco Corporation
39	Story G Parachute Pl	White River	Pipeline	55	0	2/28/1967	Tosco Corporation
40	Story Gulch Res	Story Gulch	Reservoir	0	25,000	2/28/1967	Tosco Corporation
41	Colo Min Well No 28-1	Yellow Ck	Well	4.94	0	2/28/1967	Ehs Manager, Natural Soda Inc
42	Colo Min Well No 14-1	Yellow Ck	Well	4.94	0	2/28/1967	Ehs Manager, Natural Soda Inc

Table B-2. *(cont'd)*

Map Location	Structure Name	Water Source	Structure Type	Quantity (cfs)	Quantity (af)	Appropriation Date	Appropriation Owner
43	Dunn Well No 20-1	Yellow Ck	Well	4.94	0	2/28/1967	Ehs Manager, Natural Soda Inc
44	Savage Well No 24-1	Yellow Ck	Well	4.94	0	2/28/1967	Ehs Manager, Natural Soda Inc
45	Hunter Cr Wells	Hunter Ck	Well	30	0	3/8/1967	Exxon Mobil Corporation
46	Superior Oil Term Res	White River	Reservoir	0	800	5/14/1968	Exxon Mobil Corporation
47	Superior Oil Pl	White River	Pipeline	24	0	5/14/1968	Exxon Mobil Corporation
48	Miller Ck Res	Miller Ck	Reservoir	0	45,900	7/18/1968	Tosco Corporation
49	Blacks Gulch Pipeline	White River	Pipeline	100	0	9/1/1968	Exxon Mobil Corporation
50	Blacks Gulch Res	Blacks Gulch	Reservoir	0	13,900	9/1/1968	Exxon Mobil Corporation
51	Crooked Wash P.L.	White River	Pipeline	100	0	9/1/1968	Exxon Mobil Corporation
52	Crooked Wash Res	Crooked Wash	Reservoir	0	11,800	9/1/1968	Exxon Mobil Corporation
53	Kellogg Gulch P.L.	White River	Pipeline	100	0	9/1/1968	Exxon Mobil Corporation
54	Kellogg Gulch Res	Kellogg Gulch	Reservoir	0	3700	9/1/1968	Exxon Mobil Corporation
55	Wray Gulch Res	Wray Gulch	Reservoir	0	13,500	9/1/1968	Exxon Mobil Corporation
56	Superior Pumpback Pl 1	White River	Pipeline	12	0	10/5/1968	Exxon Mobil Corporation
57	Superior Pumpback Pl 2	White River	Pipeline	12	0	10/5/1968	Exxon Mobil Corporation
58	Superior Pumpback Pl 3	White River	Pipeline	12	0	10/5/1968	Exxon Mobil Corporation
59	Wolf Ck Pl	White River	Pipeline	70	0	9/30/1971	Exxon Mobil Corporation
60	Tg 71-5 Well	Stewart Gulch	Well	1.111	0	11/29/1971	Oil Shale Corporation
61	Tg 71-4 Well	Stewart Gulch	Well	0.888	0	12/3/1971	Oil Shale Corporation
62	Tg 71-3 Well	Stewart Gulch	Well	0.444	0	12/13/1971	Oil Shale Corporation
63	Strawberry Creek Pl	White River	Pipeline	400	0	6/16/1972	Colorado River Water Cons Dist
64	Wray Gulch Pipeline	White River	Pipeline	100	0	7/19/1972	Exxon Mobil Corporation
65	Wray Gulch Pl (Crwcd)	White River	Pipeline	450	0	7/19/1972	Colorado River Water Cons Dist
66	Liberty Bell Well No 12	Story Gulch	Well	0.888	0	12/5/1972	Oil Shale Corporation
67	Camp Bird Well 12	Trib.-Piceance Ck	Well	0.444	0	9/6/1973	Oil Shale Corporation
68	Camp Bird Well 12a	Trib.-Piceance Ck	Well	0.444	0	9/6/1973	Oil Shale Corporation

Table B-2. *(cont'd)*

Map Location	Structure Name	Water Source	Structure Type	Quantity (cfs)	Quantity (af)	Appropriation Date	Appropriation Owner
69	Colo White R Hyd.Plant	White River	Pipeline	500	0	9/6/1973	Yellow Jacket Water Cons Dist
70	North Fork Fdr Conduit	North Fork	Pipeline	500	0	10/7/1976	Yellow Jacket Water Cons Dist
71	Sawmill Mountain Res	Big Beaver Ck	Reservoir	0	80,000	10/7/1976	Yellow Jacket Water Cons Dist
72	Ohio Well No 41	West Willow Ck	Well	0.044	0	8/22/1977	Oil Shale Corporation
73	Colo White R Res	White River	Reservoir	0	105,000	11/17/1981	Yellow Jacket Water Cons Dist
74	Getty Spring 3b	Willow Ck/Pic. Ck	Spring	0.637	0	7/1/1983	Getty Oil
75	Mobil Pump Station Pl	White River	Pipeline	200	0	5/4/1984	Exxon Mobil Corporation
76	Larson Res	Trib.- Piceance Ck	Reservoir	0	1,200	4/5/1988	Ehs Manager, Natural Soda Inc
77	Swepi Spring 1	Duck Ck	Spring	0.367	0	6/13/1988	Shell Frontier Oil & Gas Inc
78	Swepi Spring 10	Spruce Gulch	Spring	0.489	0	6/13/1988	Shell Frontier Oil & Gas Inc
79	Swepi Spring 13	Stake Springs Ck	Spring	0.222	0	6/13/1988	Shell Frontier Oil & Gas Inc
80	Swepi Spring 2	Water Gulch	Spring	0.233	0	6/13/1988	Shell Frontier Oil & Gas Inc
81	Swepi Spring 3	Water Gulch	Spring	0.178	0	6/13/1988	Shell Frontier Oil & Gas Inc
82	Swepi Spring 5	Water Gulch	Spring	0.044	0	6/13/1988	Shell Frontier Oil & Gas Inc
83	Swepi Spring 6	Corral Gulch	Spring	0.178	0	6/13/1988	Shell Frontier Oil & Gas Inc
84	Swepi Spring 7	Corral Gulch	Spring	0.078	0	6/13/1988	Shell Frontier Oil & Gas Inc
85	Swepi Spring 8	Spruce Gulch	Spring	0.011	0	6/13/1988	Shell Frontier Oil & Gas Inc
86	Swepi Spring 9	Spruce Gulch	Spring	0.011	0	6/13/1988	Shell Frontier Oil & Gas Inc
87	Exxon Love Ranch Res	Piceance Ck	Reservoir	0	30	11/17/1998	Exxon Mobil Corporation
88	Exxon Boies Bsulpur Res	Black Sulphur Ck	Reservoir	0	50	11/17/1998	Exxon Mobil Corporation
89	Exxon B&M Reservoir	Piceance Ck	Reservoir	0	50	11/17/1998	Exxon Mobil Corporation
90	Exxon Hunter Creek Res	Hunter Ck	Reservoir	0	30	11/17/1998	Exxon Mobil Corporation
91	Exxon Willow Creek Res	Willow Ck/ Pic Ck	Reservoir	0	30	11/17/1998	Exxon Mobil Corporation
92	Exxon Yellow Ck Res	Yellow Ck	Reservoir	0	30	11/17/1998	Exxon Mobil Corporation

Table B-2. *(cont'd)*

Map Location	Structure Name	Water Source	Structure Type	Quantity (cfs)	Quantity (af)	Appropriation Date	Appropriation Owner
93	Exxon Dry Creek Res	Trib.-Piceance Ck	Reservoir	0	20	11/17/1998	Exxon Mobil Corporation
94	Exxon Upper Piceance Ck	Piceance Ck	Ditch	4	0	11/17/1998	Exxon Mobil Corporation
95	Exxon Piceance Ck Div	Piceance Ck	Ditch	4	0	11/17/1998	Exxon Mobil Corporation
96	Exxon Lower Piceance	Piceance Ck	Ditch	4	0	11/17/1998	Exxon Mobil Corporation
97	Exxon Thirteen Mile Ck	Thirteen Mile Ck	Ditch	1	0	11/17/1998	Exxon Mobil Corporation
98	Exxon Willow Ck Div	Willow Ck/Pic Ck	Ditch	2	0	11/17/1998	Exxon Mobil Corporation
99	Exxon Hunter Ck Div	Hunter Ck	Ditch	2	0	11/17/1998	Exxon Mobil Corporation
100	Exxon Upper Fawn Ck	Fawn Ck	Ditch	1	0	11/17/1998	Exxon Mobil Corporation
101	Exxon Lower Fawn Ck	Fawn Ck	Ditch	2	0	11/17/1998	Exxon Mobil Corporation
102	Exxon Up. B. Sulphur Ck	Black Sulphur Ck	Ditch	1	0	11/17/1998	Exxon Mobil Corporation
103	Exxon Mid Blk Sulphur	Black Sulphur Ck	Ditch	2	0	11/17/1998	Exxon Mobil Corporation
104	Exxon B Sulp-Fawn Ck	Black Sulphur Ck	Ditch	2	0	11/17/1998	Exxon Mobil Corporation
105	Exxon Blk Sulphur-Pic	Black Sulphur Ck	Ditch	2	0	11/17/1998	Exxon Mobil Corporation
106	Exxon M. Fk Stewart Ck	Stewart Gulch	Ditch	3	0	11/17/1998	Exxon Mobil Corporation
107	Exxon E. Fk Stewart Ck	Stewart Gulch	Ditch	3	0	11/17/1998	Exxon Mobil Corporation
108	Exxon Upper Dry Fork	Trib.-Piceance Ck	Ditch	1	0	11/17/1998	Exxon Mobil Corporation
109	Exxon Lower Dry Fork	Trib.-Piceance Ck	Ditch	3	0	11/17/1998	Exxon Mobil Corporation
110	Exxon Yellow Ck Div	Yellow Ck	Ditch	3	0	11/17/1998	Exxon Mobil Corporation
111	Exxon Duck Ck Div	Duck Ck	Ditch	1	0	11/17/1998	Exxon Mobil Corporation
112	Exxon Corral Ck Div	Corral Gulch	Ditch	1	0	11/17/1998	Exxon Mobil Corporation
113	Exxon Ryan Gulch Div	Ryan Gulch	Ditch	1	0	11/17/1998	Exxon Mobil Corporation
114	Shell Pumping Plant	White River	Pipeline	25	0	1/1/1999	Shell Frontier Oil & Gas Inc
	Total structures: 114			**Total: 5,693.47 cfs**	**Total: 1,186,625.8 af**		

APPENDIX C

IRRIGATION DITCHES PURCHASED BY ENERGY COMPANIES

Table C-1.
Colorado River Basin – Absolute Ditch Rights

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date	Appropriation Owner
1	Low Cost Ditch	Parachute Creek	27.94	3,945	5/17/1883	Unocal
2	Vieweg Ditch	Parachute Creek	1.9	1,287	5/17/1883	Unocal
3	C C D Ditch	Parachute Creek	2.53	309	5/17/1883	Unocal
4	East Fork Ditch	Parachute Creek	6.56	243	5/17/1883	Unocal
5	Parachute Ditch	Parachute Creek	27.22	1,965	5/17/1883	Unocal
6	Riley Ditch	Parachute Creek	1	106	5/17/1883	Unocal
7	Cornell Ditch	Parachute Creek	15.675	1,546	5/17/1883	Unocal
8	Spring Ditch	Parachute Creek	0.12	202	5/17/1883	Unocal
9	Starkey Gulch Ditch	Parachute Creek	4.32	150	5/17/1883	Unocal
10	Charley Dere Ditch	Parachute Creek	0.83	350	5/17/1883	Unocal
11	Granlee Ditch	Parachute Creek	12.69	1,690	5/17/1883	Chevron Oil Company
12	Benson And Barnett Ditch	Parachute Creek	8.51	1,187	5/17/1883	Chevron Texaco Shale Oil
13	Newton Ditch	Clear Creek	3.1	1,143	7/1/1883	Chevron Texaco Shale Oil
14	C O & C P Pierson Ditch	Main Elk Creek	5	1,001	2/15/1884	Exxon Mobil Corp
15	Reservoir Ditch	Roan Creek	37.4	5,459	2/28/1884	Chevron Texaco Shale Oil
16	Upper Roan Creek Ditch	Carr Creek	14.25	1,155	8/10/1884	Texaco Inc
17	Roan Creek No 3 Ditch	Roan Creek	7.4	1,762	10/13/1884	Chevron Texaco Shale Oil
18	Atkinson Canal	Roaring Fork River	26.33	2,420	10/20/1884	Union Oil Co
19	Creek And Newman Ditch	Roan Creek	33	3,318	11/15/1884	Chevron Texaco Shale Oil

Table C-1. *(cont'd)*

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date	Appropriation Owner
20	Garden Gulch Ditch	Parachute Creek	5.25	314	4/15/1885	Chevron Oil Company
21	Dry Creek Ditch	Dry Creek (West)	2.02	52	4/23/1885	Exxon Colony Project
22	Himebaugh Ditch	Clear Creek	6.93	840	5/15/1885	Chevron Texaco Shale Oil
23	Cannon Ditch	Brush Creek	11.65	1,387	6/3/1885	Texaco Inc
24	R F Ditch	Battlement Creek	9.855	538	11/25/1885	Exxon Oil Company
25	Clear Creek Ditch	Clear Creek	50.43	3,439	4/9/1886	Chevron Texaco Shale Oil
26	Werhonig Ditch	Monument Gulch	0.2	0	7/15/1886	Exxon Colony Project
27	Dobey Ditch	Battlement Creek	5.975	354	3/7/1887	Exxon Colony Project
28	Carr And Himebaugh Ditch	Clear Creek	8.9	705	4/22/1887	Chevron Texaco Shale Oil
29	Cannon Highline Ditch	Brush Creek	4.34	455	5/10/1887	Texaco Inc
30	Shutt Ditch	Battlement Creek	6	267	5/11/1887	Exxon Colony Project
31	Trout Ditch	Main Elk Creek	3.5	557	2/5/1888	Exxon Mobil Corp
32	Benson Pierson Nelson D	Main Elk Creek	4	646	2/5/1888	Exxon Mobil Corp
33	Oak Grove Ditch	East Elk Creek	3	747	2/20/1890	Exxon Mobil Corp
34	Purdy Ditch	Parachute Creek	6.15	814	4/5/1890	Chevron Oil Company
35	Gibler Ditch	Clear Creek	4.52	404	10/1/1890	Chevron Oil Company
36	Red Glen Highline Ditch	East Elk Creek	8	1,643	11/20/1890	Exxon Mobil Corp
37	Jangle Ditch	Parachute Creek	12.97	1,521	11/12/1891	Chevron Texaco Shale Oil
38	Benson And Barnett Ditch	Parachute Creek	8.51	1,187	11/12/1891	Chevron Oil Company
39	Rulison Miller Ditch	Colorado River	4.1	453	12/8/1891	Exxon Mobil Corp
40	Flume Ditch	Carr Creek	4.35	455	4/1/1895	Texaco Inc
41	Long Gulch Ditch No 1	Clear Creek	2.24	239	11/20/1897	Shell Frontier Oil And Gas
42	Long Gulch Ditch No 2	Clear Creek	2.98	213	11/11/1899	Shell Frontier Oil And Gas
43	Short Gulch Ditch	Clear Creek	2.76	117	11/1/1899	Shell Western Esp
44	Carlisle Ditch	Roan Creek	4.35	183	4/1/1900	Texaco Inc
45	Jensen Ditch	Cot-tonwood Gulch	8.8	396	4/15/1901	Exxon Mobil Corp
46	Number One Ditch	Dry Creek (West)	3.86	153	5/1/1901	Exxon Colony Project

Table C-1. *(cont'd)*

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date	Appropriation Owner
47	Wheeler Ditch	Parachute Creek	3	183	8/14/1901	Unocal
48	Garden Gulch No 2 Ditch	Parachute Creek	1.33	175	5/1/1903	Chevron Oil Company
49	H A Newton Ditch	Clear Creek	2.86	97	5/15/1907	Chevron Texaco Shale Oil Co
50	New Hobo Ditch	Roan Creek	11.56	566	6/6/1908	Chevron Texaco Shale Oil Co
51	Parkes Ditch	Clear Creek	3.7	169	5/5/1908	Chevron Texaco Shale Oil Co
52	Longseth No 1 Ditch	Roan Creek	1.67	143	5/3/1910	Texaco Inc
53	Hayward Spring Ditch	Battlement Creek	0.75	6	8/31/1912	Exxon Oil Company
54	Ryden No 2 Ditch	Main Elk Creek	1.76	279	4/6/1912	Exxon Mobil Corp
55	Ida Dere Ditch	Parachute Creek	3	184	4/1/1914	Unocal
56	Ryden No 1 Ditch	Main Elk Creek	5.5	716	4/7/1915	Exxon Mobil Corp
57	W E Ditch	Main Elk Creek	1	458	7/1/1917	Exxon Mobil Corp
	Total Structures: 57		**Total: 468.55 cfs**	**Total: 50,293 af**		

Table C-2.
White River Basin – Absolute Ditch Rights

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date	Appropriation Owner
1	P & L Ditch	Piceance Ck	0.5	144	6/1/1883	Exxon Mobil Corp.
2	Calhoun Ditch	White River	8.17	285	8/25/1883	Shell Frontier
3	Mckee Ditch	Black Sulphur Ck	3	303	5/10/1884	Exxon Mobil Corp.
4	Ryan Ditch	Piceance Ck	10.5	408	6/1/1884	Coastal Oil
5	Willow Creek Ditch No 2	East Willow Ck	1.2	294	9/29/1884	Exxon Mobil Corp.
6	Willow Creek Ditch No 3	East Willow Ck	1.2	230	9/29/1884	Exxon Mobil Corp.
7	M H M German Cons D	Piceance Ck	17.54	880	10/22/1884	Exxon Mobil Corp.
8	Gilmor Ditch	Hunter Ck	1.5	320	5/10/1886	Exxon Mobil Corp.
9	Boies Ditch	Black Sulphur Ck	2	363	10/16/1886	Exxon Mobil Corp.
10	Emily Ditch*	Piceance Ck	5.85	794	11/5/1886	Tosco Co.
10	Emily Ditch*	Piceance Ck	0	0	11/5/1886	Puckett Land Co.
11	D D Taylor Ditch*	Black Sulphur Ck	2	418	4/5/1887	Atlantic Richfield Co.

Table C-2. *(cont'd)*

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date	Appropriation Owner
11	D D Taylor Ditch*	Black Sulphur Ck	0	0	4/5/1887	Exxon Mobil Corp.
11	D D Taylor Ditch*	Black Sulphur Ck	0	0	4/5/1887	Equity Oil
12	Last Chance Ditch*	Hunter Ck	1.4	294	4/13/1887	Puckett Land Co.
12	Last Chance Ditch*	Hunter Ck	0	0	4/13/1887	Tosco Co.
13	Black Eagle D No 1*	Black Sulphur Ck	5.95	321	4/16/1887	Exxon Mobil Corp.
13	Black Eagle D No 1*	Black Sulphur Ck	0	0	4/16/1887	Equity Oil
13	Black Eagle D No 1*	Black Sulphur Ck	0	0	4/16/1887	Atlantic Richfield Co.
14	Black Eagle D No 2*	Black Sulphur Ck	5.95	276	4/16/1887	Exxon Mobil Corp.
14	Black Eagle D No 2*	Black Sulphur Ck	0	0	4/16/1887	Equity Oil
14	Black Eagle D No 2*	Black Sulphur Ck	0	0	4/16/1887	Atlantic Richfield Co.
15	Black Eagle Alt Pt 1	Black Sulphur Ck	0	92	4/16/1887	Exxon Mobil Corp.
16	Black Eagle Alt Pt 2	Black Sulphur Ck	0	85	4/16/1887	Exxon Mobil Corp.
17	Robert Mckee Ditch*	Piceance Ck	6.33	1,235	4/18/1887	Tosco Co.
17	Robert Mckee Ditch*	Piceance Ck	0	0	4/18/1887	Puckett Land Co.
17	Robert Mckee Ditch*	Piceance Ck	0	0	4/18/1887	McMurry Oil
18	M H And M Ditch	Piceance Ck	17.54	880	4/18/1887	Exxon Mobil Corp.
19	Oldland Ditch 1*	Piceance Ck	13.8	1,000	4/27/1887	Puckett Land Co.
19	Oldland Ditch 1*	Piceance Ck	0	0	4/27/1887	Tosco Co.
20	O I See Ditch*	Fawn Ck	1.2	225	4/27/1887	Equity Oil
20	O I See Ditch*	Fawn Ck	0	0	4/27/1887	Exxon Mobil Corp.
21	No Name Ditch*	Fawn Ck	0.4	173	5/1/1887	Equity Oil
21	No Name Ditch*	Fawn Ck	0	0	5/1/1887	Exxon Mobil Corp.
22	Decker Irrigation Ditch	East Douglas Ck	2.8	94	5/6/1887	Exxon Mobil Corp.
23	Belot Moffat Ditch	Piceance Ck	11.6	1,304	5/10/1887	Exxon Mobil Corp.
24	B & M Ditch	Piceance Ck	0.9	551	5/25/1887	McMurry Oil
25	Jessup Ditch 1*	Stewart Gulch	1.2	204	6/16/1887	Puckett Land Co.
25	Jessup Ditch 1*	Stewart Gulch	0	0	6/16/1887	Tosco Co.
26	Blue Grass Ditch*	Stewart Gulch	0.6	262	7/11/1887	Puckett Land Co.

Table C-2. *(cont'd)*

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date	Appropriation Owner
26	Blue Grass Ditch*	Stewart Gulch	0	0	7/11/1887	Tosco Co.
27	Jessup Ditch 2*	Stewart Gulch	0.6	134	4/14/1888	Puckett Land Co.
27	Jessup Ditch 2*	Stewart Gulch	0	0	4/14/1888	Tosco Co.
28	Taylor Ditch	Willow Ck Of Pic. Ck	2	279	5/9/1888	Exxon Mobil Corp.
29	Hunter Ditch	Hunter Ck	1	267	5/15/1888	Exxon Mobil Corp.
30	Ebler Ditch	Willow Ck Of Pic.E Ck	1	170	5/20/1888	Exxon Mobil Corp.
31	Florence Ditch	Mid Fk Stewart G.	2.9	77	6/3/1888	Puckett Land Co.
32	Rye Grass Ditch*	Piceance Ck	8.2	901	6/5/1888	Tosco Co.
32	Rye Grass Ditch*	Piceance Ck	0	0	6/5/1888	Puckett Land Co.
32	Rye Grass Ditch*	Piceance Ck	0	0	6/5/1888	Shell Frontier
33	Schweizer Ditch*	Black Sulphur Ck	2.6	437	9/30/1888	Exxon Mobil Corp.
33	Schweizer Ditch*	Black Sulphur Ck	0	0	9/30/1888	Equity Oil
33	Schweizer Ditch*	Black Sulphur Ck	0	0	9/30/1888	Atlantic Richfield Co.
34	Schweizer Ditch Alt Pt	Black Sulphur Ck	0	110	9/30/1888	Exxon Mobil Corp.
35	Hutchinson Spring Ditch	Fawn Ck	0.5	159	7/18/1889	Exxon Mobil Corp.
36	Mcgee Ditch*	Fawn Ck	1.16	270	5/1/1890	Equity Oil
36	Mcgee Ditch*	Fawn Ck	0	0	5/1/1890	Exxon Mobil Corp.
36	Mcgee Ditch*	Fawn Ck	0	0	5/1/1890	Atlantic Richfield Co.
37	J W Bainbrick D No 1&2*	Black Sulphur Ck	0.86	181	7/1/1893	Exxon Mobil Corp.
37	J W Bainbrick D No 1&2*	Black Sulphur Ck	0	0	7/1/1893	Equity Oil
37	J W Bainbrick D No 1&2*	Black Sulphur Ck	0	0	7/1/1893	Atlantic Richfield Co.
38	Gardenheir Ditch*	Piceance Ck	2.04	350	3/5/1895	Puckett Land Co.
38	Gardenheir Ditch*	Piceance Ck	0	0	3/5/1895	Tosco Co.
39	Forney Corcoran Ditch	White River	11.47	974	3/15/1898	Puckett Land Co.
40	E Stewart Gulch D No 1*	East Stewart Gulch	0.6	46	11/1/1899	Tosco Co.
40	E Stewart Gulch D No 1*	East Stewart Gulch	0	0	11/1/1899	Puckett Land Co.

Table C-2. *(cont'd)*

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date	Appropriation Owner
41	E Stewart Gulch D No 2*	East Stewart Gulch	0.6	35	11/1/1899	Puckett Land Co.
41	E Stewart Gulch D No 2*	East Stewart Gulch	0	0	10/15/1900	Tosco Co.
42	Mcwilliams & George D	White River	4.1	495	10/15/1900	Puckett Land Co.
43	N & L Ditch	Fawn Ck	1	271	5/1/1901	Exxon Mobil Corp.
44	Oldland Ditch 3*	Piceance Ck	1.4	199	5/15/1902	Tosco Co.
44	Oldland Ditch 3*	Piceance Ck	0	0	5/15/1902	Puckett Land Co.
44	Oldland Ditch 3*	Piceance Ck	0	0	5/15/1902	McMurry Oil
45	Piceance Ditch	Piceance Ck	0.5	79	6/10/1902	XTO Energy Inc.
46	Bainbrick Mikkelsen 1&2*	Black Sulphur Ck	0.375	264	5/1/1904	Exxon Mobil Corp.
46	Bainbrick Mikkelsen 1&2*	Black Sulphur Ck	0	0	5/1/1904	Atlantic Richfield Co.
46	Bainbrick Mikkelsen 1&2*	Black Sulphur Ck	0	0	5/1/1904	Equity Oil
47	Mccarthy Spring Ditch	Piceance Ck	0.6	49	5/11/1905	XTO Energy Inc.
48	Milo Ditch	Black Sulphur Ck	0.3	36	5/1/1911	Exxon Mobil Corp.
49	Oldland Magor Ditch	Piceance Ck	2.86	476	5/10/1913	Puckett Land Co.
50	Forney Corcoran Ditch	White River	11.47	0	5/10/1913	Tosco Co.
51	Desert Ditch*	Black Sulphur Ck	1.43	182	6/12/1914	Exxon Mobil Corp.
51	Desert Ditch*	Black Sulphur Ck	0	0	6/12/1914	Atlantic Richfield Co.
51	Desert Ditch*	Black Sulphur Ck	0	0	6/12/1914	Equity Oil
52	Cow Creek Ditch	Cow Ck	0.8	96	5/20/1915	XTO Energy Inc.
53	Edmund Pauls Ditch	Sulphur Ck	0.1	11	7/21/1915	Exxon Mobil Corp.
54	Oldland Ditch 2*	Piceance Ck	18.94	660	5/1/1917	Puckett Land Co.
54	Oldland Ditch 2*	Piceance Ck	0	0	5/1/1917	McMurry Oil
54	Oldland Ditch 2*	Piceance Ck	0	0	5/1/1917	Tosco Co.
55	Duckett Ditch*	Black Sulphur Ck	1.2	242	6/10/1918	Atlantic Richfield Co.
55	Duckett Ditch*	Black Sulphur Ck	0	0	6/10/1918	Exxon Mobil Corp.
55	Duckett Ditch*	Black Sulphur Ck	0	0	6/10/1918	Equity Oil
56	Davis Ditch	Davis Gulch	0.4	63	8/16/1926	XTO Energy Inc.

Table C-2. *(cont'd)*

Map Location	Structure Name	Water Source	Quantity Abs. (cfs)	Avg. Vol. Div. (af)	Appropriation Date	Appropriation Owner
57	West Stewart Res Ditch	West Stewart Gulch	2.6	113	?	Atlantic Richfield Co.
	Total structures: 57		**Total: 206.74 cfs**	**Total: 19,061 af**		

* *Joint ownership*

APPENDIX D

COLORADO RIVER BASIN — ABSOLUTE WELLS AND SPRINGS

Map Location	Structure Name	Water Source	Structure Type	Quantity Abs. (cfs)	Av. Vol. Div. (af)	Appropriation Date	Appropriation Owner
1	Nelson Well No 1*	Parachute Creek	Well	0.018	0	5/17/1883	Union Oil
2	Sherwood Well No 1*	Parachute Creek	Well	0.022	0	5/17/1883	Union Oil
3	Sherwood Well No 2*	Parachute Creek	Well	0.018	0	5/17/1883	Union Oil
4	Seep Spring No 1*	Parachute Creek	Well	0.033	0	4/19/1922	Union Oil
5	Seep Spring No 2*	Parachute Creek	Well	0.033	0	4/19/1922	Union Oil
6	Seep Spring No 3*	Parachute Creek	Well	0.033	0	4/19/1922	Union Oil
7	House Log Gulch Sprg No 1*	Parachute Creek	Spring	0.033	0	4/19/1922	Union Oil
8	House Log Gulch Sprg No 2*	Parachute Creek	Spring	0.033	0	4/19/1922	Union Oil
9	House Log Gulch Sprg No 3*	Parachute Creek	Spring	0.033	0	4/19/1922	Union Oil
10	House Log Gulch Sprg No 4*	Parachute Creek	Spring	0.033	0	4/19/1922	Union Oil
11	House Log Gulch Sprg No 5*	Parachute Creek	Spring	0.033	0	4/19/1922	Union Oil
12	Red Spring No 1*	Parachute Creek	Spring	0.033	0	4/22/1922	Union Oil
13	Squire's Spring*	Parachute Creek	Spring	0.033	0	7/21/1922	Union Oil
14	Sheep Gulch Spring*	Parachute Creek	Spring	0.033	0	7/21/1922	Union Oil
15	Calf Spring*	Parachute Creek	Spring	0.033	0	8/9/1922	Union Oil
16	Long Ridge Spring No 1*	Parachute Creek	Spring	0.033	0	9/22/1922	Union Oil Company Of Calif
17	Long Ridge Spring No 2*	Parachute Creek	Spring	0.033	0	9/22/1922	Union Oil Company Of Calif

COLORADO RIVER BASIN — ABSOLUTE WELLS AND SPRINGS *(cont'd)*

Map Location	Structure Name	Water Source	Structure Type	Quantity Abs. (cfs)	Av. Vol. Div. (af)	Appropriation Date	Appropriation Owner
18	Long Ridge Spring No 3*	Parachute Creek	Spring	0.033	0	9/22/1922	Union Oil Company Of Calif
19	Long Ridge Spring No 4*	Parachute Creek	Spring	0.033	0	9/22/1922	Union Oil Company Of Calif
20	Long Ridge Spring No 5*	Parachute Creek	Spring	0.033	0	9/22/1922	Union Oil Company Of Calif
21	Feather Springs*	Parachute Creek	Spring	0.033	0	11/10/1922	Union Oil Company Of Calif
22	Grassy Spring*	Parachute Creek	Spring	0.033	0	11/27/1922	Union Oil Company Of Calif
23	Hidden Spring*	Parachute Creek	Spring	0.033	0	7/11/1924	Union Oil Company Of Calif
24	Cottonwood Spring No 1*	Cotton-wood Ck	Spring	0.05	0	11/8/1940	Union Oil Comp Of California
25	Union 76 Water Well No 4*	Parachute Creek	Well	1.114	0	2/14/1949	Union Oil - American Soda
26	Union 76 Water Well No 1*	Parachute Creek	Well	0.52	0	2/14/1949	Union Oil of Calif
27	Union 76 Water Well No1a*	Parachute Creek	Well	0.52	0	2/14/1949	Union Oil of Calif
28	Union 76 Water Well No 3*	Parachute Creek	Well	1.048	0	2/14/1949	Union Oil - American Soda
29	Union 76 Water Well No 2*	Parachute Creek	Well	0.99	0	2/14/1949	Union Oil - American Soda
30	Union 76 Water Well No 5*	Parachute Creek	Well	1.114	0	2/14/1949	Union Oil - American Soda
31	Union 76 Water Well No 6*	Parachute Creek	Well	0.722	0	2/14/1949	Union Oil Co Of Cal
32	Parkhurst Cabin Spg No 1*	Parachute Creek	Spring	0.033	0	3/22/1951	Union Oil Company Of Calif
33	Parkhurst Cabin Spg No 2*	Parachute Creek	Spring	0.033	0	3/22/1951	Union Oil Company Of Calif
34	Helm Gulch Spring No 1*	Parachute Creek	Spring	0.033	0	3/27/1952	Union Oil Company Of Calif
35	Helm Gulch Spring No 2*	Parachute Creek	Spring	0.033	0	3/27/1952	Union Oil Company Of Calif
36	Lone Tree Spring*	Parachute Creek	Spring	0.033	0	1/20/1954	Union Oil Company Of Calif
37	Pete Spring*	Parachute Creek	Spring	0.033	0	5/31/1955	Union Oil Company Of Calif
38	Wagon Spring*	Parachute Creek	Spring	0.033	0	6/2/1966	Union Oil Company Of Calif

COLORADO RIVER BASIN — ABSOLUTE WELLS AND SPRINGS *(cont'd)*

Map Location	Structure Name	Water Source	Structure Type	Quantity Abs. (cfs)	Av. Vol. Div. (af)	Appropriation Date	Appropriation Owner
39	Light Gulch Spring No 1*	Parachute Creek	Spring	0.033	0	6/2/1966	Union Oil Company Of Calif
40	Light Gulch Spring No 2*	Parachute Creek	Spring	0.033	0	6/2/1966	Union Oil Company Of Calif
41	Cabin Spring*	Parachute Creek	Spring	0.066	0	6/2/1966	Union Oil Company Of Calif
42	Cottonwood Spring No 2*	Cotton-wood Ck	Spring	0.01	0	5/1/1967	Union Oil Comp Of California
43	Corral Spring No 1*	Parachute Creek	Spring	0.03	0	10/7/1986	Union Oil Of Calif
44	Eisaguirre Spring No 1*	Parachute Creek	Spring	0.02	0	10/10/1986	Union Oil Of Calif
45	Schutte Spring No 1*	Parachute Creek	Spring	0.033	0	10/10/1986	Union Oil Of Calif
46	Schutte Spring No 2*	Parachute Creek	Spring	0.033	0	10/10/1986	Union Oil Of Calif
47	Sage Spring No 2*	Parachute Creek	Spring	0.033	0	10/23/1986	Union Oil Of Calif
	Total Structures: 47			**Total: 7.32 cfs**	**Total: 0 af**		

APPENDIX E

COMPARING SELECTED OIL SHALE AND NON-OIL SHALE CONDITIONAL RIGHTS IN THE COLORADO BASIN

In the table below, oil shale structures are listed in the light blue lines, and non-oil-shale structures are listed in the darker blue lines.

Administrative Number	Structure Name	Water Source	Structure Type	Cond'l Quantity (cfs)	Cond'l Quantity (af)	Quantity Absolute (cfs and af)	Appropriation Date	Appropriation Owner
36204.00000	Pumping Pl Union Oil Cal	Colorado River	Pipeline	110.16	0		2/14/1949	Encana Oil & Gas Company
37103.00000	Cities Service Pl And Pp	Colorado River	Pipeline	100	0		8/2/1951	OXY USA Wtp Lp
37503.36770	Getty Pipeline	Colorado River	Pipeline	56	0		9/3/1950	Chevron Texaco Shale Oil
37503.36991	Dragert Pump Plant & Pl	Colorado River	Pipeline	194	0		4/12/1951	Chevron Shale Oil Cp
37780.00000	Pacific Oil Co Pl No 1	Colorado River	Pipeline	57.25	0		6/9/1953	Chevron Shale Oil
37780.00000	Pacific Oil Co Pl No 2	Colorado River	Pipeline	27.63	0		6/9/1953	Shell Frontier Oil & Gas
38164.00000	Flattops Proj Bearwl Res	Canyon Creek	Reservoir	0	96,488.9		6/28/1954	Colorado Riv Water Cons Dist
38164.00000	Flattops Bearwl Con	Canyon Creek	Pipeline	200	0		6/28/1954	Colorado Riv Water Cons Dist
38164.00000	Flattops Bench Flum	Canyon Creek	Ditch	254	0		6/28/1954	Colorado Riv Water Cons Dist
38164.00000	Flattops Proj Poss Coll1	Canyon Creek	Ditch	175	0		6/28/1954	Colorado Riv Water Cons Dist
38277.00000	Dow E Middle Fork Pl	Para-chute Creek	Pipeline	13.54	0	6.46 cfs	10/19/1954	Exxon Mobil Corp
38278.00000	Dow Middle Fk Pipeline	Para-chute Creek	Pipeline	1.09	0	8.91 cfs	10/20/1954	Exxon Mobil Corp
38374.00000	Dow Pump Plant And Pl	Colorado River	Pipeline	187.11	0	30.89 cfs	1/24/1955	Exxon Mobil Corp
38753.37520	Homestake Proj Conduit	Home-stake Creek	Pipeline	120	0		9/22/1952	Colorado Springs & Aurora

COMPARING SELECTED OIL SHALE AND NON-OIL SHALE CONDITIONAL RIGHTS IN THE COLORADO BASIN *(cont'd)*

Administrative Number	Structure Name	Water Source	Structure Type	Cond'l Quantity (cfs)	Cond'l Quantity (af)	Quantity Absolute (cfs and af)	Appropriation Date	Appropriation Owner
38753.37520	Homestake Proj Conduit	Homestake Creek	Pipeline	118.7	0	41.3 cfs	9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Fall Creek	Pipeline	260	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Homestake Creek	Pipeline	80	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Cross Creek	Pipeline	130	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Peterson Creek	Pipeline	50	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Homestake Creek	Pipeline	91.4	0	38.6 cfs	9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Homestake Creek	Pipeline	80.2	0	39.8 cfs	9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Cross Creek	Pipeline	300	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Homestake Creek	Pipeline	50	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Cross Creek	Pipeline	60	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Homestake Creek	Pipeline	119.9	0	60.1 cfs	9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Homestake Creek	Pipeline	1350.2	0	179.8 cfs	9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Proj Conduit	Cross Creek	Pipeline	200	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Eagle-Ark	Eagle River	Ditch	230	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Eagle-Ark	Piney Creek	Ditch	20	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Eagle-Ark	Piney Creek	Ditch	20	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Eagle-Ark	Cataract Creek	Ditch	90	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Eagle-Ark	Piney Creek	Ditch	30	0		9/22/1952	Colorado Springs & Aurora

COMPARING SELECTED OIL SHALE AND NON-OIL SHALE CONDITIONAL RIGHTS IN THE COLORADO BASIN *(cont'd)*

Administrative Number	Structure Name	Water Source	Structure Type	Cond'l Quantity (cfs)	Cond'l Quantity (af)	Quantity Absolute (cfs and af)	Appropriation Date	Appropriation Owner
38753.37520	Homestake Eagle-Ark	Piney Creek	Ditch	30	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake East Fork	Home-stake Creek	Pipeline	189.2	0	70.8 cfs	9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Eagle-Ark	Jones Gulch	Ditch	90	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Eagle-Ark	Piney Creek	Pipeline	530	0		9/22/1952	Colorado Springs & Aurora
38753.37520	Homestake Eagle-Ark	Sheep Gulch	Ditch	20	0		9/22/1952	Colorado Springs & Aurora
39049.00000	Sinclair Oil & Gas Pump	Colorado River	Pipeline	33	0		11/29/1956	Pucket Land Company
39053.00000	Oil Shale Corp P & Pl	Colorado River	Pipeline	100	0		12/3/1956	Pucket Land Company
39067.00000	Eaton Pipeline No 1	Colorado River	Pipeline	9	0	1 cfs	12/17/1956	Puckett Land Company
39095.37858	Williams Fork Div Proj	Williams Fk R	Ditch/PL	130	0		8/26/1953	Denver Water Board
39095.37858	Darling Creek Enl	Williams Fk R	Pipeline	90	0		8/26/1953	Denver Water Board
39095.38998	Williams Fork Res	Williams Fk R	Reservoir	0.	93,637		10/9/1956	Denver Water Board
39102.00000	Roberts Tunnel Coll Sys	Straight Ck		115	0		1/21/1957	Denver Water Board
39291.00000	Ruedi Reservoir	Frying-pan R	Reservoir	0	0	102,369 af	7/29/1957	U.S. Bureau of Reclamation
39532.00000	Bluestone Project	Colorado River	Ditch	220	0		3/27/1958	Colorado Riv Water Cons Dist
40069.00000	Davis Gulch Reservoir	Para-chute Creek	Reservoir	0	1194	6 af	9/30/1974	Exxon Oil Company
40071.00000	East Middle Fork Res	Para-chute Creek	Reservoir	0	130.56		9/17/1954	Exxon Oil Company
40091.00000	Shale Pumps & Pl	Colorado River	Pipeline	11.11	0		10/7/1951	Frac Tech Services
40785.00000	Goose Pasture Tarn	Blue River	Reservoir	0	2,196.4	27257.7 af	8/31/1961	Town of Breckenridge
41442.00000	Main Elk Wheeler G Pl	Main Elk Creek	Pipeline	40	0		6/19/1963	Main Elk Co & Exxon Mobil
41442.00000	Main Elk Reservoir	Main Elk Creek	Reservoir	0	34,922		6/19/1963	Main Elk Corp/Mobil

COMPARING SELECTED OIL SHALE AND NON-OIL SHALE CONDITIONAL RIGHTS IN THE COLORADO BASIN *(cont'd)*

Administrative Number	Structure Name	Water Source	Structure Type	Cond'l Quantity (cfs)	Cond'l Quantity (af)	Quantity Absolute (cfs and af)	Appropriation Date	Appropriation Owner
41489.00000	Parshall Project	Williams Fk R	Ditch	145	0	0	8/5/1963	Colorado Riv Water Cons Dist
42042.00000	Conn Creek Feeder Pl	Conn Creek	Pipeline	50	0		2/8/1965	Shell Frontier Oil & Gas Inc
42042.00000	Clear Creek Feeder Pl	Clear Creek	Pipeline	50	0		2/8/1965	Shell Frontier Oil & Gas Inc
42042.00000	Deer Park Gulch Res	Clear Creek	Reservoir	0	1,533.6		2/8/1965	Shell Frontier Oil & Gas Inc
42042.00000	Deer Park Gulch Pmp & Pl	Colorado River	Pipeline	150	0		2/8/1965	Shell Frontier Oil & Gas Inc
42078.00000	Una Reservoir	Colorado River	Reservoir	0	369,460		3/16/1965	Colorado Riv Water Cons Dist
42078.00000	Una Res Power Conduit	Colorado River	Ditch	2700	0		3/16/1965	Colorado Riv Water Cons Dist
42140.00000	Getty Reservoir No 1	Roan Creek	Reservoir	0	2543.9		5/17/1965	Texaco Inc
42140.00000	Getty Reservoir No 2	Roan Creek	Reservoir	0	20,670.2		5/17/1965	Texaco Inc
42162.00000	Roberts Tunnel-Piney R	Piney Ck	Pipeline	170	0		6/13/1965	Denver Water Board
42485.00000	Wolcott Reservoir	Ute Ck	Reservoir	0	65975		4/27/1966	Colorado Riv Cons Dist
42485.00000	Wolcott Pipeline	Eagle River	Pipeline	492.5	0		4/27/1966	Colorado Riv Cons Dist
42605.00000	Cascade Canyon Res	Conn Creek	Reservoir	0	619.47		8/25/1966	OXY USA Wtp Lp
42605.00000	Conn Creek Reservoir	Conn Creek	Reservoir	0	422.75		8/25/1966	OXY USA Wtp Lp
42605.00000	Conn Creek Pipeline	Conn Creek	Pipeline	10	0		8/25/1966	OXY USA Wtp Lp
42605.00000	Cascade Canyon Pipeline	Conn Creek	Pipeline	10	0		8/25/1966	OXY USA Wtp Lp
42719.00000	Thompson Creek Res	Thomp-son Creek	Reservoir	0	23,893		12/17/1966	Puckett Land Co
42719.00000	Thompson Creek Pipeline	Thomp-son Creek	Pipeline	33	0		12/17/1966	Puckett Land Co
42794.00000	Roan Creek Reservoir	Roan Creek	Reservoir	0	71,300		3/2/1967	Chevron Texaco Shale Oil

COMPARING SELECTED OIL SHALE AND NON-OIL SHALE CONDITIONAL RIGHTS IN THE COLORADO BASIN *(cont'd)*

Administrative Number	Structure Name	Water Source	Structure Type	Cond'l Quantity (cfs)	Cond'l Quantity (af)	Quantity Absolute (cfs and af)	Appropriation Date	Appropriation Owner
42911.00000	Getty-Sleepy Gulch Res	Clear Creek	Reservoir	0	6538		6/27/1967	Texaco Inc
42999.00000	Trail Gulch Reservoir	Roan Creek	Reservoir	0	5,669.21		9/23/1967	Oil Shale Corp
42999.00000	Trail Gulch Res Alt Pt	Carr Creek	Reservoir	0	950.79		9/23/1967	Oil Shale Corp
43404.00000	Paradise Reservoir	Colorado River	Reservoir	0	69,895.70		11/1/1968	Pure Cycle
43621.42906	Jasper Pl	Willow Ck	Pipeline	300	0		6/22/1967	Northern Col Water Cons Dist
43621.42906	Windy Gap Reservoir	Colorado R	Reservoir	0	1,101.14	445 af	6/22/1967	Northern Col Water Cons Dist
43621.42906	Windy Gap Pump Plant	Colorado R	Pipeline	0	0	300 cfs	6/22/1967	Northern Col Water Cons Dist
43621.42906	Jasper Reservoir	Willow Ck	Reservoir	0	11,292.6		6/22/1967	Northern Col Water Cons Dist
43829.36557	Hayward & Wyatt Pl	Colorado River	Pipeline	0	0	12.725 cfs	2/2/1950	Exxon Colony Project
43829.39280	Virginia Mesa Reservoir	Colorado River	Reservoir	0	50.52		7/18/1957	Chevron Shale Oil
44526.00000	Eagle-Colorado Res	Alkali Creek	Reservoir	0	350,000	0	11/28/1971	Denver Water Board
44559.00000	Starkey Gulch Reservoir	Para-chute Creek	Reservoir	0	7,360		2/20/1967	Puckett Land Company
45290.42911	Getty W Fk Parachute Cr	Para-chute Creek	Reservoir	0	4,658		6/27/1967	Chevron Texaco Shale Oil
46751.46211	Windy Gap Pump Canal	Colorado R	Pipeline	0	0	100 cfs	7/9/1976	Northern Col Water Cons Dist
47116.45563	Middle Fork Reservoir	Para-chute Creek	Reservoir	0	1,470		9/30/1974	Exxon Mobil Corp
47602.00000	Windy Gap Pump Canal	Colorado R	Pipeline	0	0	200 cfs	4/30/1980	Northern Col Water Cons Dist
48212.48007	Mahaffey Pumping P & Pl	Colorado River	Pipeline	60	0		6/9/1981	Main Elk & Exxon Mobil
48245.00000	Lower E Middle Fork Res	Para-chute Creek	Reservoir	0	6,200		2/2/1982	Exxon Oil Company
48486.00000	Sheep Trail H Term Res	Para-chute Creek	Reservoir	0	160		10/1/1982	Main Elk Corp/Mobil

COMPARING SELECTED OIL SHALE AND NON-OIL SHALE CONDITIONAL RIGHTS IN THE COLORADO BASIN *(cont'd)*

Administrative Number	Structure Name	Water Source	Structure Type	Cond'l Quantity (cfs)	Cond'l Quantity (af)	Quantity Absolute (cfs and af)	Appropriation Date	Appropriation Owner
48486.00000	Cotton-wood G Term Res	Cotton-wood G.	Reservoir	0	160		10/1/1982	Main Elk Corp/Mobil
48486.00000	Allenwater Cr Term Res	Colorado River	Reservoir	0	160		10/1/1982	Main Elk Corp/Mobil
48486.00000	Rulison Gulch Term Res	Para-chute Creek	Reservoir	0	160		10/1/1982	Main Elk Corp/Mobil
48486.00000	Mahaffey Terminal Res	Colorado River	Reservoir	0	160		10/1/1982	Main Elk Corp/Mobil
50019.00000	Fraser V Down-stream	Fraser River	Ditch	170	0	0	12/12/1986	Middle Park W Cons Dist
50019.00000	Fraser V Upstream	Fraser River	Ditch	170	0	0	12/12/1986	Middle Park W Cons Dist
50386.00000	Wolford Mt. Res	Muddy Creek	Reservoir		30,000	65,993 af	12/14/1987	Colorado Riv Cons Dist
50386.00000	Wolford Mt Reservoir	Muddy Creek	Reservoir	0	59,930	59,930 af	12/14/1987	Colorado Riv Cons Dist
52067.00000	Fraser R Div Project	St. Louis Creek	Ditch	48	0		7/21/1992	Denver Water Board

GLOSSARY OF WATER TERMS

absolute water right
A water right that has been put to beneficial use; see also "conditional water right."

acre-feet annually (afa)
The volume of water, measured in acre-feet, over the course of a year.

acre-foot (af)
The volume of water required to cover one acre to a depth of one foot; the equivalent of 325,851 gallons, which is enough to satisfy the annual water needs of approximately eight people.

adjudication
A judicial proceeding in which water rights are decreed priority dates based on their date of first use.

administration
The act of ensuring that, in times of water shortage, water rights are satisfied in order of their priority; through administration, senior water rights holders are satisfied before water is delivered to junior water rights holders. This activity is overseen by the state engineer and his subordinate division engineers.

appropriation
The application of water from a stream, tributary, or aquifer for beneficial use at a specified rate of flow; appropriations can be for out-of-stream use, in-stream use, or storage; usually evidenced by a water court decree.

aquifer
An underground deposit of sand, gravel, or rock through which water can pass or is stored. Aquifers can be "confined" (trapped by nonporous layers of rock) or "unconfined" (seepage to adjoining layers is possible) and are often the source of water for wells and springs.

beneficial use
The application and use of an amount of water that is reasonable and appropriate (e.g., without waste) for human or natural benefit. Colorado's policy is to maximize beneficial use of all of the state's waters.

build-out
The estimated extent of residential, commercial, and industrial development in a given geographic area; usually related to upper limit of population to be served by water resource development.

call
In times of water shortage or scarcity, the exercise of senior water rights that forces curtailment of junior water rights.

Colorado River Compact
A contract between Upper Basin States (New Mexico, Colorado, Wyoming, and Utah) and Lower Basin States (Arizona, Nevada, and California) that apportions water from the Colorado River. The Upper Basin Compact is a contract that apportions Colorado River water among the Upper Basin States.

compact
A contract between states, tribes, or other governmental entities that apportions water from a river system crossing jurisdictional boundaries.

conditional water right
The legal preservation of a priority date that provides a water user time to develop his or her water right, but reserves a more senior date (the date upon which the holder first manifested an intent to appropriate). A conditional right becomes absolute when water is actually put to a beneficial use.

conjunctive use
The combined use of surface water and groundwater to achieve the optimal beneficial use; often used in areas where available water resources have been nearly fully developed and/or appropriated. Conjunctive use involves carefully coordinating the storage, timing, and delivery of both resources. Typically, surface water is used to the fullest extent possible when flows are available, while groundwater is retained to meet demands when surface flows are low. Benefits of conjunctive use may include better management capabilities with less waste; greater flood control capabilities; greater control over surface reservoir releases; and more efficient operation of pump plants and other facilities.

cubic feet per second (cfs)
A measurement of volume of water passing by a fixed point each second. One cfs is equal to 7.48 gallons per second, 448.8 gallons per minute, and 646,300 gallons per day (equal to 1.98 acre-feet per day).

decree
An official document issued by a water court that defines the amount, priority, use, and location of a water right. The document serves as a mandate to the state engineer to administer the water rights involved in accordance with the decree.

depletion
The amount of water lost to the river system by the exercise of a water right. Diversion of a particular water right is often many times greater than its depletion because much of the water diverted later returns to the river, either through surface run-off or underground seepage.

depletion allowance
In the Gunnison Basin, the additional amount of water that the Upper Gunnison River Water Conservancy District is entitled to deplete without being "called out" by the Aspinall Unit's 1957 water right.

diligence
See "due diligence."

ditch
A trench cut into the surface of the ground to transport water from a stream, canal, or storage facility to an actual point of use.

diversion
Removal of water from its natural course or location; or controlling water in its natural course or location by means of a ditch, canal, flume, reservoir, bypass, pipeline, conduit, well, pump, or other device.

division engineers
Subordinate officers under the state engineer; division engineers perform the functions of the state engineer — administering water rights — in each of Colorado's seven water divisions. The Gunnison watershed is in Division 4.

due diligence
The requirement for holders of conditional water rights to demonstrate to the water court that they are making good faith efforts toward constructing the facilities (e.g., ditch, reservoir) to apply the water right within a reasonable time. In Colorado, conditional water right holders must show due diligence to the water court every six years.

effluent
Liquid attributed to human waste (sewage), arising from various uses of water. Also often refers to water discharged after use, such as water leaving a wastewater treatment plant or industrial plant.

exchange
A process by which water rights in one part of a river (or other water supply) system are traded for the use of water rights in another part of the river system.

firm annual yield
The yearly amount of water that can be dependably supplied from the raw water sources of a water supply system.

fish ladder
An inclined water channel structure with a series of baffles or weirs that helps fish gain upstream passage around dams. These baffles interrupt and slow the flow of water, simulating pools and rapids. Fish swim up the ladder just as they would swim up natural rapids.

groundwater
Water found below the earth's surface.

headgate
A human-made structure on a stream, canal, or other water channel through which water is diverted into a ditch or canal.

instream flows
Water left in its natural stream channel to maintain the existing aquatic resources and associated wildlife and riparian habitat. In contrast to out-of-stream uses, this kind of water use does not require diversion.

junior rights
Water rights that were obtained more recently and therefore are junior in priority to older or more senior rights.

Lower Colorado River Basin
The Colorado River and its tributaries in Arizona, Nevada, and California. See also "Colorado River Compact."

perfection
The process of meeting all of the legal requirements for establishing a legal right to the use of water. Once perfected, a conditional water right becomes an absolute water right.

prior appropriation
Also called "first in time, first in right," a method (used in many western states) of allocating water between competing users. In times of water scarcity, senior water rights are satisfied ahead of junior water rights. A senior water user who wants to divert water from a surface or underground source of water may force the curtailment of upstream junior use. See also definitions for "call," "priority," and "priority date."

priority
The seniority of a water right as determined by its adjudication date and/or its appropriation date. The priority of a water right determines its ability to divert in relation to other rights in periods of limited supply, i.e., junior water rights defer to more senior water rights.

priority date
The date of establishment of a water right. A nontechnical term, a "priority date" can be the date of appropriation (when water is first put to use), the date of adjudication (when the court issues a water right decree), or the date when a user first intended to appropriate water (in the case of a conditional decree).

re-operation
An investigation of the additional water supply or water timing benefits that could result from the revised and more efficient usage of large water storage facilities, with an eye toward improv-

ing water supply reliability, environmental benefits, or both.

re-regulation
In a multi-dam system, regulating the dramatic peak flows generated by upstream dams through the measured release of water from the dam farthest downstream.

river basin
A physiographic region bounded by a drainage divide; consists of a drainage system comprised of stream and often natural or man-made lakes. See also "watershed."

second fill
A legal allowance for a reservoir or other storage right to be refilled.

senior rights
Water rights with a relatively early priority date. See also "priority date."

storage right
A water right defined in terms of the volume of water that may be stored in a reservoir or lake to be released and used at a later time, either within the same year or during a subsequent year.

subordinate
A process through which a senior water rights holder allows junior water rights holder(s) to be satisfied out of priority.

subordination agreement
A legal document by which a senior water rights holder agrees to subordinate his water use to a junior rights holder. See aslo "subordinate."

transmountain diversion
The conveyance of water from one drainage basin to another. In Colorado, the term often refers to water being transported over or through the Continental Divide. Sometimes called "transbasin diversion."

tributary
A stream that flows into another stream or body of water.

unappropriated water
Water in a river system for which no water rights have been claimed.

Upper Colorado River Basin
The Colorado River and its tributaries in New Mexico, Colorado, Wyoming, and Utah. See also "Colorado River Compact."

water court
A state district court that hears matters related to water. To obtain a judicially recognized water right, change in water right, or augmentation plan, persons or entities file applications with a water court to be issued a decree or order. There are seven water courts in the state, one for each water division, corresponding to each major drainage basin.

water right
A right to use, in accordance with its priority, a certain portion of the waters of the state for irrigation, power, domestic use, or another similar use. See also "absolute water right," "conditional water right," "appropriation," and "priority."

watershed
An area from which water drains to a single stream or river or river system or other body of water. See also "river basin."

END NOTES

[1] Bill Ritter, Jr., governor of Colorado, testimony before the Senate Committee on Energy and Natural Resources, Oversight Hearing: Oil Shale Resources, May 15, 2008.

[2] The Front Range Water Users Council members are the largest suppliers of municipal, commercial, industrial, and agricultural needs in the state of Colorado. Approximately one-half of the state's population receives water from council members.

[3] Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee, *Energy Development Water Needs Assessment (Phase 1 Report)*, September 2008.

[4] *Id.*, p. 6-1.

[5] U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Programmatic Environmental Impact Statement (PEIS)*, pp. 4-144 to 4-145.

[6] Associated Governments Northwest Colorado, *Northwest Colorado Socioeconomic Analysis and Forecasts, Final Report*, April 4, 2008, p. 10.

[7] Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee, *Energy Development Water Needs Assessment (Phase 1 Report)*, September 2008, p. 4-7.

[8] Jim Pokrandt, Colorado River Water Conservation District, Aspen Public Radio, broadcast September 18, 2008.

[9] U.S. Department of Energy, Office of Petroleum Reserves – Strategic Unconventional Fuels, *Fact Sheet: Carbon Management for Strategic Unconventional Resources*, available at www.unconventionalfuels.org/publications/factsheets/Carbon_Management_Fact.pdf, accessed December 4, 2008.

[10] Intergovernmental Panel on Climate Change, "Summary for Policymakers," in *Climate Change 2007: Fourth Assessment Report*, Synthesis Report, available at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf, pp. 2 and 5.

[11] These ensemble runs were produced by 19 global circulation models.

[12] Western Water Assessment, *Colorado Climate Change: A Synthesis to Support Water Resource Management and Adaptation*, report done for the Colorado Water Conservation Board, 2008, p. 1.

[13] *Ibid.*

[14] Richard Seager, Mingfang Ting, Isaac Held, Yochanan Kushnir, Jian Lu, Gabriel Vecchi, Huei-Ping Huang, Nili Harnik, Ants Leetmaa, Ngar-Cheung Lau, Cuihua Li, Jennifer Velez, Naomi Naik, Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America, *Science* 25 May 2007: Vol. 316. no. 5828.

[15] From 1932 to 1939, the annual difference between evaporation and precipitation was 1.29 inches higher than average; during the 1950s Southwest drought (1948-1957), it was 1.87 inches higher than average.

[16] The University Corporation for Atmospheric Research, *Synthesis and Assessment Product 4.3 (SAP 4.3): The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*, May 2008, available at http://www.sap43.ucar.edu/, accessed December 8, 2008.

[17] Intergovernmental Panel on Climate Change, "Summary for Policymakers," in *Climate*

Change 2007: Fourth Assessment Report, Synthesis Report, available at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

[18] Bill Ritter, Jr., governor of Colorado, testimony before the Senate Committee on Energy and Natural Resources, Oversight Hearing: Oil Shale Resources, May 15, 2008.

[19] In-situ retorting involves heating the oil shale while it is still underground, and then pumping the resulting liquid to the surface.

[20] The shale is first mined and then heated to a high temperature.

[21] The Front Range Water Users Council members are the largest suppliers of municipal, commercial, industrial, and agricultural needs in the state of Colorado. Approximately one-half of the state's population receives water from council members.

[22] U.S. Department of the Interior, Bureau of Land Management, "Oil Shale Management — General; Final Rules," *Federal Register* 73, no. 223, November 18, 2008, p. 69450.

[23] Bill Ritter, Jr., governor of Colorado, testimony before the Senate Committee on Energy and Natural Resources, Oversight Hearing: Oil Shale Resources, May 15, 2008.

[24] Although there is no one measure of energy quality, *energy return on investment* (EROI) is a commonly used calculation of how much energy is needed to locate, extract, and refine an output of energy. An EROI of 1 would be breaking even. Reported oil shale EROIs are in the range of 1.5:1 to 4:1, with a few extreme values between 7:1 and 13:1. See, for example, Cutler Cleveland and C. Hall, Presented at ASPO -US conference Denver November 10, 2005, available at http://globalpublicmedia.com/events/564. See also "Unconventional Oil: Tar Sands and Shale Oil - EROI on the Web, Part 3 of 6," available on the The Oil Drum Web site at http://www.theoildrum.com/node/3839.

[25] Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee, *Energy Development Water Needs Assessment (Phase 1 Report)*, September 2008, p. 5-9.

[26] U.S. Department of the Interior, Bureau of Land Management, "Oil Shale Management — General; Final Rules," *Federal Register* 73, no. 223, November 18, 2008, p. 69423.

[27] *Id.* p. 69449.

[28] James T. Bartis, et al., *Oil Shale Development in the United States: Prospects and Policy Issues*, RAND, 2005, p. 6.

[29] U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Programmatic Environmental Impact Statement (PEIS)*, p. 4-3.

[30] *Id.* at p. 4-3.

[31] J.A. Veil and M.G. Puder, *Potential Ground Water and Surface Water Impacts from Oil Shale and Tar Sands Energy-Production Operations*, Argonne National Laboratory, October 2006, p. 13.

[32] U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Programmatic Environmental Impact Statement (PEIS)*, p. 4-34.

[33] URS, Inc., *Energy Development Water Needs Assessment, Final Draft*, September 2008, p. 3-36.

[34] *Id.*, p. 4-7 and Table 4-6.

[35] *Id.*, p, 6-1 and Table 6-1.

[36] U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Programmatic Environmental Impact Statement (PEIS)*, Table 4.5.2-1, notes d & e, p. 4-44.

[37] Information regarding water rights in Colorado is available on the state's Decision Support System Web site, available at http://cdss.state.co.us/DNN/default.aspx. The research for this part of the report relied heavily on the information available in this source and was supplemented with a review of decrees obtained from the Division of Water Resources.

[38] Litigation in the 1990s challenged whether the diligence requirement for conditional water rights owned by three companies and intended for use in oil shale development had been met.

The Colorado Supreme Court found that the diligence standard had been satisfied in all cases despite the passage of as much as 45 years since the rights had been established. *Northern Colorado Water Conservancy Dist. v. Oxy USA, Inc.*, 990 P.2d 701 (Colo. 1999). See also *Municipal Subdistrict, Northern Colorado Water Conservancy Dist. v. Chevron Shale Oil Corp.*, 986 P.2d 918 (Colo. 1999); *Northern Colorado Water Conservancy Dist. v. Getty Oil Exploration Co.*, 997 P.2d 557 (Colo. 2000).

[39] Conditional and absolute decrees in the Yampa River Basin were also examined. While there are some large conditional storage decrees that include industrial uses, it does not appear these structures are expected to directly serve oil shale production. No decrees in the Yampa River Basin owned by the companies historically interested in oil shale production were found.

[40] Windy Gap Reservoir provides water to the Platte River Power Authority and to 13 water providers along Colorado's Front Range. The project diverts water on the Colorado River near the confluence with the Fraser River. However, because the rights are relatively junior to senior downstream rights, water availability is unreliable, so plans are in place to construct a new reservoir to allow for increased storage in wet years. Water rights associated with this "firming" project would have 1960s and 1970s priority rights.

[41] U.S. Department of the Interior, *Hydrologic Determination 1988: Water Availability from Navajo Reservoir and the Upper Colorado River Basin for Use in New Mexico*, April 1988; and *Hydrologic Determination 2007: Water Availability from Navajo Reservoir and the Upper Colorado River Basin for Use in New Mexico*, April 2007.

[42] Eric Kuhn, *The Colorado River: The Story of a Quest for Certainty on a Diminishing River* (Roundtable Edition), Colorado River Water Conservation District, May 8, 2007.

[43] Western Water Assessment, *Colorado Climate Change: A Synthesis to Support Water Resource Management and Adaptation*, report done for the Colorado Water Conservation Board, 2008.

[44] In addition, there is a proposal from a private developer to transport basin water from Flaming Gorge Reservoir on the Green River to the Front Range as well as a proposal by the Northern Colorado Water Conservancy District to bring water from the Yampa River to the Front Range.

[45] U.S. Fish and Wildlife Service, *Final Programmatic Biological Opinion for Bureau of Reclamation's Operations and Depletions, Other Depletions, and Funding and Implementation of Recovery Program Actions In the Upper Colorado River Above the Gunnison River*, Denver, Colorado, December 1999.

[46] A significant population decline could even prompt reinitiation of the PBO. Specifically, "a negative population response would trigger reinitiation if the population declined to 350 adults." *Id.* 71.

[47] One should not assume the "second increment" development will take place. The fish are not recovering according to plan, so additional depletions may be limited. In that case, the first increment will be the ceiling vis-à-vis depletions above the 15-Mile Reach.

[48] In 1979, Occidental Oil Shale, Inc. hired water engineers to develop a plan for water development in the White River Basin. See Clifford E. Jex Engineers and Tipton and Kalmbach, Inc., *Plan for the Water Supply for Development of Oil Shale Industry in White River Basin, Colorado*, November 1979. This report discussed the value of utilizing different existing conditional water rights best suited, in their view, for such development.

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