Water Under Pressure: What Oil Shale Could Mean for Western Water, Fish and Wildlife
A report for Sportsmen for Responsible Energy Development
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Introduction

For more than a century, efforts to wring oil out of rock formations in the Rocky Mountain West have waxed and waned. The deposits underlying northwestern Colorado, southwestern Wyoming and northeastern Utah have been portrayed as ``the Saudi Arabia'' of oil shale, a vast source of domestic energy that would cut U.S. dependence on foreign oil, create many jobs and produce millions of dollars of revenue for state and local governments.

That same area, the 16,000-square-mile Green River Formation, is home to some of the nation's most valuable fish and wildlife habitat. Colorado's Piceance Basin boasts North America's largest migratory mule deer herd and some of the country's largest elk herds. The huge tracts of public land also support greater sage-grouse, Colorado River cutthroat trout, black bear, bald eagles and mountain lions. Hunting, fishing, other wildlife-based activities and outdoor recreation are cornerstones of the regional economy and integral to the area's lifestyle, heritage and identity.

Coursing through the wildlife habitat, ranches, fruit orchards and communities is the water that allows the people, the wildlife and the commerce all to thrive in the semi-arid climate. The rivers, fed by mountain snow and beloved by anglers, include the Green, the White, Uintah, Lake Fork, Strawberry and Duchesne. They include Utah's top two fishing destinations, the renowned Green River gorge and Strawberry Reservoir, as well as hundreds of miles of headwaters trout and larger reaches with fat rainbows and browns.

This report explores how large-scale commercial oil shale development in Utah, Wyoming and Colorado could affect the region's water supply and quality and what that might mean for fish, wildlife and communities. After more than 100 years of trying, we are still several years away from an economically viable oil shale industry. The technology is unproven and the potential environmental impacts are unknown. Even conservative estimates indicate the volume of water needed to transform kerogen – a precursor to oil – into a usable fuel could be huge. For a resource that lies in the midst of the semi-arid West, with sparse precipitation and few large rivers, it is not clear where the water would come from, or how it would affect the fish that live in the local streams. With the region already straining its water supply and facing continued population growth, finding another increment of water for oil shale, while protecting native and sport fisheries, may be an insurmountable challenge.

The U.S. Bureau of Land Management (BLM) is currently proposing a cautious approach to oil shale development. The BLM has proposed keeping development off sensitive wildlife habitat, limiting new public leases to research and demonstration projects and moving ahead with commercial leases only after the pilot projects produce results. This approach is a prudent way to test oil shale potential and limit the risk to the regions water supplies..

What is Oil Shale?

Oil shale is a type of rock that contains the substance kerogen. Kerogen is not oil. Were it left in the ground for millions of years, the natural pressure and heat from the earth would slowly convert it to oil. By applying heat artificially, it is possible to short-cut this long, geologic time-line, and effectively "cook" the kerogen to release oil.

Of the worlds know oil shale reserves, 70% are located in the Green River Formation which lies under northwest Colorado, northeast Utah and southwest Wyoming, in three broad deposits. Colorado's Piceance Basin has 80% of the total. Seventy three percent of the surface lands overlying the oil shale are under federal control.

Settlers first discovered oil shale in the 19^{th} century. Multiple attempts to develop oil shale followed in the 20^{th} Century, mostly led by branches of the military provideing funding to private oil corporations. Congress set aside some of the federal lands rich in oil shale as a naval fuel reserve in 1910. During World War II, Congress passed the Synthetic Liquid Fuels Act of 1944, and followed that with the Defense Production Act of 1950. Under these laws the U.S. Bureau of Mines experimented with three surface facilities in Colorado and Utah. The Department of Energy had a "synfuels" program in the 1970's and early 1980's. When the last facility funded under this effort closed in 1982, over 2000 workers lost their jobs on a single day and it seemed the technologic and financial challenges were too much to overcome for the country to develop an oil shale industry.

Twenty three years later, Congress ushered in another round of interest in the West's oil shale with passage of the 2005 Energy Act. The Act directed the federal Bureau of Land Management, which controls most of the land in the Green River Formation vicinity, to look at what it might take to develop an oil shale industry, as well as what the impacts might be. In 2006, BLM leased six areas to different companies for research and development. In 2008, the agency released its initial environmental analysis, suggesting that it could move forward with a program to lease 1.1 million acres of federal lands for oil shale development. However, after additional consideration of this and other options, in 2012, BLM sent out for public comment an updated strategy of leasing 462,000 acres for research, with potential subsequent leases for commercial development.

For sportsmen, the big question related to oil shale development is whether oil shale can be developed in an economically and environmentally prudent way? There are magnificent big game herds that crisscross the region during their seasonal migrations, including the largest mule deer herd in the country. There are the already at-risk sage grouse and, the oil shale region lies in the middle of the semi-arid west, where rivers are relatively small and precipitation is light. Building a commercial oil shale industry in this environment will require large quantities of water – and that water may not be readily available without affecting river flows that are essential for the survival of native and sport fish.

The Rivers of the Oil Shale Region

The rivers flowing through the oil shale region start in the mountains, fed primarily with spring snowmelt. As a result, flows during spring runoff can be an order of magnitude larger than during the nine-month low flow season over the rest of the year. Precipitation in the region is sparse. Utah is the second driest state in the nation. Average annual precipitation in Vernal, the largest city in northeast Utah (population 9000), is less than 9 inches, by most accounts, a desert, since it receives less than 10 inches annually. Meeker, the largest town in northwest Colorado (population 2500), on the eastern edge of the Piceance Basin, receives almost double that amount, at 16.5 inches per year, still far less than the national average of over 29 inches.

Headwater reaches are cold, home both to native cutthroat trout, and wild rainbow, brown and brook trout fisheries. As they flow out of the mountains onto wider, lower valleys, their waters warm and the natural landscape changes to scrub. In these reaches, there are again native fish, including endangered species. While remote, the valleys are traditional ranch country, although today they are also significant recreation destinations – for white water rafting, for prime trout fishing, and for hunting, hiking and more. Within the last decade, traditional oil and gas drilling has boomed, so the landscape is dotted with rigs.

The region's largest river is the Green, with headwaters in Wyoming. Seasonal flows in the Green provide an excellent example of rivers' seasonal variability in the region. During runoff, monthly flows averaged 11,300 cubic feet per second (cfs), while the lowest monthly flow, in August, has averaged 1900 cfs. The daily average, at Green River, Utah is 6121 cfs. The larger of the two proposed Wyoming oil shale leasing areas spans the 65 mile flowing reach of the Green downstream of Fontenelle Reservoir as well as the upper two thirds of Flaming Gorge Reservoir.

The Green flows primarily south from Wyoming into Utah, with Flaming Gorge, the region's largest reservoir, straddling the border between the states. Below Flaming Gorge Dam, the Green turns east, flowing through a remote but renowned stretch of spectacular river gorge from Dutch John right below the dam to Brown's Park on the Colorado border. Knowledgeable anglers claim that this thirty mile reach of blue ribbon trout fishery is the best tail water fishing in the West. Between Flaming Gorge flat water recreation and the fishing and rafting below the dam, Trout Unlimited has estimated that Green River recreation is worth $118M annually to Uintah & Daggett (UT) and Sweetwater (WY) counties. As the Green arcs through Colorado, it bisects Dinosaur National Monument and starts to lose elevation; the cold water fishery gives way to more white-water rafts than one can count on a summer's day. Back in Utah, the river soon turns back south and cuts through the high desert until it meets the Colorado River mainstem in Canyonlands National Park. The Green pours between 3 and 6 million acre feet of water (MAF) into the Colorado at this confluence, depending on how wet the year is. An acre foot (AF) of water is 326,000 gallons, enough to cover a football field a foot deep. Water users on the Green consume 1.3 MAF of water on average per year.

Joining the Green from the east is the White River. The Utah oil shale leasing area extends from the Utah-Colorado border on the east across the Tavaputz Plateau, including lands on both sides of the White, to the confluence of the White and Green, and also extends up a 30+ mile reach of the Green. In contrast to the Green, the White River is smaller. Upstream of Rangley, CO (population 2300), about 12 miles east of the Utah border, the river's high season runoff fluctuates between 4572 and 717 cfs, with the lowest flows in January between 260 and 572 cfs. (One cfs of flows for a day equals 2 acre-feet of water.) The White River forms the northern border of Colorado's oil-shale rich

Piceance Basin and runs west through Utah's Uintah Basin, beginning in the Flattops Wilderness near the Continental Divide in Colorado and meeting the Green south of Vernal. While much of the river crosses private lands, once out of the wilderness area, the reach in and around Meeker is known for big – 20 inch plus –rainbows and cuttbows. In Utah, the river bisects the Uintah and Ouray Indian Reservation.

Colorado's Piceance Basin is bounded on the South by the main stem of the Colorado River. Due to the more mountainous geography to the south, most experts believe that the primary source of water for oil shale development in Colorado will come from the White River.

From the west, the Uintah, Lake Fork, Strawberry and Duchesne rivers flow out of Utah's Uintah Mountains. The first three are tributary to the Duchesne, which meets the Green just north of its confluence with the White. Each sports native cutthroat trout and wild brookies in their high alpine meadows and upper reach canyons. Strawberry Reservoir, Utah's most popular trout fishing destination, lies at the headwaters of the Strawberry River. Both the Uintah and the Duchesne support recreational boating as well.

While the rivers of oil shale country are predominantly healthy, and give anglers many reasons to visit, even now, in some reaches, during some seasons, they show signs of stress, most of which relate back to low stream flows caused by water diversions. Unnaturally low flows can adversely affect fish by increasing temperatures above what cold-water trout need to survive and thrive, as well as by decreasing the dissolved oxygen in the water below levels necessary for fish to survive. Low flows at the wrong time of the year can, effectively, remove spawning sites or rearing habitat for young-of-the-year. All of these adverse effects translate into low growth and stressed populations.

For example, the State of Utah already lists 368 miles of rivers and streams in these drainages as impaired due to low flows, high temperature, high levels of dissolved solids (salts) and selenium, a common pollutant flushed from the soils with agricultural run-off. Among these reaches are several on the main stem Duchesne River. In total, 164 miles of trout stream in the region do not meet water quality standards.

In the most recent analysis that the Bureau of Land Management prepared to consider leasing for potential oil shale development, the agency counted 753 miles of stream habitat in the oil shale region. In its earlier assessment of alternatives, BLM proposed leasing lands that included 674 of those miles, while the agency's current preferred alternative would lease lands that include 386 miles of stream.

The Oil Shale Region's Water Users Today

How water is allocated among states and users – state law

In the West, where quantities of water are limited, each state allocates water based on its unique version of the "doctrine of prior appropriation." The basic tenets of the doctrine – notably "first in time is first in right" and "use it or lose it" – are common. The first to divert water from a stream has the most senior right, which is satisfied before the next diverter gets any. In addition, because the measure of a water right is its use, if a diverter stops using some of all of the water appropriated, the courts or agencies in charge of administering the system will declare the unused portion of the water abandoned. Because it can take years to perfect a water right – i.e., go from the idea of using the water to actually being able to use it, most states allow water users to get a seniority date based on when they make their idea public; they then periodically show the court or agency administrator how they are making progress towards putting the water to use. In Colorado, these are called "conditional" water rights.

The right to use water is a transferable property right. Water rights holders can change their place of use, for example, moving water from one field to another. They can also change their type of use, e.g., from farm to city. Changes will not be approved, however, if they harm other water rights holders on the stream.

Changes are also limited to the quantity of water actually consumed, rather than the amount diverted. Imagine a farmer with a 10 cfs water right. The crop that receives this water use 6 cfs to grow; the additional 4 cfs is only necessary to push the water down the ditch from the stream to the field. When the farmer applies the water to the land, this 4 cfs seeps back into the soil, eventually flowing back to the stream underground. This portion of the water diverted is called "return flow." Because the irrigator did not use the return flow to grow the crop, the 4 cfs cannot be transferred.

In the White River basin in Colorado, yearly average water use is 46,700 acre-feet, 88% in agriculture. Oil shale companies have over 1 MAF of conditional water storage rights for oil shale development, and over 10,000 cfs per day of direct flow water rights, with seniority dates from the 1950's and 1960's. Some of these would be new water diversions; some would be transfers from existing agricultural use. Regardless, for a river that discharges 800,000 AF to the Green River at their confluence in a wet year, there is not 1 MAF available to divert, without drying up the river and all its tributaries. While these quantities of water exceed projected oil shale development water demands under even high-end water use scenarios, it is none-the-less instructive to see how much the industry believes it should have in its portfolio. The vast quantity of water in the queue is all the more striking because most analysts predict that virtually all of the water diverted for oil shale development –except that needed for work force domestic uses – would be fully consumed.

The Colorado River Compact: a state-federal water allocation partnership

In addition to state laws regarding water allocation, the Colorado River Basin, which is the main stem Colorado River with all of its tributaries, including all of the rivers named in this report, is the subject of a federal-state Compact. The Compact allocates these waters among the states. In 1922, the states and Department of the Interior negotiated a deal dividing the basin waters between the Upper (Colorado, New Mexico, Utah and Wyoming) and Lower (Arizona, California and Nevada) Basin states. Based on the data available then, water experts thought the river basin's annual yield was at least 17.5 MAF. Over 1 MAF is lost to evaporation every year off the big reservoirs in the Basin and the United States has a treaty with Mexico to deliver 1.5 MAF to that country every year.

Over the last 90 years, scientists have learned that the average annual yield of the Colorado River Basin may be less than 14 MAF. The Lower Basin states and Mexico use their full entitlement under the Compact. However, the Upper Basin's annual consumptive use averages 4.3 MAF, substantially less than the 7.5 MAF the Upper Basin believes is its Compact share.

Who uses how much

In most of the West, irrigated agriculture uses the majority of water diverted from rivers and streams (as well as from ground water) – from 80 to more than 90% depending on the State. These irrigators usually own the senior rights on a river. Looking at Colorado River Basin usage, in Utah, irrigation accounted for 80% of average annual use, with energy accounting for 4% and cities 16%.

In Wyoming, 85% of Colorado River basin water went to irrigated agriculture, with 5% going to cities and 9.4% to energy. Over one-quarter of the State of Colorado's Colorado River Basin consumptive use is diverted out of the basin (east of the Continental Divide) for both irrigation and municipal use. Of the fraction that is used within the basin in Colorado, agriculture accounts for 96% of consumption.

How much is left for future development

The BLM's recent analysis of the environmental impacts of developing a commercial oil shale industry in the Green River Formation, used Bureau of Reclamation data to conclude that Colorado, Utah and Wyoming together have routine legal and physical access to 5.3 MAF of water per year, less than their 7.5 MAF share, but 1 MAF more than their average current use. This quantity of water must supply the needs of the region in the future, including population growth, new industry, including the expansion of oil and gas drilling that is happening around the region, and increased agricultural demand if the climate warms, which would lengthen growing periods and evaporation. At the same time, those who live in the region and visit do not want new users to obtain their supplies in a way that harms the region's current population, fisheries or wildlife resources.

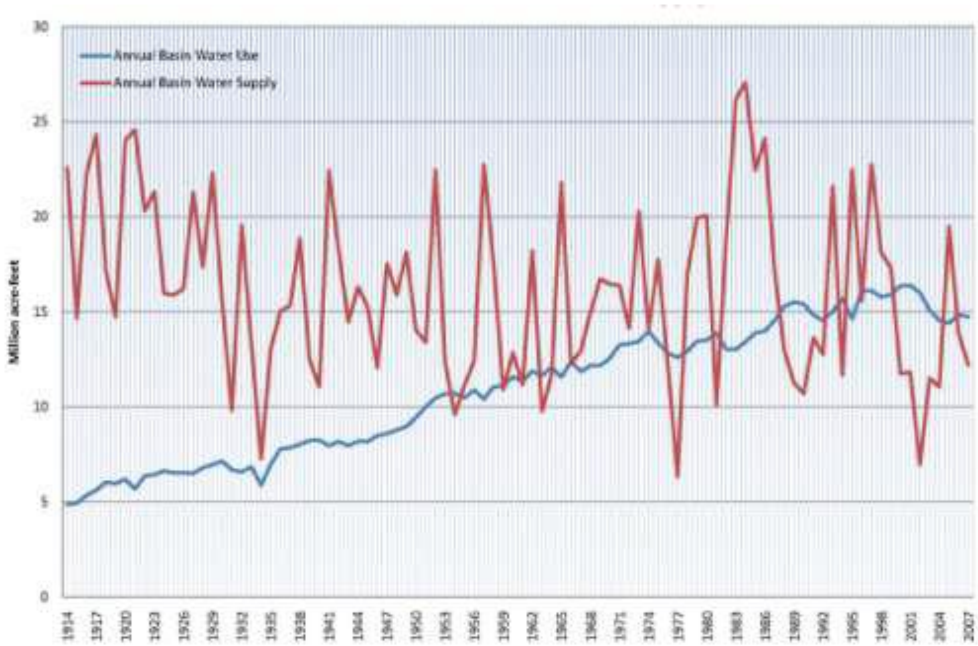
Were oil shale development to occur and need water, it would, at least, increase competition among new water users. It would also almost certainly require taking water from present uses and converting it to new demands. There are, basically, two choices for such a large new water user: buy water off of farms and ranches, or appropriate new water rights, taking water from the rivers. In the oil shale region, either option could adversely affect fisheries. Because a large fraction (depending on the crop between 10 and 40 percent) of the water diverted for farms and ranches ultimately returns back to the stream weeks or months later, irrigation operations sometimes maintain or even increase stream flows in the late summer and early fall. As a result, removing this water from agriculture and putting it to use, instead, to benefit a year-round industrial development that will contaminate the water such that most of it, if not all, would never return to the stream, is a high risk proposition for the fisheries that depend on existing healthy flows to survive. The second option, diverting additional water from streams, also – directly– results in lower flows that are likely to reduce at least the quality, and likely the quantity as well, of fish habitat.

Water Quality

Today, the streams and rivers that cross the lands where oil shale development could occur have mostly good quality water. Where there is degradation, it typically occurs in association with mining, road building and irrigation runoff, or as a result of the adverse physical effects of de-watering streams. The development of oil shale is an intensive process requiring the construction of roads, transmission lines and significant land disturbances. The risk of water quality degradation from this intensive development is high and will require significant oversight. A river subject to significant diversions may have water that becomes too warm or too silty to sustain healthy fisheries. In addition, oil shale extraction can contaminate the water used with both toxic organic carbons like benzene and diesel fuel and heavy metals like selenium and cadmium, which are often found in the same rock formations that contain the kerogen.

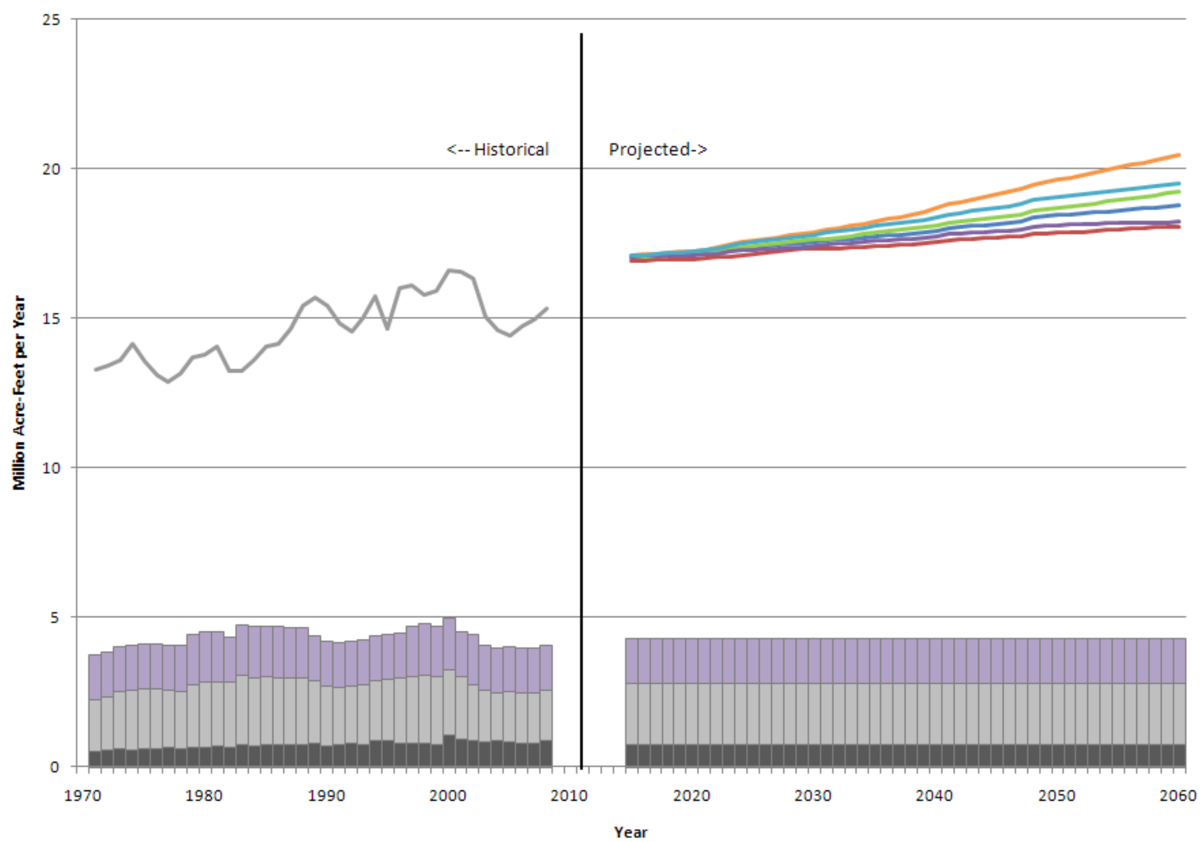
Future Water Supply & Demand Scenarios

All Colorado River Basin water users together already use more water in an annual average year than the river produces.



Predictions for the future show the imbalances between supplies and demands getting worse, as the region's population grows. The Bureau of Reclamation has developed six scenarios to model possible future imbalances. By 2060 even the future demand scenario with the smallest increase shows demands almost 3 MAF more than current. The different future demand scenarios include different assumptions about future water demands for oil shale, ranging from 0 to120,000 AF. This latter amount, however, is far less than what a number of the studies described later in this report estimate as the water needs for full-scale oil shale development – as much as 400,000 AF of water. Factoring this additional demand into Reclamations' scenarios could increase the largest projected imbalance by 9%.

The chart below comes from the Bureau of Reclamation. The gray line on the left side of the graph shows historical water use. The colored lines to the right show Reclamation's six scenarios for future demands. One can see that future demands are projected to start above historical demands and go up from there. By 2060, Reclamation is projecting that even in the lowest demand scenario (red line) will exceed 17.5 MAF, while the highest exceeds 20 MAF, a quantity the river has rarely produced in a wet year. The purple and gray bars at the bottom of the graph slow historical and projected quantities of water the U.S. must deliver to Mexico by treaty and that is lost, either to evaporation from the big reservoirs likes Lakes Powell and Mean, or elsewhere in the system. These three categories constitute the basin water not consumed by U.S. water users.



Quantified demand scenarios have been adjusted to include Mexico's allotment and estimates for future reservoir evaporation and other losses.

Higher demands coupled with lower supplies in the future will not only lower stream flows. The results will also likely adversely affect water quality, increasing sediment, salinity and temperatures, even with no increased discharges of pollutants. Reducing flows or increasing pollutant loads during the nine-month low flow period could render streams unable to support native or introduced fisheries. The critical information will be when and where lower flows occur. Modest decreases during seasonal high flows might have less dramatic impacts, although periodic high flows are necessary to flush sediment, clean cobble on river bottoms and get rid of invasive plant species. Maintaining non-runoff season base flows and providing at least limited periodic flushing flows can successfully mitigate the stream impacts of water diversions and impoundments, while sustaining resident fisheries. A recent example balanced protection of the trout fishery in the Black Canyon of the Gunnison National Park, the endangered native fish downstream and upstream reservoir operations that benefit irrigators and provide hydropower and flood control

The Many Unknowns related to the development of Oil Shale

One aspect of the conversation around oil shale development in the Western US is the enormous uncertainty. Other than the geography and the quantities of kerogen, little else is known.

Technologies to Develop Oil Shale

There are two primary technologies to extract oil from shale: surface mining and retort, and in-situ recovery. The surface mining path itself starts with a choice in the method to bring the kerogen to the surface for processing: strip mining and underground room and pillar mining. Strip mining would be the choice for kerogen seams closest to the surface (less than 250 feet deep), with underground room and pillar mining viable for those deposits less than 1000 feet below ground. According to the Bureau of Land Management's most recent draft assessment, based on current information, approximately one quarter of the Green River oil shale resource would be accessible by these methods. At the surface, the next step is to heat the mined kerogen in a "retort" facility to extract the oil. Previous efforts to extract oil shale have all involved surface retort, as does the current oil shale development in Estonia.

In-situ mining would be the technology of choice for the majority of Green River Formation oil shale, which is 1000s of feet below ground. With this technology, the heat necessary to release the oil is pumped underground to where the kerogen is, and then the oil extracted is pumped back to the surface. In some versions of in-situ extraction, the developer not only puts a heat curtain in place around the kerogen to cook it, but a refrigerated wall around the heat curtain, to keep the heat pointed at the kerogen, rather than warming up adjacent rock.

Both the surface and in-situ processes leave substantial pollutants from retort in the environment. The processes for reclaiming the mine and surface disturbances, stabilizing and/or disposing of the waste rock, and cleansing the underground, in situ retort zone, will also potentially require technologies that are as yet unproven, and significant water resources.

The industry must also determine where to "upgrade" the oil extracted from the kerogen into a more widely useable product: locally in the Green River Basin, or closer to end users elsewhere. The answer will affect the water budget for oil shale development, since upgrading requires water. Similarly, as noted above, while turning the kerogen into oil requires a lot of energy, the energy source to accomplish this process has significant implications for the amount of water necessary for that purpose. Thermo-electric power plants cooled with water obviously require more water than plants that are air-cooled. But it is also true that natural gas fired plants use less water than coal fired plants.

Given the relatively remote location of the Green River Formation, the industry will need to transport the oil to market, presumably via pipeline; this transport will almost certainly require additional energy and may also require additional water. Throughout, there is a work force to house, adding another set of water demands.

How much water would oil shale development use?

The Government Accounting Office (GAO), a research service for Congress, recently examined the potential water demands for an oil shale industry. The GAO broke down development into five sets of water demands. The unit of measurement for oil is conventionally in barrels, so descriptions of the quantity of water needed to produce a barrel of oil is also expressed in barrels. A barrel is 42 gallons. Across the twelve studies the GAO examined, they found a range of 1 - 12 barrels of water per barrel of oil:

	Surface Retort bbl water / bbl oil		**In Situ** bbl water / bbl oil	
	Range	Average	Range	Average

Extracting, retorting	0.9 – 1.9	1.5	0 – 1.0	0.7
Upgrading liquids	Combined with above		0.6 – 1.6	0.9
Power generation	0 – 0.9	0.3	0.1 – 3.4	1.5
Reclamation	0.6 – 0.8	0.7	0 – 5.5	1.4
Workforce	0.3 – 0.4	0.3	0.1 – 0.3	0.3
TOTAL	**1.8 – 4.0**	**2.8**	**0.8 – 11. 8**	**4.8**

It is interesting to note that the mid-range water needs for in-situ development dwarf those of surface retort processes. However, the land impacts of surface mining would dwarf those of in-situ processing. Thus, it is important to remember that, while water use is a factor to watch as the nation again contemplates a commercial oil shale industry, there are direct trade-offs between the impacts of the different technologies to the different resources of concern to sportsmen.

The range of estimates in the studies GAO reviewed results from different assumptions about the process. For example, industry scientists have proposed that, while they will need water for reclamation and power, they will not have to divert new water for these purposes, but will instead use water pumped out of the ground during the extraction phase. Other analyses assume the industry could not reduce new diversions by using this water because most of it is too saline. These scientists also contend that reclamation of in-situ retort zones may only need 1 barrel of water per barrel of oil, while the Center for Oil Shale Technology Research has estimated that this step alone would require 5.5 barrels of water per barrel of oil. Finally, while most analyses assumed that upgrading the oil extracted would occur locally, one report proposed moving this step outside the Green River Basin, thereby simply shifting the water needed for this step elsewhere.

However, the most remarkable aspect of all these numbers is their comparison to traditional fossil fuel development. Oil from shale has a much higher energy intensity than other sources of energy; that alone makes its water requirements higher than other sources of fuel. Adding in its other water needs only makes the comparison worse. One energy industry engineer compared energy sources in terms of the amount of water needed to produce a British Thermal Unit (BTU) of energy.

Energy Resource	**Steps Included**	**Range, Gallons of Water Used per BTU Produced**
Conventional Oil	Extracting, Production & Refining	8 – 20
Coal (no slurry transport)	Mining & Washing	2 – 8
Coal (with slurry transport)	Mining, Washing & Slurry	13 – 32
Natural Gas – Conventional	Drilling & Processing	1 – 3
Natural Gas – Shale, Frac'd	Drilling, Frac'ing & Processing	0.6 - 3.8
Oil from Oil Shale	Extraction, Production & Refining	22 – 56

From a water consumption point of view, notwithstanding the uncertainty, states and the federal Bureau of Reclamation have plugged in numbers for recent studies. For a 1.5 million barrel per day output, the range of annual water use goes from 100,000 to 400,000 acre feet. Based on the projections in the Basin Study about future water needs for the seven basin states,, finding this quantum of water will be difficult, especially without shorting competing demands and without triggering a move by the Lower Basin states to demand delivery of more water from the Upper Basin. As the GAO remarked,

> Water is likely to be available for the initial development of an oil shale industry, but the size of an industry in Colorado or Utah may eventually be limited by water availability. Water limitations may arise from increases in water demand from municipal and industrial users, the potential of reduced water supplies from a warming climate, fulfilling obligations under interstate water compacts and the need to provide additional water to protect threatened and endangered fishes.

This is consistent with a Rand's Corporation study from 2005 that used a 3:1 bbl water to oil ratio:

> The earliest constraining factors [for commercial oil shale development] would be limitations in local water supply systems, such as reservoirs, pipelines, and ground water development. A bigger issue is the impact of a strategic-scale oil shale industry on the greater Colorado River Basin. Demands for water are expected to continue to grow in the foreseeable future, making the earlier analyses regarding oil shale development outdated.

The recent BLM analysis set the range for water for oil shale demands for both surface mining and in situ facilities. At their mid-point water use for a 1 million barrel per day of oil production level from in-situ technology and 250,000 barrels per day of oil from surface retort, oil shale development would require 363,000 AF/year. (Note that this is three times the amount BLM's sister agency used for its oil shale demand projections, which is a reflection of the high level of uncertainty represented in different players' emphasis of different studies.) If, as the BLM also posited, the three states together have only approximately 1 MAF of additional water to develop, the oil shale industry demand would require one third of the total. While this level of water intensity, as well as the size of the industry are speculative, the potential scope of the water demands for the industry can be summed up as follows: large and larger.

While the Green River mainstem and most of its tributaries currently have relatively high quality, healthy flows, even today there are pinch points (places where there are either flows that are too low, or quality too poor, or both, for healthy river dependent species). Between the flows necessary to maintain, and one day even recover the native fish in this basin and the flows necessary to sustain the vibrant river recreation industry that has brought welcome economic strength to the area, removing as much as the 10% of the basin's water for oil shale could endanger the region's economy, its environment or both.

What might the water quality impacts be?

Surface mining for oil shale, like many other types of mining, can result in large waste piles. Even in situ mining will cause land disturbances associated with the roads and facilities necessary for production. Such land disturbances, inadequately regulated, can result in substantially additional polluted runoff into surface streams.

Cooking the kerogen, whether in situ below ground or in a surface retort facility leaves behind salts and other minerals. If these pollutants leach into ground water or surface water streams in certain quantities, they can spoil fresh water, making it unfit to drink or toxic to crops, stock, game and/or fish. Washing the contaminated rock, as many companies have acknowledged will be necessary, either underground or on the surface, would transfer the pollutants to the washing water; companies would then have to treat this volume of dirty water prior to releasing it back to the environment. Alternatively, they could inject the water deep underground, far below usable sources of groundwater. Neither the companies nor government agencies involved in exploring the feasibility of a commercial oil shale industry have demonstrated the long-term ability of these technologies to protect the environment from contamination. As an example in a permit application for its small research and demonstrate site in the White River Basin of Colorado, Shell disclosed its intent "to rinse its underground production area over 20 times, requiring up to 4 acre feet [of water] each day for over two years." This quantity is large, and exemplifies the challenges the industry will face, not only in finding enough water from this semi-arid landscape to meet its large demands, but also in treating and disposing of its waste streams.

Conclusion

Oil shale development is an intensive, industrial mining process that requires large amounts of water, disturbs vast acres of land, and must be accompanied by significant construction of roads, transmission lines, effluent ponds and tailings piles. While water use scenarios vary greatly due to the many unknowns with this untested technology, all tests and projections concede that oil shale development is a thirsty industry. To develop successfully, large scale oil shale extraction is likely to create water shortages for other water users in this semi-arid region where many rivers are already working overtime. The industry's need for, and use of, water would not only reduce stream flows directly, but would run a high risk of causing degradation of water quality, due both to the introduction of contaminants into surface and ground water and the higher temperatures and loss of physical habitat that occurs with lower stream flows. The adverse effects of these water shortages will ripple through the rural communities of the basin whether their economies are based on agriculture, recreation or both. The reductions in stream flows and water quality will also almost certainly have negative repercussions for the area's fish, whether the endangered and threatened species that are barely hanging on, or the great trout fisheries much beloved by local and more distant anglers.

In light of the potential risks involved with growing an oil shale development industry, the only prudent strategy requires an abundance of caution. The industry can only proceed if it adopts a step-wise approach that demonstrates first through additional research, then with demonstration facilities and finally with small scale pilots its economic and environmental feasibility. The fisheries and rivers of the oil shale region are too important to allow oil shale development to proceed in any other way.

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