Feasibility of the Lake Powell Pipeline Development Act and Proposed Water Conservation Alternatives

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In 2006, after four years of drought, the Utah Legislature was tasked with addressing the increasingly limited water supplies throughout the state. At first, state agencies decided the construction of a pipeline from Lake Powell to Washington and Kane counties would meet the water needs of a growing population in southwestern Utah. However appealing the solution first appeared on paper, many in the academic and scientific community are now skeptical of the feasibility of the project as well as its economic and ecological impacts. In addition, alternative measures to meet future water needs are numerous, inexpensive, and feasible, which calls the proposed policy into question—especially in a fiscally conservative state such as Utah. Using current data projections, legislative audits, and a range of reports, this paper aims to determine the economic and ecological feasibility of the Lake Powell Pipeline Project. Furthermore, this paper will review the strengths and weaknesses of three alternative policies: instream flows, rainwater harvesting, and agricultural water conversion. Based on a comparison of these various policies, this paper will then conclude with suggestions for the best outcome for the state of Utah.

Keywords: Lake Powell Pipeline, Water Conservation, Utah Water Policy

After numerous requests and public pressure from the academic community and local non-profits, such as the Utah Rivers Council, the Utah Legislative Auditor General (OLA) completed a performance audit on projections of Utah's water needs in May 2015. Analyzing the data used by the Utah Division of Water Resources, the audit determined the figures used were unreliable for understanding the future water needs of Utah's growing population. These inaccuracies were not only expected by skeptics, but were also the primary reason for the audit requests. The audit also included recommendations of how to improve the data collection process through cooperation of interstate agencies, data validity checks, and annual water use reviews, among others (OLA, 2015). Additional water conservation goals were suggested including agricultural water conversion of irrigated land for municipal and industrial use, smaller lot sizes, and the metering of all water service connections or universal metering (OLA, 2015, pp. 8, 44–45).

The OLA audit has exposed a significant flaw in Utah state policymaking and offers an opportunity to make improvements not only on the decision to undertake large projects, such as the Lake Powell Pipeline discussed in detail below, but also to revamp the collection of water data. Doing so will allow future decision makers to arrive at more informed and sound polices based on scientifically reliable and rigorous data. The effects of climate change are difficult to predict but are more easily responded to with accurate data. As a result, the need for such data is critical to states that must increasingly anticipate climate change's looming impacts.

The Lake Powell Pipeline

In 2006, the Utah State Legislature passed the Lake Powell Pipeline Development Act, authorizing the Utah Board of Water Resources to construct the Lake Powell Pipeline (Utah Division of Water Resources, 2015). On March 31, 2015, Governor Gary Herbert signed into law S.B 281—Water Infrastructure Funding (proposed by Senator J. Stuart Adams, R-Davis County). The sole purpose of the law was to fund the Bear River and Lake Powell Pipeline projects with an initial general fund of $5 million to be appropriated in fiscal year 2016 (Water Infrastructure Funding, 2015). The fund is set to cover approximately 139 miles of pipeline from Lake Powell to Sand Hollow Reservoir, as well as a series of pumping and hydroelectric facilities that will be installed to deliver an estimated 82,000 acre-feet (26.7 billion gallons) of water to Washington and Kane counties in southwestern Utah (Utah Division of Water Resources, 2015).

With an estimated $2 billion price tag and approximately $27 million spent on paperwork and planning alone, state officials claim power sales generated through hydroelectric pumps will help to offset the cost of pumping. However, taxpayers of Washington and Kane county water districts are expected to cover the costs of construction through water sales (Utah Rivers Council, 2012, p. 2). In addition, state budget estimates differ from the projected cost estimate developed in November 2015. Compared to the $2 billion estimate, new costs estimates range from approximately $1.4 to $2.4 billion with another $3 billion needed for pumping stations (Citizens For Dixie's Future, 2016). This conservative estimate is not entirely reliable due to the uncertainty of the alignment of the pipeline. Pipeline alignment matters because the transport of water via pipeline across rough Utah terrain is an energy intensive process that makes the use of pumping stations necessary. The planned use of hydroelectricity to power these pumps helps in eliminating energy use but can potentially become an overbearing cost for residents of Washington County. The alignment of the pipeline can also impact water quality due to the increased need for heavy equipment and large-scale operations, as will be discussed in the ecological impacts section below.

Although numerous pipeline alignments are currently under study, Figure 1 illustrates the proposed alignment by the Utah Board of Water Resources to the Federal Energy Regulatory Commission (FERC). This alignment follows the major highway from Glen Canyon Dam to a point about 10 miles east of Kanab where it turns southwest and primarily follows existing road and power lines south of the Kaibab Paiute Indian Reservation. The pipeline then returns to the highway and on to Hildale, Utah. At that point, the pipeline heads north and west to the Hurricane Cliffs then on to Sand Hollow Reservoir. This alignment was preferred over others because it was expected to be the least expensive and environmentally damaging route.

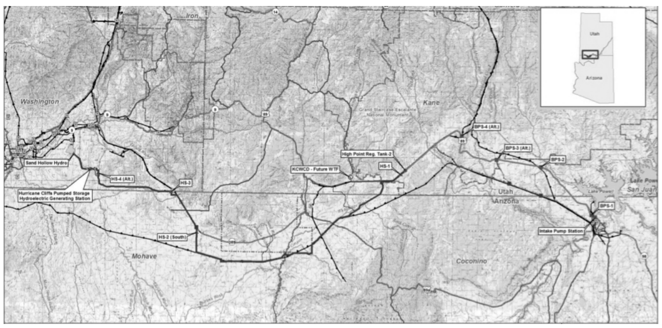

Figure 1. Project Segment Map of Lake Powell Pipeline
Note. From Washington County Water Conservancy District

Construction of the Lake Powell Pipeline is anticipated to begin in 2020 with the pumping of water to Washington and Kane county water conservancy districts by 2025 (Utah Division of Water Resources, 2015). However, questions of whether or not water levels will be sufficient for pumping are still hotly debated.

Feasibility Issues and the Lake Powell Proposal

The state of Utah indicates projects, such as the Lake Powell Pipeline, are necessary to provide for future generations. In May 2015, John Schaff, auditor general of the OLA, released "A Performance Audit of Projections of Utah's Water Needs" (2015), wherein the auditor states:

> In order to effectively manage the state's water resources and plan for future water needs, accurate water use data is critical. The Division of Water Resources relies on water use data submitted by local water systems to the Division of Water Rights as the starting point for projecting future water needs. Unfortunately, we found that the submitted data contains significant inaccuracies. State water agencies as well as local water systems operators also acknowledge these inaccuracies. (page ii)

Furthermore, Schaff argued that the division needs an improved process to ensure water data is correct and reliable. He also questions the overall reliability of the division's baseline water use study (OLA, 2015, page ii).

The measuring of baseline water use is a critical matter. Despite this, the Division of Water Resources based its projection of future water needs on a year 2000 study. Problematically, the 2000 study was drawn from a compilation of previous studies completed between 1992 and 1999. The problem arises because the methods, resources, and accuracy of data collection were lesser in those years than in the 2000. In addition, because secondary water use is generally not metered, a large portion of the reported outdoor water use in the year 2000 study was based solely on estimates from prior years. Because of inaccurate data, the division estimated Utah would exceed its non-shared supply of water by 2040. Moreover, as illustrated in Figure 2, the concerns over unreliable data are amplified in places like Washington County, because the pipeline project estimated it to be one of the highest water consuming counties in the United States—at more than twice the national average.

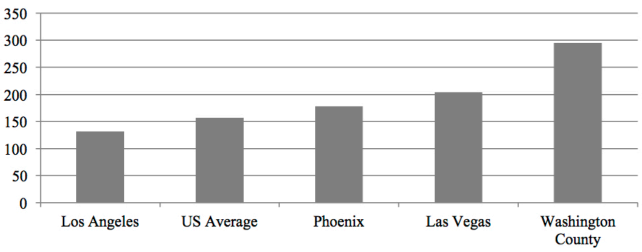

Figure 2. Washington County: per person water use, gallons per day
Note. From Utah Rivers Council

An inaccurate 2006 report from the Governor's Office of Planning and Budget (GOPB) projects water demands in Washington County will outpace supply by 2020. A new more accurate GOPB report from 2012, however, shows demand can be met through current water resources through the year 2040 (Utah Rivers Council, 2012, p. 23).

Another issue raised by the related projections is the question of population growth. Despite inaccurate population projections in 2006, the 2012 report is considered more accurate, in part, because it reflects the slowing population growth trend, which is not accounted for in prior calculations of Utah's water needs. This change in projected population growth is significant as population size is a primary factor in determining future water needs. Moreover, a 2015 report on Lake Powell Pipeline feasibility for Washington County demonstrates that population growth is expected to decline (Blattenberger et al., 2015, p. 1). A 2005 GOPB report estimated population growth to be 32.4% higher than the 2012 GOPB report. This change in estimates underscores the lack of certainty and rigor behind state population figures, which has serious impacts on water use estimation and the need for projects, such as the Lake Powell Pipeline.

While the available projections are intended to assist policymakers in producing the best decisions based on the needs of the state, the overall outcome has been one of uncertainty and confusion. The combination of inaccurate water data collected by the state and the overestimation of population growth has led to a clouded decision making process on the part of the state. These recently revealed facts raised questions about the feasibility of the proposed pipeline project and remain a large source of controversy for the division and elected officials involved in the law's oversight.

Economic Impact

Another critical area of importance to the pipeline is its fiscal impact. Considering the economics of the proposed policy, it appears that water conservation and the solvency of Washington County—where much of the funding burden will be placed—are of lesser importance than successfully completing the pipeline project. The Lake Powell project may not be economically feasible in the long term.

The fiscal impacts of the Lake Powell project first came to light in 2012. A group of economics professors sent a preliminary analysis to the Utah State Legislature expressing concern about the repayment plans in regards to the proposed Lake Powell Pipeline (Blattenberger et al., 2012). The primary concern, according to these economists, is the expected means of repayment mandated in the agreement. Currently, the Lake Powell Pipeline Development Act requires that project costs be repaid to the state with interest, pursuant to, "Agreement for delivery—Period for repayment of costs" section of the act. (Utah Code Ann. § 73-28-402, 2006).

Table 1
Annual Debt Service Payments by the Washington County Water Conservancy District

Repayment Cost	**Interest Rate**			
	0.03	**0.04**	**0.05**	**0.06**
$969,000,000	$37,660,000	$45,110,000	$53,080,000	$70,210,000

As seen in Table 1, the group calculated the amount the Washington County Water Conservancy District (WCWCD) would be required to repay over an assumed 50-year period with varying interest rates (currently no set rate has been determined). However, a 2011 review of WCWCD financial statements reports a $10.275 million change in net assets in 2011. Based on such figures, the district would be unable to repay the estimated $969 million at any of the above interest rates. To compound the issue, albeit annual revenues have increased slightly in the past four years, the slowing of projected growth in the region will further diminish any hope of repayment. Many speculate the actual repayment amount for this district will be even higher. Either way, it is unclear how much the WCWCD will be expected to pay and how it will repay those debts. Even with this conservative estimate, such uncertainty is a financial liability that suggests this policy may not be economically feasible or realistic.

In an effort to address the growing economic uncertainty related to the proposed payment plan, the WCWCD proposed an alternative repayment plan that includes an initial 10% down payment, plus a period of bond financed repayments lasting until 2020. After the initial down payment and financed repayments, annual payments of $20 million dollars would begin in 2020 and end in 2032 (Blattenberger et al., 2012, p. 2). However, some economists worry that this approach is also not economically feasible. According to Gail Blattenberger et al. (2012):

> If the district is able to make the 10% down payment and these $20 million annual payments, the amount they would owe in 2033 would be $1.065 billion if the interest rate is 3% (more if the interest rate were higher); to pay this off by the year 2080, the annual payment needed at 3% percent would be approximately $47,345,000 per year. (p.2)

To accomplish the goal outlined by the WCWCD, net annual revenues would need to increase by 370%. If the WCWCD is to meet such a drastic increase, it must consider increasing property taxes, liquidating district-owned land, and raising water rates. Moving forward with the implementation of these options may not accomplish the WCWCD's stated goals for repayment of pipeline costs For example, Utah law allows the WCWCD to tax no higher than 0.001% per dollar (Water Conservancy District Act, 2010) where the WCWCD currently taxes at 0.00097%, an increase from 0.000676% per dollar in 2009 (Washington County, 2009, p. 4). Even if at the maximum legal amount, just $301,642 in additional revenues would be accrued (Blattenberger et al., 2015, p. 7).

Selling district-owned land offers limited further revenue to the county that provides a fraction of the funds needed for repayment. According to the Washington County Water Conservancy District Audited Financial Statement (WCWDAFS) the district owns approximately 1,000 to 1,200 acres that may be declared surplus property. Current fair market value is $50,000 to $125,000 per acre, but the value of this land is expected to increase in the years to come (Washington County Water Conservancy, 2015, p. 7). If sold at the current market price, the district could expect to receive $150 million (Blattenberger et al., 2015), which is somewhat promising but also does not cover the required costs.

While increasing taxes and selling of land may help to cover some of the missing revenue, the remaining options are less helpful. For example, raising water rates generally encourages water conservation on part of the consumer, because this simple incentive drives consumers to use less to save more. Consequentially, as the water rate increases, water consumption declines, and overall revenues are unlikely to increase substantially and may even decline. Use of this policy approach, therefore, may actually be a detriment to the desired outcome.

With each new consideration, it becomes increasingly clear that this project is simply not economically feasible—especially from the perspective of Washington County. Subsequently, the use of state tax dollars to meet water demand for Washington County may become an ethical dilemma that unfairly burdens the county's estimated 155,602 residents (United States Census Bureau, 2015) as they begin to repay these tax dollars with interest. Moreover, the plans currently do not provide a clear enough picture as to how the project will provide economic benefits that outweigh the monetary costs. As of now, it appears that the best partial solution is increasing fees across the board; however, even this option may be impossible due to existing legal limits protecting taxpayers from such poorly planned policies.

In light of public concern over the Lake Powell Pipeline project, Utah Governor Gary R. Herbert announced:

> In the interest of providing additional budget flexibility and oversight, ensuring funding certainty, maintaining our water and treatment infrastructure, and encouraging more efficient water use, we must analyze whether there are better approaches to fund future water needs. Utah should conduct a comprehensive water funding, pricing, and usage study to understand the full costs of water in the state. (Governor's Office of Management and Budget, 2015, p. 63)

This step in the right direction will help reevaluate whether or not the pipeline has potential economic success. If real progress is to be made to address the financing of the project, state officials must take a step back to reevaluate the project and consider all options.

Ecological Impacts

Ensuring that Washington County survives the economic impacts of the Lake Powell Pipeline Project is one of many concerns. The ecological impacts may also be excessive. Further understanding of the issue requires a holistic examination of the ecological repercussions of the Lake Powell Pipeline that adversely impact surface water quality around the state. Impacts from soil erosion, loss of ground cover, runoff, and other damaging effects already impact a variety of areas including Kanab, Ash, Mill, and LaVerkin Creeks, the Paria and Virgin Rivers, the Quail Creek and Sand Hollow Reservoirs, and even Lake Powell itself.

Perhaps the most pressing issues associated with the Lake Powell Pipeline are construction impacts. The construction phase of the pipeline will see extensive earthwork and grading of topsoil that will disturb the groundcover and surrounding vegetation. Furthermore, the necessary booster pumps, hydroelectric stations, and transmitting lines will add to the exposure of lower level soils that in turn may cause erosion that is especially prevalent with the loss of vegetation (Utah Board of Water Resources, 2010, p. 4–2). Unstable soils with no foundation can lead to heavy erosion, degrading water quality due to wind and runoff. Each individual creek or river may also suffer from the increased sediment loads caused by erosion, ultimately reducing the amount of light penetrating local creeks and rivers that in turn reduces oxygen levels for aquatic life and photosynthesis for non-animal life, such as river bottom plants (Utah Board of Water Resources, 2010). Soils disturbed from the clearing, grading, and excavating, will cause adverse effects and only a limited number of vegetation will adapt and survive in the resulting arid settings that remain (Federal Energy Regulatory Commission, 2008).

Efforts to decrease the costs of the project also pose ecological and environmental threats. Several locations will use open-cut crossings for the pipeline (Utah Board of Water Resources, 2010, p. 4–2). These types of crossings cause more sediment release and erosion. Another serious issue is the changing of stream flow dynamics. For example, changes in dissolved oxygen and even the curves and cuts of a river may prevent fish from resting in eddies and rapids where oxygen rich pockets occur. The construction of this pipeline could alter the physical makeup of a river upon which instream resources rely. As a result, these natural, life-sustaining stream characteristics could degrade, resulting in a cascade effect of failing ecosystems.

Lake Powell and its surrounding creeks, rivers, reservoirs—and the life they contain—could suffer from the pipeline. The pipeline would also create severe downstream impacts. All 1,450 miles of the Colorado River run through seven U.S. and two Mexican states. Prior to 1998, it came to rest in the Gulf of California. Since 1963, the Colorado River met the ocean only during El Niño events of the 1980s and 1990s. Rising in the Rocky Mountains, the Colorado flows southwest through the Grand Canyon, Lake Mead and, once upon a time, into Mexico. In addition, the Colorado runs through Lake Powell where the proposed pipeline would draw its water. The overuse of Lake Mead in the past several decades has lowered the lake to a level that prevents the Colorado from continuing south to the Pacific Ocean. Water projects, such as the Lake Powell Pipeline, will further decrease the flow of the Colorado, which in turn could have devastating ecological consequences on river and ocean life as well as human settlements dependent on the river. One example is the impact on regional deltas. Delta ecosystems once flourished from nutrient-rich river sediments where creatures, such as fish, mayflies, and otters, flourished. Depletion of the Colorado River will only further degrade the fucntion of these ecosystems. Likewise, the aquatic life in Lake Powell itself has suffered over the years from the introduction of invasive and foreign species into its habitat and chemical spills, such as the recent Gold King Mine wastewater spill (City of Tucson, 2016). As a result, the ecological equilibrium of Lake Powell has become off-balance. As water levels continue to drop and water quality worsens, it is possible the Lake Powell Pipeline will slow this once mighty vein of life sustaining water to a trickle.

Clearly, there are a number of factors to consider when it comes to understanding the feasibility of this project. How will the construction phase affect climate change through the release of greenhouse gases (GHG)? Will Lake Powell have sufficient levels to pump? What are the actual costs to society and the environment? These questions are critical and citizens want answers. Without knowing the final project alignment and projected resources, there are only guesses as to what impacts will results in terms of air and water quality. Utah already experiences some of the worst air quality in the nation and climate change has altered our state's precipitation patterns. Additional air and water pollution should be avoided. If the state is to achieve responsible water use and expansion practices, policymakers must rethink or reconsider the Lake Powell Pipeline project. One clear alternative is to put the pipeline project on hold and focus instead on conservation alternatives that are more environmentally responsible and fiscally realistic.

Water Conservation Alternatives

In light of its weak economic and ecological feasibility, as well as the flawed system of measurement upon which the Lake Power Pipeline policy was founded, other alternatives deserve further consideration. For example, potential pathways towards sustainability and water conservation in Western states are possible through simple yet effective approaches including environmentally friendly stream flow policies, rainwater harvesting, and agricultural water conversion. The following section will explore the strengths and weaknesses of these alternative policies.

Instream Flows

The first alternative involves various stream flow policies. An understanding of instream flow policy in Utah must begin with a brief overview of the history behind water law in Utah (Crowther, n.d.). The settling of the Salt Lake Valley by the pioneers in 1847 required agricultural success in order to survive in a semi-arid region. A successful settlement was dependent on the transportation and diversion of water from streams to settlements by way of ditches and canals. Soon after Utah adopted the underlying principle of western water law: the Doctrine of Prior Appropriation. The two tenets of this law were "first in time is first in right" (Waters Declared Property of Public, 2010) and "use it or lose it" (Beneficial Use Basis of Right, 1953). The first principle declared that whoever made first beneficial use of water would be entitled to first rights. The second principle contends that once a stream has been diverted and first rights appointed, the water must be used for the public good. This is to ensure that all water use is economically beneficial—even if it promotes inefficient water usage.

In contrast, Oregon law allows the use of available (unappropriated) water for instream flow appropriations. To do so, the state authorizes the minimum quantity of water necessary to support public needs without requiring that the water be available for any specified time period or diverted for other use (In-Stream Water Rights, 2013). In contrast, Utah, "does not recognize water in a stream that is needed by fish and wildlife as a 'legal' use of water. Other states recognize the legal value of such rights called instream flows" (Utah Rivers Council, 2012, p. 15). Further, instream flow rights must arise from an existing right, not a new appropriation. Water rights only establish a right to use water; any failure to make full use will result in the loss of water right(s) (Beneficial Use Basis of Right, 1953).

Currently, flow levels and diversion of water in Utah are determined through flow (i.e. rate of water discharged from a source, given in volume with respect to time, measure in cubic feet per second (CFS), where one CFS = 448.83 gallons per minute), and volume (i.e. measured in acre-feet, which is the amount of water necessary to cover one acre of land with one foot of water, where one acre-foot = 325,851 gallons) (Gittins, n.d.). Other Western states use "indicator species," such as fish, as a determinant of stream flow. Fish act as a measurement of the environmental conditions in a given locale. If fish in a stream are thriving, then generally other instream resources are, too (Zellmer, 2008). Utah does not consistently rely on indicator species or scientifically informed policy in determining stream flow, but instead on archaic, outdated policies. Stream flow determinants are important, though, in that they often reflect a state's instream flow policy and the importance of finding an equilibrium between supporting agricultural economy and healthy streams.

Economic impacts. After the Doctrine of Prior Appropriation took hold in the United States, the west looked to increase economic output with agricultural development. Ambitious expansion tamed western waters under a new policy, which began to impact stream flow ecosystem services. Sandra Zellmer (2008) explains

> In western states and provinces, the law historically considered water left in the stream to be wasted. Western state laws encouraged full appropriation of rivers and streams, primarily to satisfy the need to divert water to arid areas for economic and domestic purposes. (p. 285)

Because Western law encourages the full and beneficial use of water resources, well-balanced stream ecology has been sacrificed for the economic benefits of agriculture. A historical trend to reserve water rights for those who wish to divert it (mainly for industrial commerce), rather than to keep it in streams (for conservation or tourism), has allowed Utah to maintain a robust economy and become one of the fastest growing states in the nation.

The state's water-dependent agricultural industry received 85% of annual water resources (OLA, 2015), accounting for $2.5 billion in total economic output in 2011 (Ward, Jakus, & Coulibaly, 2013, p. 1). However, agricultural revenue does not offset the costs of the Lake Powell Pipeline. Retaining and fully utilizing water in Utah promotes economic activity in the state's agricultural sector.

Though Utah water law has served some of the state's citizens well in the past, it does not benefit all. In addition, wildlife and natural resources are certainly not considered in the equation. Instead, outdated water conservation policies deter sustainable use, prevent preservation, and reduce ecological value of streams and rivers. While changing such policies seems reasonable, doing so will be difficult due to the status quo's economic benefit to a few minor, but influential, players in the political system. Making a substantial change, therefore, will require a new way of thinking and a strong commitment to reasonable stream withdrawals.

Ecological impacts. In 1986 Utah adopted instream flow legislation followed by the earliest legislation of Oregon in 1955 (Nueman, Squier, & Achterman, 2006). The Conserved Water Program in Oregon, a companion to the Instream Water Rights Act, was implemented in 1987 and states, "Any person may purchase or lease all or a portion of an existing water right or accept a gift of all or a portion of an existing water right for conversion to a instream water right" (Purchase, Lease or Gift, 2013). The Conserved Water Program benefits Oregon's citizens who improve the efficiency of their water use. Benefits include the option to either keep a portion of saved water or gift it to another for instream use or for other purposes (Zellmer, 2008). These statutes encourage conservation of streams and instream resources while permitting water rights holders to make beneficial use of stream flow withdrawals without allocating the full share appropriated, thereby sustaining instream flows. Oregon also allows water rights holders to gift a portion of their stream flow shares to a third party.

Appropriation of instream flows through sale or lease to private or public owners with the intent of keeping water in the stream, as opposed to diverting it, often results in improved stream flows and ecosystem health (Zellmer, 2008, p 286). Utah law does not allow the use or acquisition of unappropriated water for instream flow grants.

Oregon and non-profit groups have created a bipartisan effort over the past decade allowing for 84 projects to protect 117 CFS, while 303 CFS have been restored instream across the state (Neuman, Squier, & Achterman, 2006). Contrary to Oregon's efforts, the WCWCD collects the majority of its water from the Virgin River to reservoirs via pipeline (Cram, n.d.). Based on successful water projects Oregon has demonstrated that instream flow laws can be organized in such a way that preserves the ecological value of streams, rivers, and surrounding wildlife, while maintaining economic viability and beneficial use of the water. While many of Oregon's statutes are experimental and groundbreaking, such as instream flow policy designed to protect the natural world, there are drawbacks. These policies pose a threat to the politics and administration of the state by increasing competition over an increasingly scarce and monetarily-valuable resource. Furthermore, with less water diverted from streams for agricultural and industrial use, the state's economy may suffer from decreased total economic output received from agriculture.

Traditional Western water law is not designed to promote environmentally preferential instream flow policy. One urges full and beneficial use of available water resources while the other promotes instream flows, respectively. In order for instream flow policies to work, there must be a balance between stream flow protection and diversion of water for beneficial use. As Utah has yet to achieve such a balance, the state's instream flow policy has become obsolete and detrimental to a sustainable water future.

Rainwater Harvesting

A second conservation alternative possible in Utah is rainwater harvesting (RWH). This section will examine the economic benefits of RWH, the role Utah state rainwater collection policies play, and how this simplistic alternative improves water quality. RWH is a proven strategy of water conservation that strengthens the health of streams, rivers, and lakes. Furthermore, RWH encourages homeowners and businesses through the financial incentive of lowering water bills. Rainwater collection is currently being tested along the Wasatch Front and has been found to be popular among both residents and local city governments as an inexpensive approach to water conservation (Utah Rivers Council, 2015).

The catchment of rainwater is a relatively new practice in Utah that has seen significant success in early pilot programs. The Utah Rivers Council, an environmental non-government organization, implemented Utah's first rainwater catchment program in 2015. The program has now sold more than 2,300 rain barrels (Utah Rivers Council, 2015). With each barrel holding 50 gallons, an estimated 115,000 gallons of rainwater are saved with each decent rainfall. Illegal under state law until 2010, Utah residents may now collect up to 2,500 gallons of rainwater in above ground containers or underground cisterns (Capture and Storage of Precipitation, 2010).

Economic impacts. A 2008 study by Civil Engineer, Mark Jensen entitled, "Feasibility of Rainwater Harvesting for Urban Water Management in Salt Lake City," shows rainwater capture is feasible in terms of implementation and that the outcomes of such policies highlight a positive cost benefit effect (Jensen, 2008). The possibility of successful implementation and positive monetary outcomes of RWH indicates the clear potential of rainwater collecting devices as a conservation policy in Utah.

While RWH may not be the sole solution for Utah's water needs, the approach is cost effective in comparison to the pipeline project. Jensen's 2008 study on rainwater capture and storage in Salt Lake City shows, "if developed lots could provide 41% of the area that is available for precipitation capture, 75% of total water use could be achieved" (Jensen, 2008, p. 47). As Figure 3 illustrates, these savings would be significant as 85% of annual water use in Utah is diverted to agriculture, and the remaining 15% is allotted for municipal and industrial use (Utah Rivers Council, 2015).

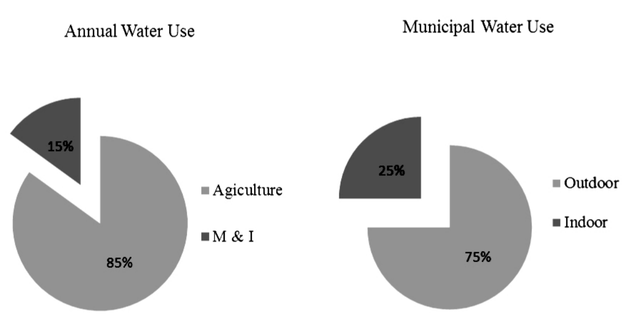

Figure 3. Comparison of Annual and Municipal Water Use
Note: From Utah Rivers Council (2015)

Still in its infancy in Utah, RWH does not produce significant savings for the consumer due to the already low water rates existing in Salt Lake City today. As Table 2 shows, Utah has some of the lowest water rates in the western United States (Circle of Blue, 2014).

Table 2.
Average Monthly Water Bill in Western Cities

City	**Average monthly bill for family of four using 50 gallons/person/day**	**Average monthly bill for family of four using 100 gallons/person/day**	**Average monthly bill for family of four using 150 gallons/person/day**
San Antonio	22.65	43.66	74.25
Salt Lake City	17.22	27.19	37.79
Los Angeles	36.53	75.98	122.41
Seattle	55.25	98.77	153.22
Santa Fe	54.78	153.78	284.10

Note: From Circle of Blue

Further, water rates vary slightly in Utah's cities where some have flat rates, such as Orem, and others have tiered rates that increase by a few cents per thousand gallons, such as St. George (OLA, 2015). Increasing rates to reflect the true cost of water would naturally lower consumption on part of the consumer to save on monthly water bills. Water prices reflecting the true value would negate the need for RWH as its primary functions are increased water savings and quality.

Ecological impacts. While there are no current data on strong economic benefits of RWH to the state of Utah or its residents, it is possible that water utilities could see ecological benefits from rainwater collection. As more water is collected and used for activities such as lawn watering, it will seep directly into the ground water table. Without RWH, water often encounters cemented areas laden with petroleum byproducts and other chemicals that water treatment facilities must remove. Salt Lake City's water utility required more than $14 million to manage stormwater alone (Salt Lake City Department, 2012, p. 12). By skipping extensive water treatments, the rainwater entering the ground may be less impacted by toxins overall.

Limitations of RWH are its potential uses—potable or non-potable. Rainwater is relatively pure but encounters pollutants once it has fallen onto a roof, down a storm drain, and into a collection barrel. Dust, ash, pathogenic bacteria, heavy metals, mosquito larvae, and other inorganic contaminants limit harvested rain to outdoor municipal use only (Mosley, 2005, p. 4). To allow for indoor use, rainwater must be treated for the removal of any contaminants. With 75% of total water use achievable, it is possible nearly all outdoor muncipal water use could be eliminated through the use of both above ground rain barrels and underground cistern storage. Capturing 75% of water use requires large cisterns of up to 8,500 gallons to capture water for use in a small residential home due to changing precipitation patterns in a semi-arid region. Because Utah summers receive little precipitation, early winter months receiving heavy precipitation are an ideal time to collect water for use throughout the year. RWH involving large underground cisterns is an intensive approach and not ideal for older neighborhoods and smaller lots; however, revised policies could require new development projects to include such infrastructure in their designs. In addition, as with any water conservation alternative, RWH is not a solution in itself. When combined with multiple alternatives we begin to see significant water use and waste reductions. As a result, this policy cannot be expected to achieve large scale results on its own and will need to be pushed by city planners and decision makers to ensure the infrastructure is available in the future.

Although RWH is a feasible water conservation alternative, current laws prevent the full use and allocation of this tool. Utah code prohibits the collection of more than 2,500 gallons and also requires that the water collected go toward beneficial use, which is subject to the previously mentioned Doctrine of Prior Appropriation and all other state water laws. The benficial use of captured rainwater does not, however, constitute a water right per say. Because water rights are not offered, the collector is not bound by the Doctorine of Prior Appropriations. As a result, rainwater cannot be directly taken away without good cause (e.g. due to detrimental effect to the health of the general population, violation of saftey regulations, or any other state or state engineer code violation). Despite such preventative policies, as the ease and popularity of this alternative increase, Utah may see increased rainwater collection over a wide enough area to produce significant water conservation.

Agricultural Water Conversion

Another effective water conservation alternative to the Lake Powell Pipeline is agricultural water conversion, which is a readily available method in both Northen and Southern Utah. Future water resources, such as agricultural water conversion, have not been included in the planning and layout of the Lake Powell Pipeline. The idea behind agricultural water conversion is simply the conversion of irrigated land, for municipal and industrial use as potable or non-potable water.

Economic benefits. While simple, the economic benefits and drawbacks of each proposed conversion must be examined on a case-by-case basis to ensure maxium potential. Of 1.4 million acres of irrigated land, it is estimated that 10% will be urbanized by 2050 (Adams & Millis, 2013). To better grasp the cost of purchasing water for agricultural conversion, consider the current market that prices water between $116 and $150 per acre-foot (325,851 gallons) per year (Bammes, 2015). If water is owned by irrigation companies, prices may rise between $2,000 and $3,000 to purchase these appropriated rights (Storey, n.d., p. 3).

Using the most current market price of agricultural water in Utah, purchasing 10% of the 1.4 million irrigated acres for conversion to municipal and industrial use would cost $21 million. This assumption does not take inflation into account. Considering that the Lake Powell Pipeline is projected to begin water delivery in 2025, it is unlikely that a notable difference in the market price of water would occur. Comparing the $21 million cost of water rights to convert agricultural land to the nearly $5 billion estimated costs of the Lake Powell Pipeline, it is evident that this policy should be seriously considered as an alternative from an economic perspective. The difference in costs between agricultural conversions and the Lake Powell Pipeline show that agricultural water conversions, when coupled with multiple additonal water conservation alternatives, provide a payment plan that the WCWCD can achieve.

Ecological benefits. Part of the merit behind agricultural water conversion is the utilization of water in the immediate area versus water from a long distance. Transporting water via a pipeline, for example, has many impacts. The following will discuss the impacts of this alternative on Utah's environment.

Development of agricultural lands provides a surplus of water that becomes availiable for alternate use. This is a scenario that has played out throughout the state for decades (Utah Rivers Council, 2015), where surplus water is slowly converted from an agricultural source to a municipal and industrial resource. An environmental impact statement prepared in 2011 stated the conversion of agricultural water for municipal and industrial use in the Heber Valley posed no significant impacts on local ecological and natural resources (Utah Foundation, 2014, p. 11). The Heber Valley impact statement provides a preliminary study for policymakers to use as a guide. Further studies are needed, however, focusing on conversions in Utah to gather a much larger bank of more conclusive and reliable data—something that is not so easily done due to the state's slow conversion rate of irrigated lands.

Additionally, the Utah Board of Water Resources projected an agriculutural land conversion rate of 0.54 % per year from 1990 to 2040. This projection is innacurate as the Washington County agricultural land conversion rate was 1.66% between 1990 and 2007 (Nuding, 2013). This increased use of agricultural water in Washington County helps to keep more water in streams and rivers. The Lake Powell Pipeline is essentially drawing water from Lake Powell and the Colorado River (south of the lake as the river flows through it).

A 1993 Divison of Water Resources plan estimated the Kanab Creek/Virgin River Basin had 25,600 acres of irrigated cropland that diverts more than 123,000 acre-feet of water. Of this, 87,800 acre-feet of the agriculturaly diverted water is in Washington County (Blattenberger et al., 2015, p. 1). These numbers show an opportunity to utilize readily availiable water to help offset the need for a pipeline. Though the 1993 report is the most recent, it is expected that more land has become availiable in that time since Southern Utah has expanded its cities to cover more irrigated land.

According the the 2015 Legislative Audit of the Divison of Water Resources (Office of the Legislature, 2015), Washington County has nearly 10,000 acre-feet of water availiable for agricultural water conversion that is nearly guaranteed to be approved for agricultural water transfer by the state engineer. As the availiable water remains untouched, a nearly decade long pattern emerges where municipal and industrial expansion fails to acquiesce all available agricultural water resources. Many cities in Utah require water rights to be transferred to the city when irrigated land is developed and agricultural water becomes available. Aquiring water rights makes the conversion process simpler and cheaper for the city. Springville City is one such example. According to Springville City Code 11-3-307, "At any time development occurs on any property annexed, the owner or developer of the property must tender water shares to the City in accordance with Springville City Code" (Office of the Legislative, 2015, p. 49). The Divison of Water Resources has long acknowledged agricultural water offers a solution to providing water for expanding populations. Slowly, more agricultural lands are being converted as development continues. Around 50% of water use is agricultural in Davis, Salt Lake, Utah, and Weber counties (Utah Divison of Water Resources, 2010). High agricultural use in these counties show that conversions of irrigated land is taking place, albeit slowly. Some conversions have taken place already. Since 1993, more than 10,000 acres of irrigated land in

Washington County have been reduced, much of which having been converted from agricultural use to municipal and industrial use (Blattenberger et al., 2015).

Progress has been made but on a small scale. It is time for the state to seriously consider the potential benefits of agricultural water conversion as a tool to reduce Utah's dependency on large scale water projects, such as the Lake Powell Pipeline.

Policy Analysis

Instream flows, rainwater harvesting, and agricultural water conversion are just a few examples that stress the need for the Utah State Legislature and Divison of Water Resources to address and better coordinate their efforts to ensure water for future generations with cities and local water providers. These water conservation methods provide benefits the Lake Powell Pipeline cannot. Accompanying these conservation benefits are drawbacks that are much easier to amend than any complications that may burden the Lake Powell Pipeline. Moreover, these conservation methods provide an ideal opportunity for the Division of Water Resources to bridge the communication gap with the Division of Water Rights so that better collaboration between the two agencies can produce water policy that benefits all. This communication gap is an ongoing issue identified by the legislative auditor contributing to the poor decision making currently being witnessed in regards to Utah's water future and projects, such as the Lake Powell Pipeline (OLA, 2015).

The primary drawback to these water conservation techniques is a result of the Doctrine of Prior Appropriation (Beneficial Use Basis of Right to Use, 1953; Waters Declared Property of Public, 2010). This legal doctrine, commonly referred to as "use it or lose it," prevents farmers or ranchers, for example, from conserving water due to a fear of losing the rights to water. The reason for urging water rights holders to use their portion of water is to ensure its beneficial use. This use may be labeled beneficial when the economy or overall population benefits. This policy however, is not suited for the Utah's current needs and should be amended to allow for the more nuanced needs of water use now and into the future.

It was not until 2010 that rainwater collection became legal (Capture and Storage of Precipitation, 2010), and even now residents may harvest only 2,500 gallons of rainwater under state law. This policy platform seems to be centered around increased city utility revenue and promoting economic expansion. This policy, though, cannot sustain our state as we enter a new era of uncertainty—economically and ecologically—over an ever-growing water demand. Throwing significant sums of money at our water problems will not promote proactive water planning that encompasses all of Utah's needs. To become a water efficient and sustaining state, instream flow policies must be altered and multiple water conservation alternatives need to be implemented on a larger scale.

The Lake Powell Pipeline is a project the state of Utah should not advance or support as it is currently proposed. Instead, water conservation alternatives and the data behind them cannot responsibly be ignored. The pipeline's costs are not only unrealistic for small counties, such as Washington County, to repay, but are also unclear as project plans are continually changing. Furthermore, the negative environmental impacts of the pipeline project are not concrete or readily provided in state reports of the pipeline, attributed again to the uncertainty of planning around the Lake Powell Pipeline.

Water is becoming increasingly scarce worldwide. Utah must not ignore the realities of future water shortages and climate change through the construction of expensive, ineffective major projects, such as the Lake Powell Pipeline. More informed policy solutions are possible through these water conservation methods. Without an overhaul of state water policy, our water future will remain uncertain.

Conclusion

Through a review of recently available data, it appears that the Lake Powell Pipeline is not the economically or ecologically advisable policy option it was once thought to be. In contrast, the pipeline's ecological impacts are detrimental to the well-being and vitality of Utah's rivers, steams, lakes, and their resources. Also affected are the non-human life and keystone speicies important to the natural regulation of Utah's wilderness. In addition, if Utah is to remain financially and economically solvent, its water resources must be regulated and governed properly.

To address these concerns, the Divison of Water Resources and the Utah Board of Water Resources should rethink the current approach to securing water access for future generations in the interest of both current and future citizens. This project, as proposed, will invoke severe consequences on the state's economical and ecological health in the long term, not to mention a litany of negative effects to downstream communities in the Colorado River Basin. The alternative water conservation measures highlighted in this research have significant potential and should be considered along with recent requests for improved data collection policies. Together, a more holistic approach will provide a successful solution to Utah's water dilemma. In sum, based on the arguments presented here, it would be folly to pursue the Lake Powell Pipeline and continue to ignore feasible water conservation alternatives currently ready for implementation.

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