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INSTREAM IMPACT

Leveraging Water Transactions for Environmental Flows

A Group Project submitted in partial satisfaction of the requirements for the Master of Environmental Science and Management for the Bren School of Environmental Science & Management

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The Bren School of Environmental Science & Management produces professionals with unrivaled training in environmental science and management who will devote their unique skills to the diagnosis, assessment, mitigation, prevention, and remedy of the environmental problems of today and the future. A guiding principal of the School is that the analysis of environmental problems requires quantitative training in more than oe discipline and an awareness of the physical, biological, social, political, and economic consequences that arise from scientific or technological decisions.

The Group Project is required of all students in the Master of Environmental Science and Management (MESM) Program. The project is a year-long activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Group Project Final Report is authored by MESM students and has been reviewed and approved by:

James Salzman

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Abstract

Water scarcity poses an enormous environmental challenge in the western United States. As cities grow and agricultural operations expand, so do their water diversions from rivers and lakes, leaving less water for the environment. The decline of coal energy production, however, may be the environment's unlikely answer for supplemental water supplies. Increased competition with natural gas and renewable energy, as well as requirements for compliance with environmental regulations, are driving the decommissioning coal-fired power plants (CFPPs) throughout the west. The Nature Conservancy (TNC) has identified this changing energy landscape as an opportunity to improve instream flows and advance conservation objectives. If the organization can successfully leverage water transfers to acquire water rights from retiring CFPPs, critical resources could be reallocated back to the environment. Thus, the members of the Instream Impact team sought to address the question: Is the procurement of water rights from retiring CFPPs for environmental purposes a sound investment strategy for TNC? To offer an informed response, the team identified 35 retiring CFPPs in the western states and conducted three case study analyses. To assess each acquisition opportunity, the team explored (i) the role of state-specific water law in environmental flow transactions, (ii) the likely outcomes of discrete funding models, and (iii) the potential to deliver conservation results. They hope that their research will help inform future decision-making so that western states can continue to maintain healthy populations, robust economies, and magnificent environments—all of which rely on water resources.

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The Nature Conservancy

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Table of Contents

List of Figures

List of Tables

Executive Summary

Coal has played a central role in the United States since the nineteenth century. Recent decline in consumption of this fossil fuel for energy production, however, signals a watershed moment for a nation built on coal. With the rapid deployment of natural gas and renewable energy technology, coal-fired power plants (CFPPs) are closing across the country.

The Nature Conservancy (TNC) has identified the changing energy landscape as an opportunity to leverage water transfers for alleviating water scarcity and advancing conservation objectives, particularly in the western United States. If TNC can successfully acquire water rights from retiring CFPPs, critical water resources could be reallocated back to the environment. Thus, the members of the Instream Impact team seek to address the question: *Is the procurement of water rights from retiring CFPPs for instream flows a sound investment strategy for TNC?*

Three key tasks were completed to inform a response. First, the team performed data collection, compilation, and analysis to identify the potential to reallocate water from retiring CFPPs to the environment in the western United States. Next, the team conducted three cases study analyses in which the following dimensions of each procurement opportunity were explored: (i) the enabling conditions of state-specific water law, (ii) the financial implications of discrete investment strategies, (iii) the potential for instream flow augmentation and delivery of conservation results, and (iv) the role of risk and uncertainty. Finally, the team extrapolated, organized, and packaged the lessons learned from each case study into a document that may guide TNC in future acquisition opportunities.

Purpose and Objectives

The purpose of this research is to assess the water rights of three decommissioning coal-fired power plants (CFPPs)—Coleto Creek Power Plant (TX), Colstrip Power Plant (MT), and JE Corette Power Plant (MT)—in order to (i) inform a recommendation on the specific procurement opportunity, and (ii) develop a document that may guide TNC in future procurement opportunities. The primary objectives of this report are to:

(1) Compile coal industry data and assess coal plants' water use

a. Investigate factors driving the decline of coal throughout the United States
b. Identify CFPPs in the western United States expected to decommission (i.e., retire or convert to a natural gas facility) within the next twenty years
c. Determine CFPPs in the western U.S. for in-depth analyses (i.e., "priority CFPPs")

(2) Conduct research on state water law

a. Investigate the similarities and differences in state water law across the western U.S.
b. Identify the enabling conditions of state law for water transfers and environmental flows, particularly with respect to non-governmental organizations

(3) Develop methodology to assess water rights from CFPPs

a. Assess CFPP water rights, water use, and diversion or storage infrastructure.
b. Analyze costs and benefit associated with two financing strategies: public/private funding and impact investing.
c. Quantify instream flow augmentation and assess environmental benefits.

(4) Apply methodology to three priority CFPPs: Coleto Creek, JE Corette, and Colstrip

a. Conduct in-depth analysis of three priority CFPPs—Coleto Creek Power Plant (TX), Colstrip Power Plant (MT), and JE Corette Power Plant (MT)—using methodology
b. Make recommendations to TNC about investment options

(5) Create a guidance document to assess future water rights acquisition opportunities

a. Extrapolate lessons learned from each case study to develop a document that may inform TNC's future acquisition opportunities
b. Develop CFPP Water Right Acquisition Checklist to analyze future opportunities

Project Significance

The recent trend of increasing water scarcity and the decommissioning of CFPPs across the western United States presents a unique problem and opportunity. Water supplies have historically fueled the growth of cities, agriculture, and energy production in the western U.S., and, as a result, environmental needs have competed for scarce water resources. Freshwater species, riparian plants, and migratory waterfowl depend upon habitat conditions directly influenced by the volume and timing of water flow.[1] Freshwater diversions to meet the needs of competing water users have continued to deplete freshwater from riparian ecosystems, and only recently has the environment been recognized as a beneficial use across western states.

Coal energy generation requires large amounts of water for cooling, historically representing a significant portion of industrial water use. Over the past decade, however, coal energy production has experienced a sharp decline as natural gas and renewable energy—two sources that require substantially less water for operations—have been on the rise. This decoupling of water use and energy production presents opportunities to acquire water rights associated with retiring CFPPs to provide environmental benefits.

TNC is working directly with municipalities, agricultural producers, and industrial stakeholders, as well as donors and investors to purchase water for nature. This project is intended to inform TNC's current work in water transaction to include acquisitions from energy sources.

The project identified retiring CFPPs in the western U.S., and, when possible, the water rights, volume of water, and source of water associated with those plants. Three in-depth case studies were conducted to contextualize the problem and better identify the information necessary for assessing the feasibility of potential transactions. The case studies identified potential financing options, lessees, and environmental flow needs in the region, which culminated in a recommendation for each of the three water right purchase scenarios. The case studies not only serve to illuminate the feasibility of specific scenarios but also provide a framework for assessing future transactions by identifying important enabling conditions and cost-effectiveness measures.

The research project provides TNC with insights concerning the feasibility of acquiring water rights from CFPPs, both from a financial and conservation perspective. The project summarizes the conditions for which investing in a CFPP water right produces relevant conservation benefits and financial returns. As a result of this project, TNC has a framework for effectively analyzing CFPP retirement scenarios. If this project catalyzes environmental flow transactions, potential beneficiaries will include not only the owners of decommissioned or converted CFPPs but also farmers, water managers, rural communities, and natural ecosystems through the permanent or temporary transfer of water.[1] Most importantly, the purchasing of water either for dedication to environmental flows or for transfer to downstream users can help restore water flows to freshwater ecosystems.

Chapter 1: Background

U.S. Energy Landscape

Coal is a sedimentary rock formed from decayed organic matter.[2] The most abundant fossil fuel in the United States, coal has long served as an essential source of energy.[2] In the nineteenth century, coal fueled locomotives; today, it powers the country with electricity. The influence of coal, however, extends far beyond its energy-generating potential. Coal has spurred labor organization, technological innovation, and economic growth.

The United States is organized in five coal basins: (i) the Appalachian Basin, (ii) the Illinois Basin, (iii) the Gulf Coast, (iv) Rocky Mountain/Great Plains, and (v) Colorado Plateau. The Rocky Mountain/Great Plains and Colorado Plateau coal basins encompass all coal mines currently in operation in the western region of the country.

Coal Industry Trends

In 2011, the U.S. coal industry was booming. Demand had recovered from the Great Recession, prices witnessed record highs, and the market value of the four largest mining companies reached a combined $33 billion.[3] Over the course of the following five years, however, U.S. coal production fell by 27%, prompting the release of more than 58,000 coal miners and contractors from their jobs.[3] In the western U.S., coal production began its decline as early as 2004, and has continued to decline over the next decade (Figure 1).

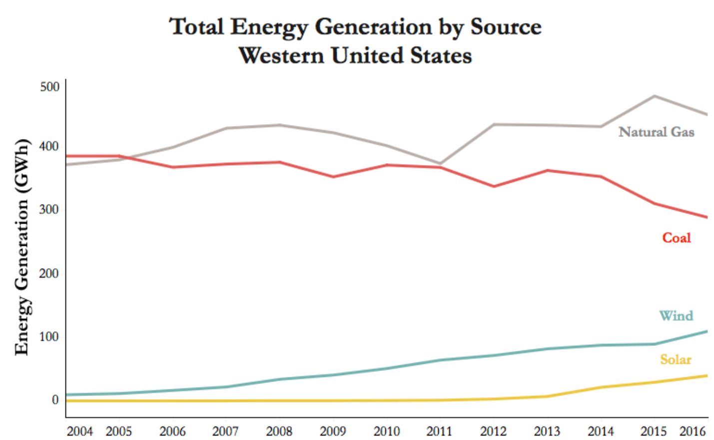

Figure 1: Net energy generation by source in the western U.S. from 2004 to 2016 (includes Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming).[68]

The recent decline of coal production in the U.S. has been driven primarily by domestic market forces. As the cost of natural gas and renewable energy production declines, these sources continue to comprise a greater proportion of the U.S. energy profile. The rise in natural gas is attributed to more efficient and cost effective horizontal drilling and hydraulic fracturing. Advancements in hydraulic fracturing technologies have allowed U.S. mining companies to improve the productivity of existing wells and expand the reach of extraction. A surge in domestic supply has driven down the price of natural gas and transformed the American energy landscape.[3] For the first time in decades, natural gas surpassed coal as the country's principle electricity-generating source in 2016.[4] The Energy Information Administration (EIA) projects that natural gas will continue to outcompete coal in the upcoming decades (Figure 3).[4] Additionally, increased renewable energy generation can be attributed to the declining marginal cost of wind turbines and solar photovoltaic panels as production technology improves. Additionally, the advances in renewable technology have greatly reduced operational and maintenance costs compared to coal and natural gas.

Environmental Regulations

Environmental regulations promulgated by President Barack Obama represent another financial blow to the coal industry. The suite of initiatives, which attempt to correct "grandfathering" practices pervasive in the Clean Air Act (CAA), aim to set more stringent environmental performance standards and require utilities to implement expensive emissions-control technologies. Of the ten regulations advanced by the administration, only four took effect before 2016:

1. The **Cross-State Air Pollution Rule (CSAPR)**, which seeks to address the interstate transport of air pollution by requiring upwind states to reduce SO_2 and NO_x emissions.[5]
2. The **Mercury and Air Toxic Standard (MATS)**, which sets technology-based emissions limitations on mercury, acid gases, and toxic pollutants from power plants.[6]
3. The **Cooling Water** Intake, which regulates the design and operation of intake structures in order to reduce the mortality of aquatic organisms.[7]
4. The **Coal Combustion Residuals**, which establishes technical requirements for the safe disposal of coal ash from CFPPs.[8]

Although the future of Obama-era environmental regulations under the Trump administration is uncertain, the country's social landscape make prospects for the coal industry's recovery low. In a nationally representative survey conducted shortly after the 2016 presidential election, seven in ten registered voters—and nearly 50% of Trump supporters—affirmed the United States should participate in an international agreement to curb global warming.[9] Despite President Trump's attempts to dismantle environmental regulations (both internationally and domestically), mounting public concern will likely continue to drive policy and market changes that ensure the transition toward clean energy alternatives.

State and local environmental regulations have been an increasingly important factor contributing to decommissioning CFPPs in the west, as all states are required to maintain and regularly update their Climate Action Plans to address emissions. For example, Colorado, Oregon, and Montana have all recently passed clear air legislation. Colorado is of specific interest for decommissioning CFPPs as they recently passed the Clean Air – Clean Jobs Act (2015), which seeks to reduce emissions statewide. This has facilitated recent and projected decommissioning of almost half of the state's CFPPs within the next ten years.

Future Energy Projections

U.S. coal production has been declining for less than a decade, and the U.S. EIA projects this trend to continue through 2050. As shown in Figure 2, coal energy production is expected to decline substantially—by 34 to 58% by 2050—under three projection models, the reference case, high oil and gas technology and resource use, and high resource use without the Clean Power Plan (CPP). Both the reference case and high oil and gas production scenarios assume that the government will enforce the CPP; thus, both

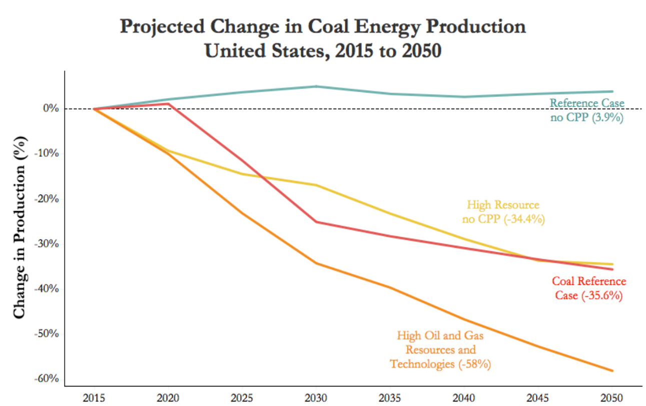

Figure 2: U.S. EIA projections for domestic coal energy production.[10]

market forces and environmental regulations will continue to drive down coal production in these scenarios. Only one scenario projects a slight increase of less than 4% in coal production over this time: the reference case without the CPP.[10] These projections show that the recent trend of decline in domestic coal production is likely to continue, but depends on domestic energy market conditions, developments in technology, and federal enforcement of the CPP.

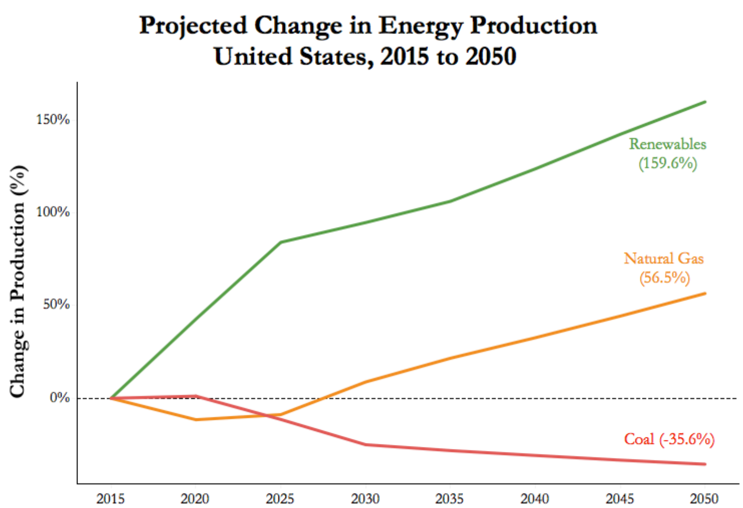

Figure 3: U.S. EIA projections of change in domestic energy production from 2015 to 2050 by energy source. Energy sources modeled under reference case scenario conditions, which assumes continued improvements to existing technologies and relevant regulations remain unchanged and reflects current economic forecasts.[10]

The U.S. EIA projects that an increase in renewable energy, natural gas, and hydroelectric energy will offset energy losses projected from the decline in coal production over the next 30 years. By 2050, solar and wind energy sources are projected to increase by nearly 160%, natural gas is projected to increase by about 56%, and hydroelectric is projected to increase by about 47% (Figure 3). The significant increase in renewable energy and natural gas is attributed to the declining cost of technology and production. This increased availability of these energy sources will continue to drive down the demand for coal.

International Market

Coal consumption abroad also drives domestic trends. East Asian markets—in particular, China—influence global coal prices and, consequently, U.S. export sales.[3] In fact, it was largely China's insatiable demand for energy that spurred the turn-of-the-century boom in U.S. coal production. Between 2001 and 2011, a disproportionate share of Chinese investment was channeled into infrastructure development, increasing the country's energy demand by 250% and inflating coal prices on international markets.[3] This made U.S. exports to Europe and Latin America commercially viable. When the structure of Chinese growth moved away from heavy industry, the slowdown in energy demand "sent shockwaves through global coal markets that reverberated within the United States."[3]

Unfortunately for U.S. coal producers, it is unlikely that international markets will bring about a resurgence in domestic production. China has passed its energy-intensive phase of development, and India—the closest runner up in driving global demand—will be unable to carry the baton due to its largely energy-light economy. Furthermore, the EIA projects that growth in coal demand from the remaining developing countries will be negligible between 2015 and 2020.[3] Going forward, therefore, it is unlikely that emerging economies will create enough demand to offset the decline Chinese consumption.

Water Use in the Energy Sector

Energy production is historically linked to water use because of the integral role steam plays in coal, gas, oil, and nuclear energy generation. Water requirements for electrical power generation are variable not only based on fuel type but also cooling system type.[11] Consequently, as power generation shifts away from coal, water use for power production will also shift. Coal is one of the most water-intensive sources of energy, second only to nuclear (Table 1). As energy generation from coal declines significantly and natural gas, wind, and solar continue to increase, the water intensity of the west's energy profile will continue to decrease, revealing a decoupling of these systems in the west.

Table 1: Water use by fuel type (coal, nuclear, natural gas, concentrated soal, solar photovoltaics, wind), cooling (once-through, pond, tower, dry, inlet) and technology.[12]

Fuel Type	Cooling	Technology	Median Withdrawal (gal/MWh)	Median Consumption (gal/MWh)	Consumptive Use Factor
Coal	Tower	Generic	1,005	687	68%
Coal	Once-Through	Generic	36,350	250	1%
Coal	Pond	Generic	12,225	545	4%
Natural Gas	Tower	Combined Cycle	253	198	78%
Natural Gas	Once-Through	Combined Cycle	11,380	100	1%
Natural Gas	Pond	Combined Cycle	5,950	240	4%
Natural Gas	Dry	Combined Cycle	2	2	100%
Natural Gas	Inlet	Steam	425	340	80%
Nuclear	Tower	Generic	1,101	672	61%
Nuclear	Once-Through	Generic	44,350	269	1%
Nuclear	Pond	Generic	7,050	610	9%
Wind	Wind	Wind Turbine	0	0	0%
Solar Photovoltaics	N/A (Utility Scale)	Utility Scale PV	26	26	100%
Concentrated Solar	Tower	Trough	865	865	100%
Concentrated Solar	Dry	Power Tower	26	26	100%

While withdrawal rates are important for understanding the quantity of water removed from a system, consumption rates allow for a better understanding of the net quantity of water that could potentially be returned to the environment. The timing and quality of non-consumed return flow from a CFPP can, however, still have major environmental impacts. As such, those qualities should be assessed along with the net quantity of water returned to a system.

As coal-fired energy generation declines, water demand for energy production also declines. This creates opportunities to reallocate water rights historically used for coal energy production, although there is uncertainty about the actual amount of water becoming available for transfer to other use. While the U.S. Energy Information Administration (EIA) reports yearly on water use and consumption by the energy sector, the data has limitations. A report by the Union of Concerned Scientists reveals that withdrawal and consumptive use amounts reported to U.S. EIA are significantly different from calculated rates based on cooling technology.[11] This discrepancy in actual water use creates legal uncertainty for potential transfers, as these reports reveal potential differences in actual historic use and reported to the U.S. EIA or stated on the plant's associated water right.

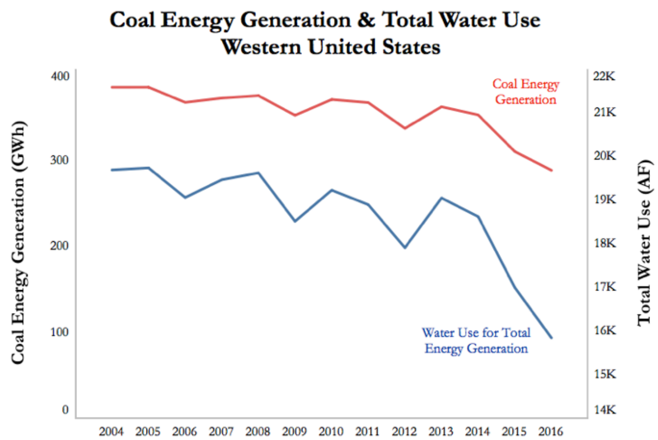

Figure 4: Coal energy production in the west declined by about 100 GWh between 2004 and 2016, which resulted in a reduction of approximately 5,000 acre-feet (AF) in water use for total energy production (coal, natural gas, wind, and solar).[68,69]

Water Law and Enabling Conditions for Water Transactions

The following sections outline important aspects of the water landscape in the western U.S., which will create a basis for understanding and analyzing options available for moving water from the energy generation sector back to the environment. This will include an overview of water law, the water rights permitting system, and potential water transactions enabled by the law. It concludes by outlining a framework for evaluating environmental water transactions, which is implemented through case studies later in the report.

Water Law and Water Rights

Water law comprises the rules and regulations that determine how surface water is diverted and used across the Unites States. While each state has its own separate body of water law, many similarities exist between how water is regulated. Water law in all states plays two important functions through: (i) outlining the water rights permitting system and (ii) outlining the process for selling, leasing or transferring water rights (water transactions).

States in the western U.S. follow the prior appropriation doctrine for the use of surface water, which allocates surface water through a water right permit allowing the permit holder to divert water. This differs from the riparian right allocation system, which preceded the prior appropriation system and remains prevalent in the eastern U.S. The riparian system allocates water based on land ownership abutting a river or stream. The prior appropriation system, however, allows for the diversion and use of water on land that is not adjacent to the river or stream where it originated. Although the ways in which a water right is defined vary slightly between western states, Figure 5 represents important attributes for most paper water rights.

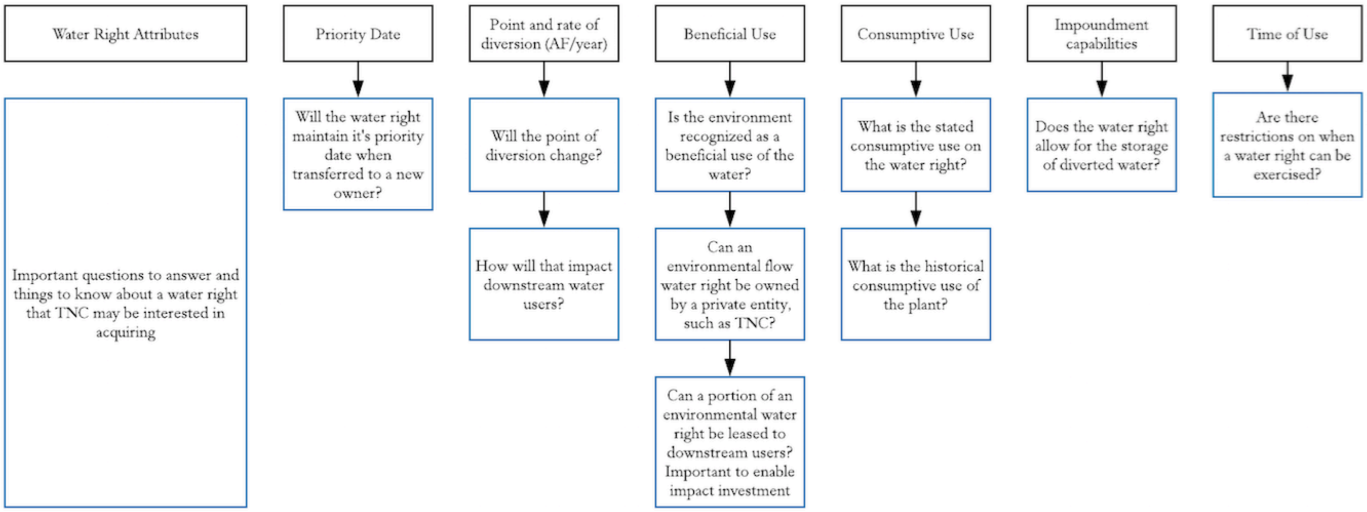

Figure 5: The primary attributes of and information about the water rights that are taken into account in the assessment of case studies.

A change in one or more of these attributes necessitates oversight from the state permitting agency. Such a change occurs when a water right is bought or sold and will be covered in more detail in the following section. Of the attributes outlined above, beneficial use is of particular importance in that it outlines what the state recognizes as a beneficial use of state waters. Up until recently, water held for instream flows was not recognized as a beneficial use and so could not be protected through the water rights permitting system.[13]

Importantly, water rights allow for the use of a specified amount of water but not the ownership of the water itself. This is relevant during years when there is not enough water to accommodate all water rights, in which case, the priority date of a right determines the order in which water is allocated.[14] Consequently, water rights with earlier priority dates are often more reliable and thus more valuable. In drought years when water supplies are strained, all senior water rights will be fulfilled before junior uses can divert water as specified by their water right.

In many states, permitting agencies also have the authority to cancel all or portion of a water right if it is not being actively used. This is known more colloquially as the "use-it-or-lose-it" clause and can lead to inefficient water usage since a water user can lose access to a water supply if they can't show record of historical beneficial. Water transactions will be covered more in the following section, but some states allow for the sale of conserved water, which helps counter the inefficient use of water.

Water Transactions

A state's water law outlines not only how surface water is used via the water right permitting system but also how existing water rights are amended. The ability of "freed" water resources from the energy generation sector to be used by others, including the environment, requires a system for water transactions to be in place. State-specific water law determines the legality and ease for which such transactions occur.

A key objective of the project is to determine areas that are best suited for acquiring water rights to supplement instream flows. An understanding of which states are favorable to water transactions in general, as well as environmental transfers is a key aspect of this analysis. For example, in certain scenarios, TNC may be interested in purchasing a water right with the intention of allocating the entire right to instream flows. This scenario relies upon an understanding of environmental water transfers, which differ from state to state. TNC may also, however, have an impact investment scenario in which a portion of the water right may be dedicated for instream flows while a portion is left available for downstream leases. In such a scenario, understanding the broader body of water law dictating water transfers more generally is important as well.

Sales and Leases of Water Rights

More generally, a water transaction occurs when there is the sale or lease of a water right. The permanent sale of a water right necessitates a change in at least one of the water right attributes listed above. For a change to be approved by the respective state permitting agency, it must be concluded that the change will not adversely affect other water rights holders, both ones that are more AND less senior. Each state water law has its own definition of and method for determining whether an adverse effect will occur.[14] Typically, an amount up to the historic amount of water diverted and historic consumptive use of the water right can be changed.[15] As such, an applicant must provide information concerning the historic beneficial use of the water and the extent of historical use and consumption.

Terminology between states can differ but the temporary sale, or lease, of a water right does not require as much oversight from the permitting agency since the attributes of the water right are not permanently changed. In Montana, a water right may be temporarily changed for up to 10 years with the option to renew for 10 more years. There is no limit to the number of times it can be renewed but it must be approved by the DNRC (section 85-2-407, MCA).[15]

The short-term sale of a certain amount of water is also allowed in many cases, in which case oversight is extremely low because the underlying water right is not being amended at all. Typically, such a transaction can happen as long as the rules dictating the use of the water on the underlying water right itself are not altered (e.g. point of diversion, rate of diversion etc.). Finally, many states allow for the lease or sale of conserved water, which incentivizes a water rights holder to make efficiency gains and/or reduce losses in their system.

The state oversight necessary for water rights transfers in all 12 states makes the process time-consuming and uncertain, increasing transaction costs of water rights transfers and likely adversely impacting the number of transactions that occur.[16] Higher transaction costs affect *any* water transfer but significantly deters environmental transfers from occurring by creating an added obstacle.

Environmental Transfers

All western states recognize fish habitat and recreation as a beneficial use of water, to some extent.[16] States do, however, differ in the permissible purposes or locations of environmental transfers, how long the transfers last, and who can hold the water rights associated with an environmentally beneficial water right.

The following list represents states where TNC can legally hold water rights for environment flow purposes.[16] Unless otherwise stated, such a water right can be held in perpetuity:

- **California** (conserved water can legally be set aside as an environmental flow)
- **Montana** (only for a 10-year time period at which point the water right must be renewed)
- **Nevada** (founded on a Supreme Court case rather than statutory law)
- **New Mexico** (but the original priority date may not be maintained)
- **Texas**
- **Utah** (private nonprofit fishing groups and state agencies are the only entities able to hold an instream flow; to date, only the Division of Wildlife Resources holds instream flow rights)
- **Washington** (only instream flow water rights held by the state are exempt from relinquishment or abandonment)

In the following states, environmental flows are recognized as a beneficial use of water but only the state or a political subdivision of the state can hold those rights. While TNC would not be able to hold an environmental flow water right in these states, they are still worth investigating, as negotiations can be made with state agencies to donate such water rights to improve environmental flows:

- **Arizona** (if the water right is to hold its original priority date)
- **Colorado** (Colorado Water Resource Board)
- **Idaho** (Idaho Water Resource Board)
- **Oregon** (Oregon Water Resources Department)
- **Wyoming** (State of Wyoming)

Where water markets are present, such transactions can happen more efficiently. Water markets are an effective market mechanism that allow for the buying and selling of water rights between users. Water transactions, which culminate into a water market, is a potential tool for restoring stream flows by purchasing or leasing water rights to alter appropriative water rights from their current beneficial use (e.g. electrical generation) to instream flow.

It is important to take into account the impacts of environmental water transfers on other water users—especially rural communities and Native American tribes. Transferring water to new uses signals shifts in water-intensive sectors, which has direct impacts on local economies, especially in rural communities near these decommissioning CFPPs. Some CFPPs' water rights may be affected by Native American tribal water agreements, and thus, should be considered when assessing transaction opportunities.

While the rules dictating the transfer of water rights are essential for understanding where such environmental transfers can occur, other factors likely influence the frequency of these transfers as well. Such factors may include funding availability, political and social attitudes, agency priorities and staffing, level of water trust or other conservation NGO activity within the state, and legal mandates to restore stream flows.[16]

Valuation of Environmental Water Transactions

The value of water varies greatly by use and state throughout the west. For transactions in most western states, municipal buyers have the greatest willingness to pay, followed by the agricultural sector and environmental uses. The value of environmental uses of water may be comparable or significantly lower than agricultural uses, and often underestimates the full value of the environmental benefits it creates. In any case, environmental water demand varies greatly by state but is highest in Nevada, Wyoming, Arizona, Colorado, New Mexico, and Utah. For example, in Arizona and Nevada, agricultural and environmental uses of water are cost competitive whereas in Wyoming, and environmental water uses are more cost competitive with municipal uses.[17] Alternatively, environmental uses of water are significantly cheaper in Colorado and New Mexico, compared to both municipal and agricultural uses.[17]

The differences in value of water for environmental purposes across the western US may signal to potential purchasers of instream flow rights where it is more cost-effective to make such investments. For example, TNC may be more interested in purchasing water where the price is not competitive with other uses, such as municipal or industrial, since the lower price may signify less competition with the environment or greater community acceptance of environmental flow rights. Alternatively, the greatest environmental benefit may come in locations where environmental water uses are more cost competitive with municipal and agricultural uses since the price likely accounts for the relative scarcity of water in the region. Along with the location of an environmental water transaction, the length of a transaction can impact the cost-effectiveness of a transaction as well as its long-term viability. In states where environmental water transactions are more controversial, short-term transfers may be a beneficial strategy for engaging skeptical community members and convincing stakeholders that a win for the environment does not have to mean a loss for the economy or local businesses.[18]

Often, funders of environment water transactions are focused on achieving a specific environmental goal that aligns with their institution's mission. While this focus is commendable, it often leads to the under-utilization of cost-effective measures other uses for those funds are not examined.[19] An alternative approach would be to examine a range of environmental water transactions, the associated environmental benefit, and the total cost of the transaction. By choosing projects based on their cost-effectiveness rather than just the outcome, funders of environmental water transactions can have a larger impact in the long run.

Chapter 2: Methodology

To assess the potential of water from retiring CFPPs to benefit the environment retiring CFPPs were identified, and in-depth case studies of representative CFPP retirement scenarios were conducted. The methodology is split into two parts: (1) identifying retiring CFPPs and selecting appropriate case studies and (2) a four-part methodology for assessing retiring CFPPs used for the case studies. The four-part methodology includes (1) an analysis of water rights held by the CFPP, (2) the potential impact of augmented instream flows, (3) identification of conservation priorities, and (4) a financial acquisition assessment. Each case study culminates in a recommendation for TNC, which identifies known uncertainties and risks associated with different courses of actions.

Selection of CFPPs

A comprehensive database of CFPP retirements in the western U.S. was compiled using data from the U.S. Energy Information Administration Form EIA-860, which collects information at the generator level (Figure 6). Water usage data was acquired from a report by the U.S. Geological Survey (USGS) as well as estimates calculated by the Union of Concerned Scientists. To verify the accuracy and completeness of the database, an August 2017 monthly update by Doyle Trading Consultants, LLC was reviewed to determine all CFPPs of interest where identified.

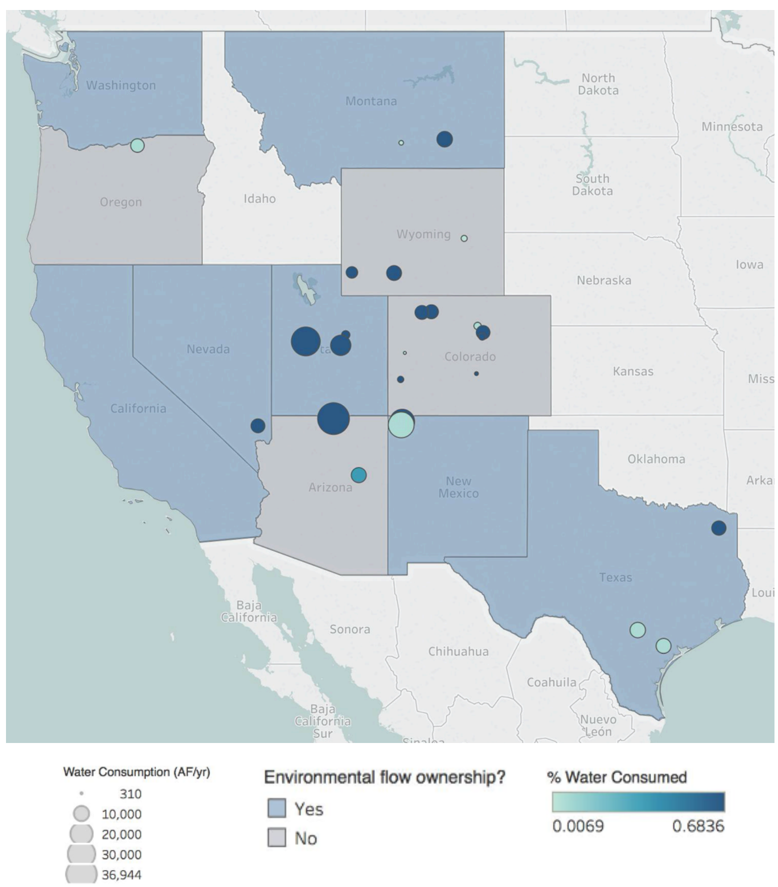

Figure 6: Map of 35 CFPP retirements (2015-2030) in the western U.S. Capacity and water consumption of each plant are indicated by size and color, respectively.

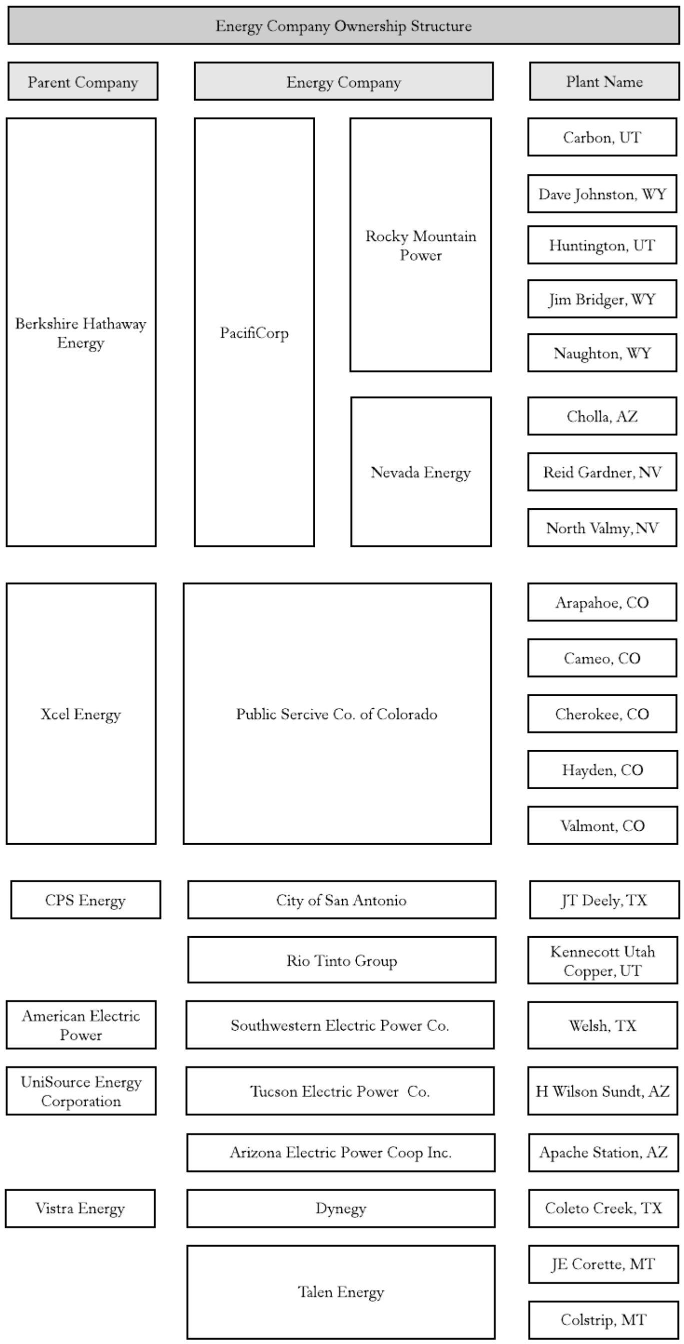

Figure 7: Ownership structure of large energy companies in the

The database of retiring CFPPs was used to identify and research the operating and parent companies the CFPPs. Often, the same companies own part of multiple plants so understanding the ownership landscape is important for determining the feasibility of transactions. The ownership structure of large energy companies in the west is summarized in Figure 7.

Where possible, water rights from retiring CFPPs were identified by accessing various state agency websites. Often, electronic copies of the water rights were available online. In other cases, state agencies were contacted for copies of water rights held on file.

Below is a list of western states in which retiring CFPPs were identified. Preliminary research was done on each state's water law to determine the status and flexibility of environmental water transfers. Lessons learned from the various state's water law and other site-specific research is summarized below (number indicates the number of identified plants in each state, most information is from EIA Form 860, unless otherwise indicated):

- **Arizona (4) –** all of the identified plants use groundwater or surface from the Colorado River Basin. The plants that use groundwater are not located in an Active Management Area (AMA), which means pumping is not regulated beyond pump specifications and there are no paper water rights to be transferred.[20] Colorado River Basin water transactions were not pursued because it necessitates inter-state water law, which is beyond the scope of our project.
- **California (3) –** all of the identified plants in California have already retired and it was unclear what, if anything, has happened with their water rights.
- **Colorado (9) –** a majority of these plants (5) are owned by Excel Energy, which already has agreements in place with local municipalities to trade effluent water for the CFPPs high-

priority freshwater right and so such scenarios will be difficult to move water away from municipal use and back to the environment.[21]

- **Montana (2)** – both identified plants are owned by the same company (Talen Energy) and draw water from the Yellowstone River. While one plant is set to retire in 2022, the other plant already retired in 2015 but it is unclear if anything has happened to the water right. This may be an opportunity to acquire multiple rights in a single transaction since the ownership and source of water are consistent between plants.
- **New Mexico (2) –** two retiring plants were identified, Four Corners and San Juan. Both plants are owned by Tucson Electric Power Company (TEP) , which plans to reduce its coal-fired capacity by 508 MW between 2017 and 2022.[22]
- **Nevada (2) –** two retiring plants were identified, North Valmy and Reid Gardner, but the regional TNC office requested that the plants not be looked into further because of current relationships on the ground.
- **Oregon (1) –** one planned retirement was identified in Oregon, Boardman Plant, which is the last CFPP in the state. The planned retirement year for the plant is 2021. While an in-depth case study was no completed, preliminary research on the plant and the surrounding area is summarized in the appendices.
- **Texas (6) –** initially, three planned retirements were identified, JT Deely, Welsh, and Coleto Creek Power Plants. Because of initial work and interest by the regional TNC Texas office, an in-depth case study of Coleto Creek was completed and is summarized below in the results section. Welsh was determined to not have downstream water users or pertinent environmental water needs. JT Deely may be of interest because of its location near San Antonio and should be looked into further. As of January 2018, three more retirements were identified and a ranking of potential transactions within Texas is summarized in the results.
- **Utah (4) –** four plants of interest were identified, of which, two have already retired and the other two are set to retire in 2025 and 2035. Because of the relatively long timeline for these plants and a lack of available information, case studies were not completed for these plants.
- **Washington (1) –** there is only one CFPP left in the state of Washington, of which, one unit is set for retirement in 2020 while the other in 2025. An in-depth case study was not completed for this plant, but since Washington has a history of supporting instream flows, this could be a scenario that should be analyzed more thoroughly. It should be noted, however, that unless an instream flow right is held by the state, it can be relinquished or deemed abandoned at any time.
- **Wyoming (5) –** five plants were identified, of which, two retired in 2014. One plant, Naughton, was planned to retire in 2017 but plans changed after the state of Wyoming extended the deadline for retrofits out to 2018.[23] The plant will either be decommissioned or switch to natural gas at that point. In-depth case studies were done for the Wyoming plants because of uncertainties in the retirement date and final outcome. The planned retirement date for the other plants is 2027.

Montana and Texas were identified as appropriate states to conduct case studies on retiring CFPPs because of TNC regional support and appropriate water law. Compared to retirement scenarios in other states, a combination of available data and interest from regional TNC offices helped to focus the scope of our project on three case studies in those states. The selected case study plants also provide a breadth of different cooling technologies and storage capabilities so better represent the diversity in possible retirement scenarios.

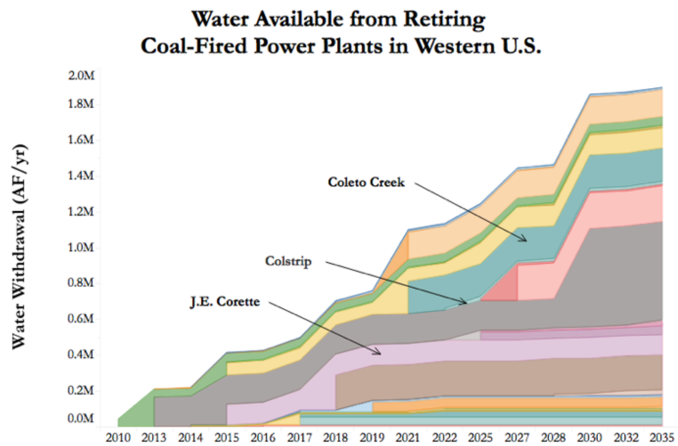

Figure 8: More than 35 coal plants will retire between 2010 and 2035. As a result, nearly 2 million acre-feet (AF) of water withdrawals historically used for cooling will become available.

Case Studies of Priority CFPPs

Three in-depth case studies were conducted for selected CFPPs in the states of Texas and Montana. A combination of applicable state water law, appropriate plant closures, and support from regional TNC offices supported the selection of these CFPPs. Each case study includes an analysis of (a) water rights held by the plant (b) financial acquisition options, (c) instream flow augmentation potential, and (d) relevant conservation opportunities. Below is a description of what each section of the case study includes.

Water Right Analysis

For each case study, relevant water rights were identified and analyzed to inform the amount and location of water diversion and use as well as other use stipulations surrounding the water right (e.g. duration of water use or associated storage capabilities). Surface water rights were the focus of the analysis but in some cases, rights associated with groundwater and/or dams were also analyzed to understand if there was a conservation potential from removal of infrastructure or improvement of groundwater contamination. The water right analysis also shed light on the consumptive vs. non-consumptive amounts of water use for each CFPP, which is sometimes noted in the water right. TNC is most interested in consumptive water use because that represents a net increase in water that can be returned to the system. The benefits associated with non-consumptive water usage is much more difficult to quantify and may be negligible. The water right analysis as helped to inform the reliability of water right in terms of its priority date and thus the likelihood of the fulfillment during a year when water levels in a particular basin are impacted.

Instream Flow Augmentation

To understand the relative magnitude of water that would be added to the stream, the consumptive amount of the water right was compared to USGS stream gauge data from a point downstream of the power plant. Two different scenarios were used, one where the power plant *cannot* store the water, so the instream flow volume increase is spread throughout the year, and another scenario where the power plant *can* store the water and thus time the release of water downstream.

Some water rights have the maximum flow rate for a water diversion written on the document. If it was possible to determine the flow rate of the consumptive use portion of the water right, then dividing that flow rate of the water right by the discharge rate of the stream gives an easy way to understand the relative amount of water added to the stream.

$$J\% = \frac{F\ (cfs)}{D\ (cfs)} * 100$$

Equation 1: The amount of water added to the stream as the percentage of streamflow in cubic-feet/second. F: Flow rate of consumptive portion of water right, D: Average discharge of stream, J: Percentage of water added to the stream as a result of the water right transaction.

Not all power plants have the maximum flow rates written on the water right. In this situation the relative magnitude of water added to the stream was calculated from the annual volume consumed by the power plant. Assuming that a power plant cannot store its water and that it runs consistently day-to-day, the total volume of the consumptive water right (C) was taken and divided by 365 to get the daily average amount of water that would be added to the stream (V). Then the daily amount of water added to the stream (V) was divided by the average discharge per day (A) since 2006. Finally, this fraction is multiplied by 100 to get the percentage of the water flowing in the stream (J) under average conditions due to the added water right. This can also be done during low flow conditions to see how the water right can contribute during the lowest flows of the water year.

$$V\ \left(\frac{vol}{day}\right) = \frac{C\ (vol)}{365\ (days)}$$

Equation 2: The daily amount of water added to the stream, where C is the total volume of consumptive water right and V represents the daily amount of water added to stream.

$$J\% = \frac{V\ (\frac{vol}{day})}{A\ (\frac{vol}{day})} * 100$$

Equation 3: The added water to the stream as the percentage of average daily discharge, where A is the average discharge per day of stream (Source: USGS stream gauge data) and J represents the percentage of water flowing in stream due to the added water right transaction.

The Coleto Creek power plant in Texas is slightly different since it has the option to store part of its water right. In this situation, the consumptive right in its entirety (V) is compared to the total 7-day low flow values (L) since it is possible to time the release of water from the reservoir. We calculated the consumptive volume of water into a flow rate and assumed that this water would be released over a period of 60 days.

$$R = \frac{C\ (AF) * 435560\ (\frac{cf}{AF})}{60\ (days) *\ 24\ (hr) * 3600\ (s)}$$

Equation 4: The amount of water rate augmentation over a 60-day period as a result of the water transaction period. C represents the total volume of consumptive water right, L signifies the average discharge per day during the 7-day low flow of stream (Source: USGS stream gauge data), and R represents the rate of water flowing through the stream over a period of 60 days.

Knowing the relative increase in stream flow is important information for valuing the affect that this transaction will have on downstream organisms. If the river is so large that adding a few thousand gallons of water to it, spread out over an entire year, will not make a large difference to the organisms that live in the river, then it might not an attractive investment opportunity.

Conservation Priorities

With respect to conservation priorities, our team identified federally endangered species that may benefit (directly or indirectly) from additional instream flows and investigated the benefits that can be harnessed from their non-use value. There is a vast literature on endangered species' biological features, their relation to the water quality and quantity, and the species' non-use values. Thus, their non-use value provided us with a good metric for estimating an important component of expected benefits from water right transactions. For the state of Texas, the primary endangered species of concern was determined as the whooping crane, whereas for Montana, the endangered species of concern is the pallid sturgeon. Some of the valuation methods that were used for endangered species research and included in this project are willingness-to-pay, land value, conservations costs, and revenues from recreational activities.

TNC's main interest in this project lies on transformational change in environmental protection culture through the promotion of a novel instream flow source for habitat benefits, which is unquantifiable by nature. Also, the whooping crane is a federally recognized endangered species with a very small population, which makes non-use valuation an even more challenging task. The pallid sturgeon's main habitat is also located further downstream from the diversion locations, which gives rise to further uncertainties and weakening the case for additional instream flow impacts on the river condition. The resulting values of endangered species via these methods vary significantly and should be handled with caution while making a decision. Therefore, in most cases, conservation priorities cannot be fully quantified. As a result, due to the complex nature of ecosystems, many benefits are likely to be neglected or underestimated as unknown uncertainties.

The data and information on conservation priorities were mostly collected from peer-reviewed articles, water authorities, and local and state agencies in Montana and Texas (e.g. Department of Fish, Wildlife & Parks, Department of Natural Resources and Conservation, Texas Commission on Environmental Quality), federal agencies (e.g. U.S. Geographical Survey, U.S. Department of the Interior, U.S. Fish & Wildlife Service), non-governmental organizations (e.g. The Aransas Project), court cases and academic institutions (e.g. Texas A&M University).

Financial Acquisition Opportunities

The financial implications of a water rights acquisition were also assessed for each case study through two distinct purchasing scenarios: impact investment and grant funding, which could include some private funding as well. The purchase price of each water right was estimated based on best available data. Water transaction data was found on AcreValue, the Water Transfer Data Base (funded by the National Science Foundation and the California Water Resources Research Center and presented by the Bren School), and courtesy of a WestWater Research database provided by Highland Economics in Montana. This purchase price of a water right was weighed against potential conservation opportunities and downstream lease agreements (for the impact investment scenario). The impact investment scenario also assumes a 10-year fund length, after which the water right is sold assuming any appreciation in the value of water right is directly offset by the discount rate. When using a mix of grant/private funding, TNC holds the water right in perpetuity and gains environmental benefits indefinitely.

To account for inflation and normalize the data provided, all sale and lease prices were adjusted to 2017 values (based on 2017 average CPI) and converted to committed annual average prices for the leases and annual prices for the sales. The discount rate was estimated by dividing average lease price by average sale price. The transaction costs associated with purchasing a water right were estimated at $2,000,000 per transaction based on advice from NatureVest and corroborated by a Texas Water Development Board (TWDB) study assessing water rights transaction costs. This transaction cost includes legal and negotiation fees. A 2% transaction cost was also used to estimate costs associated with identifying and negotiating leases, which was also informed by NatureVest best practices.

Conservation benefits were not quantified in the financial assessments. Rather, TNC can determine if the stated conservation potential justifies the costs outlined by the financial assessments. These financial analyses are intended to inform TNC of projected purchase and lease costs and sensitivity to market conditions. Although these analyses do not quantify conservation benefits associated with water rights acquisition, TNC may use these costs to evaluate if further research into conservation benefits is warranted.

Chapter 3: Case Studies

The aforementioned case study methodology was implemented for three CFPPs identified during the *selection of CFPPs* project stage. One of the plants is located in Texas while the other two are in Montana. Below are in-depth case studies for the power plants that were analyzed. Each case study provides a background of relevant state-specific conservation objectives and water demand as well as a financial and instream flow analysis for the specific CFPPs. The case studies are intended to elucidate not only the potential for a water transaction in that location but also the conditions that must be met for a transaction to be feasible in other locations throughout the west.

Texas Case Study

Case study analyses were performed on the Coleto Creek CFPP in Texas, which is located about an hour and a half south of Austin. This site was selected because of the Texas branch of TNC region's interest in the plant. They have had communications with the energy company that previously had owned the plant, Dynegy, so this project was intended to further their research. The location of the plant, upstream from the wintering whooping crane population, further enhanced the appropriateness of such an analysis since a potentially large conservation benefit exists. Finally, Texas state water law is favorable for environmental flow transfers as a private agency is allowed to hold environmental flows in perpetuity.

The following sections outline the conservation objectives associated with the Coleto Creek Power Plant water rights, or the benefits associated with such a transaction. Then, an in-depth case study of the Coleto Creek Power Plant examines the water rights held by the energy company, the potential for that water right to augment instream flows, and an estimation of the costs associated with the water right acquisition. The case study concludes with a recommendation about whether TNC should pursue the water right and, if so, through what strategy.

San Antonio Bay Conservation Objectives

The major conservation objective identified for the Texas case study is the endangered whooping crane (*Americana grus*) through increased freshwater flows into San Antonio Bay. The impact this may have on land value and tourism are also discussed.

Whooping Crane

The whooping crane is a federally listed endangered species that spends the summer breeding months in Canada and migrates to southeast Texas during the winter. In the 1940's there were as few as 20 whooping cranes in the wild, but international conservation efforts enabled populations to increase to approximately 430 cranes by the 2016-2017 winter season.[24]

Whooping crane wintering habitat is located near the San Antonio Bay (the Bay) along the Gulf Coast in Texas. Consequently, their survival is likely related to salinity levels and other environmental conditions in the Bay since it is one of their main foraging grounds. The following sections outline the (1) biology, and (2) economic valuation of the whooping crane with respect to its wintering habitat in the Bay.

Biology of Whooping Crane

Whooping cranes live in family units of three or four (two parents and one or two juveniles) and are quite territorial. One whooping crane family demands on approximately 0.5 square mile of land (320 acres). However, this number may change depending on the land quality and topography. For example, if the marshes are very narrow, the cranes will require a longer coastline habitat to offset the disadvantages of their narrow habitat. Land development along the Bay threatens the remaining coastal habitat areas and restricts the growth of the whooping crane population. Therefore, in addition to land acquisitions, improvement in the quality of the remaining whooping crane habitat is a conservation option.[25]

Enhancing the whooping crane's food availability in the Bay is one way to improve their habitat quality. The whooping crane subsists mainly off of blue crab and wolfberry fruits. The blue crab's lifecycle is directly linked to salinity levels in their coastal marine habitat.[26] If the salinity level is high in the Bay, they may not return for spring mating season, which results in less food availability for the whooping cranes.[25] Past research shows that low blue crab numbers significantly influence both adult and juvenile whooping crane mortality rates.[27] Alternatively, the wolfberry fruit's peak availability coincides with the annual whooping crane arrival in October.[28] When salinity levels in the Bay are high, wolfberry fruit density is lower, which can lead to whooping cranes being deprived of one of their main and most easily accessible food sources.[28]

Due to the Bay's salinity levels affecting the whooping cranes' food sources, increasing freshwater flows to the Bay may impact estuary conditions by lowering salinity levels, and improving the whooping crane habitat. Furthermore, the Guadalupe River, which flows into the Bay, experiences a significant reduction in flows during late summer, when both the blue crab and wolfberry fruit need low salinity levels the most.[29] Although the whooping crane does not arrive to the Bay until the winter, improving their habitat before they arrive will still have a positive impact on their population by ensuring there is enough food when they arrive.

The correlation between salinity levels and whooping crane deaths was the subject of a lawsuit as well. The Aransas Project (TAP) sued the Texas Commission on Environmental Quality (TCEQ) in 2010, claiming that excessive water right permitting by TCEQ led to the death of at least 23 whooping cranes following the drought of 2008-2009. The lawsuit alleged that excessive permitting violated the Endangered Species Act via illegal harm and harassment. TAP claimed that increased salinity levels in the Bay were a result of decreased fresh water inflows from the Guadalupe River, which impacted recruitment of blue crabs.[30] The judge in Corpus Christi federal court ruled in favor of TAP and demanded that TCEQ issue Incidental Take Permits to the water users and establish a Habitat Conservation Plan. However, the ruling was reversed after TCEQ took the case to the federal Fifth Circuit Court of Appeals.[30]

In contrast to the research done by TAP, a report prepared by Texas A&M University and contracted by the Texas Water Development Board, claimed "that a 123,348,920 m^3/year (100,000 acre-feet/year) reduction in freshwater inflow, applied uniformly throughout the year, assuming other environmental factors repeated their historical (1997 to 2007) trends, had no noticeable effect on peak wolfberry densities, or on maximum or minimum blue crab densities."[28] The report also concluded that the effect of salinity on whooping cranes remained uncertain, despite lower wolfberry levels and some correlation between higher salinity levels and lower blue crab populations. However, this report did not include the data from the massive drought that took place from 2008 to 2009, which is the single main event that laid the foundation for TAP's case in the lawsuit against TCEQ.

Economic Valuation of the Whooping Crane

As a charismatic species, there is vast literature on the economic valuation of whooping crane. Various initiatives, research projects, and funds for whooping cranes provide an insight into the valuation of the bird species and are summarized in Table 2. Although the economic valuations presented will not be included in the subsequent cost analysis, the figures provide TNC an idea of the societal value placed on these birds, which may prove useful in deciding in the costs of purchasing a water right provides substantial benefit.

According to a non-use valuation research project on whooping cranes in 1984, the total combined option price and existence value of the whooping crane resource in the United States was estimated to be $1,580 million in 1984; applying an adjustment for inflation this value becomes $3,820 million in 2017.[31] While this is good evidence that the whooping crane has a large existence value, it should be noted that the study was conducted when the whooping crane population was much lower than it is today. Consequently, current nonuse existence value of a single whooping crane is likely lower than it was in 1984 but the value of the entire population may remain similar.

A contingent valuation study on whooping cranes conducted in 1983 and published in 1988 identified the annual median willingness-to-pay (WTP) for the entire whooping crane population to be between $62 and $67 ($156-169 in 2017) but stated that the value could fall anywhere between $21 ($53 in 2017) and $149 ($376 in 2017).[32] Using the 2017 values and extrapolating the findings to the entire population of the United States in 2017 (325,719,178 people),[33] the WTP for the entire whooping crane population is $90.2 billion, with a sensitivity range of $3.6 billion and $103.3 billion. While the original study surveyed individuals directly surrounding the Aransas National Wildlife Refuge, where the whooping crane winters, as well as further removed urban populations, including Los Angeles and Chicago, it is unclear how representative the sample is of the entire United States. As such, it is important to use these numbers conservatively. Again, it should be noted that, when this study was conducted in 1983 the whooping crane population was smaller than it is today, which may impact WTP.

The value of land that supports whooping crane habitat also provides insight into the whooping crane's economic valuation. Oftentimes, however, the land value captures, not only, the presence of whooping cranes, but also, other attributes of a land parcel. As an example of land transaction for habitat protection, Texas Parks & Wildlife (TPW) purchased 17,351 acres of for $37.7 million in August 2014 ($39.1 million in 2017), for a unit price of $2,253/acre in 2017. TPW also awarded $316,800 to Guadalupe Blanco River Trust for the acquisition of 218 acres of whooping crane habitat in September 2015[36] ($328,222 in 2017, $1,506/acre). Assuming that whooping cranes live in families of three and all families require approximately 320 acres of habitat in the marshlands, the newly acquired habitats are collectively capable of accommodating at least 55 whooping crane families, or about 165 whooping cranes. If the sole purpose of the land purchases is whooping crane conservation, each whooping crane is valued at $238,959, with a range between $160,598 to $240,370/bird (2017 dollars). However, these numbers likely represent the upper end of WTP for a whooping crane since it ignores other corollary benefits associated with the piece of land, including benefits to other species or the desire for open spaces.

The benefit received by the existence of the whooping crane can also be estimated in terms of avoided conservation costs. Patuxent Wildlife Research Center, located in Maryland, was home to 75 whooping cranes before its propagation program was de-funded. The Department of the Interior quantified the budget saving as $1.5 million (or 5 full-time employees) in September 2017.[34] Assuming a simple linear relationship between the facility's maintenance cost and the number of whooping cranes nurtured, the budget corresponds to $20,000/bird, which is much lower than the value acquired using land value. In any event, the monetary resources allocated to support the whooping crane population sheds light on the species' economic value. The de-funding of the project, however, may signal the relative unimportance of the species to the federal government, and, by extension, United States citizens.

Table 2: Values of the whooping crane population according to different valuation methods.

Valuation Method (Year of study)	Unit Nominal Value (range)	Nominal Value of Whole Population	Unit Real Value (range) in $2017	Real Value of Whole Population (range) in $2017
Total combined option price[34] (1984)	–	$1.58 billion	–	$3.82 billion
Contingent valuation (WTP)[35] (1988)	$62-67 ($21-$149)/person	$15.2-16.4 billion	$156-169 ($53-$376)/person	$51-55 billion
Land value (2014)[36]	$2,173/acre	$37.7 million	$2,253/acre	$39.1 million
Land value (2015)[39]	$1,453/acre	$316,800	$1,506/acre	$362,704
Estimated crane value per land value	–	–	$238,959 ($160,598-$240,370)/crane	–
Conservation Cost (2017)	–	–	$20,000/crane	$1.5 million
Reward for finding a whooping crane shooter[38] (2013)	$15,000/crane	$15,000	–	–

Water Demand in the Guadalupe-Blanco River Basin

Demand for water in the Guadalupe-Blanco River Basin is expected to grow, driven primarily by industrial and municipal water needs (Figure 9 and Table 3).[35] Other current and future water uses are important since they represent potential lessees of a water right as well as competitors of the environment for an already precious resource.

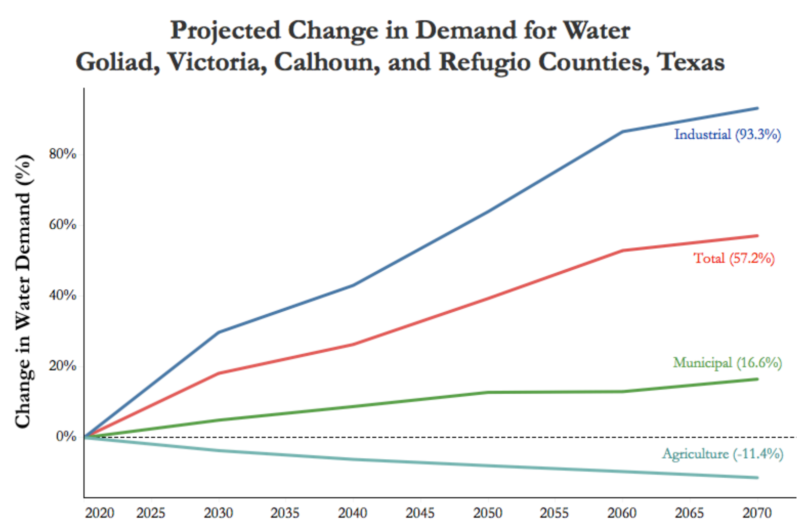

Figure 9: Projected demand for water in the Guadalupe-Blanco River Basin based on estimations for Goliad, Victoria, Calhoun, and Refugio Counties.[35]

Table 3: Projected increase in water demand in Guadalupe-Blanco River Basin during 2020-2030 and 2020-2070.[70]

Sector	2020 – 2030	2020 – 2070
Industrial	-1,537 AF	+101,769 AF
Municipal	+ 1,308 AF	+ 4,381 AF
Agricultural	+ 32,514 AF	- 4,746 AF
Total	+ 32,285 AF	+ 101,404 AF

An example of industrial water use in the Guadalupe-Blanco River Basin is Invista Energy, a subsidiary of Koch Industries, which has a plant near Victoria, Texas. The Invista Energy plant produces chemicals used in the company's polymers and fibers business and holds a consumptive water right of 33,000 AF/year.[36] Another large industrial interest in the Basin is Dow Chemicals, which operates a facility in Seadrift, Texas and owns diversion rights amounting to more than 1 million AF/year, although it is unclear what portion of the diversion is consumptively used.[36]

There are a number of important municipal and governmental-owned water interests in the Guadalupe-Blanco River Basin, as well. The Guadalupe-Blanco River Authority (GBRA) holds multiple consumptive water rights, although it is unclear if the agency can store water. Additionally, the City of Victoria is expected to demand an additional 850 AF/year by 2030.[35] The Texas Parks and Wildlife Department (TPWD) holds diversion rights of 540,000 AF/year but has limited storage capacity amounting to 800 AF at any point in time.[36] Recently, TPWD has developed tools to identify water rights that can improve instream flows within the Guadalupe-Blanco River Basin. For example, the U.S. Fish and Wildlife Service contracts water from the GBRA for delivery into the Aransas National Wildlife Refuge, which is the home of the endangered whooping crane, and thus could be interested in securing more water or water storage for drought years.

Understanding the demand for water in the Guadalupe-Blanco River Basin will help to identify potential (1) water use competitors, (2) lessees of water, and (3) changes in the demand of water overtime. All of these will in turn impact the price of water and the potential to lease water as a strategy for funding a water right purchase. In summary, there are significant municipal and industrial water users in the Basin but their location relative to the CFPP of question will determine if they have an impact on water right prices or would be interested in leasing water.

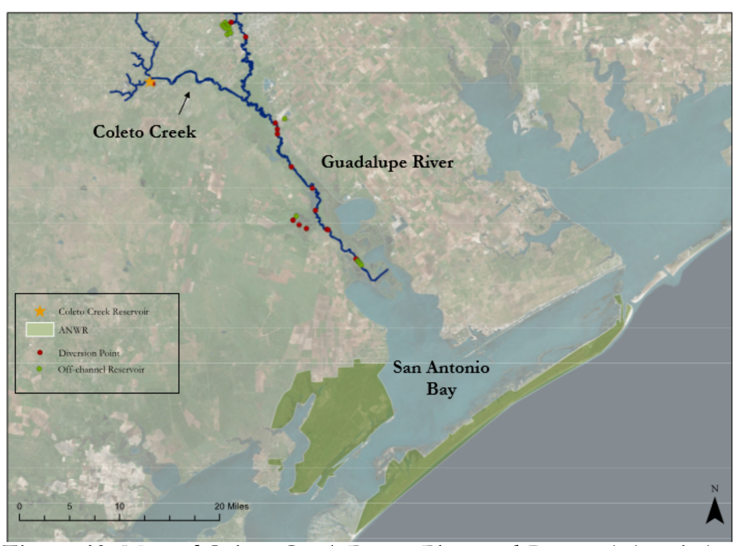

Figure 10: Map of Coleto Creek Power Plant and Reservoir in relation to Guadalupe River and San Antonio Bay, where the Aransas National Wildlife Refuge is located. Other water users in the basin are also denoted.

Case Study: Coleto Creek Power Plant, TX

Coleto Creek Power Plant (Power Plant) is a 600 MW facility located on a tributary of the Guadalupe River in the Guadalupe-Blanco River Basin in South Texas (Figure 10). The plant was recently purchased by Vistra Energy, in October of 2017.[37] The power plant sits on the southeastern edge of the Coleto Creek Reservoir, which serves as a recreation area as well as a cooling pond for the plant. Coleto Creek Power Plant is upstream of the Aransas National Wildlife Refuge, which is an important nesting ground for the endangered whooping crane. The Power Plant has substantial diversion, consumptive, and storage water rights that could help conserve their critical wintering habitat along the Gulf Coast.

The following case study outlines (1) the water right held by the power plant, (2) current streamflow conditions in the region, (3) projected regional water demand growth, (4) a water rights acquisition financial analysis and (5) potential instream flow augmentation schemes. The analysis concludes with a scenario summary and a course of action recommendation informed by state-specific water laws.

Figure 11: Coleto Creek Power Plant.

Water Rights Associated with Coleto Creek Power Plant

Coleto Creek Power, LP, which is owned by Vistra Energy, owns a water right that allows for both the diversion of water from Guadalupe River and the storage, or impoundment, of water in the Coleto Creek Reservoir (Table 4). The water right allows for the diversion of 20,000 AF of water annually, of which 12,500 AF can be consumptively used for the purposes of power generation. The water right permit also allows for the impoundment of a maximum of 35,000 AF of water at any given time, which allows the power plant to store water in the Reservoir. The water right owned by Coleto Creek Power, LP has a priority date of January 7, 1952 and January 10, 1977 for the diversion and impoundment rights, respectively. The priority date for the diversion right falls in the middle of the other water right permits recognized by the state for the Guadalupe-Blanco River Basin, with priority dates going as far back as 1887 (Figure 12).

Table 4: Water rights associated with Coleto Creek Power Plant, which includes a diversion and impoundment right. The diversion right allows for 12,500 AF/year of consumptive use.

WR	Priority Date	Source Name	Use	Amount	Use Type
378	5/13/1977	Coleto Creek Reservoir	Industrial	35,500 AF	Impoundment
18-5486	1/7/1952	Guadalupe River	Industrial	20,000 AF/year	Diversion

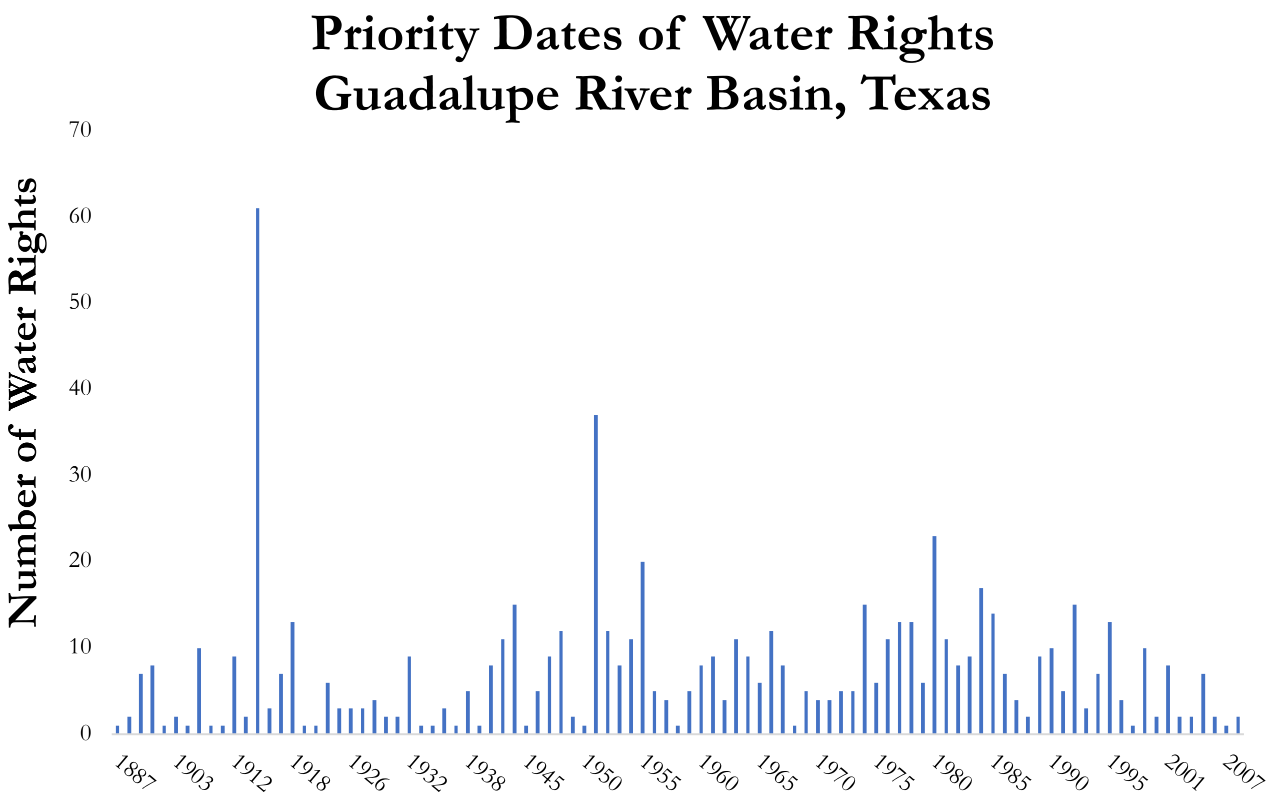

Figure 12: Priority dates associated with water rights in the Guadalupe River Basin. The diversion and impoundment rights held for Coleto Creek have priority dates of 1952 and 1977, respectively.

As permitted under water right #18-5468, water is diverted from the Guadalupe River to the Coleto Creek Reservoir and released from the reservoir into Coleto Creek, which eventually feeds back into the Guadalupe River and flows down to San Antonio Bay. The water right restricts the flows into and out of the Reservoir as stated below.[38]

i. Dam must have an outlet to allow water to pass that the owner is not entitled to divert or impound.
ii. All inflows that are less than 5 cubic feet per second (cfs) into the Coleto Creek stream must be released from the Reservoir. When inflows are greater than 5 cfs, a minimum of 5 cfs must be released. No releases are required when no inflows are going into the reservoir.
iii. Water may be diverted from the Guadalupe River only when the water is flowing over the salt-water barrier and diversion dam maintained by the GBRA.

While the above restrictions represent the minimum requirements of water usage outlined by the water right, it is unclear whether Coleto Creek Power, LP has further negotiations in place with the GBRA, which jointly maintains the Reservoir for recreational purposes. The capacity of the reservoir is 35,084 AF with a surface area of 3,100 acres and lies 98 ft. above mean sea level.[39] The height of the reservoir is regulated by a dam that releases water into Coleto Creek, a tributary of the Guadalupe River.

Financial Analysis

This section analyzes the monetary costs associated with purchasing water rights from the Coleto Creek Power Plant. Both public/private funding (a mix of federal grants and private donations), and impact investing (private investor capital) are analyzed as potential purchase strategies.

Table 5 outlines general assumptions of the financial model and values used for the discount and inflation rates. The diversion amount was found on the Coleto Creek Power Plant's water right.[40] The discount rate of 5.1% was estimated by dividing the average lease price of water came in Texas divided by the average purchase price of a water right sold in Texas using price data from the Water Transaction Database mentioned in the methodology. The inflation rate is from the Consumer Price Index provided by the Bureau of Labor Statistic.

Table 5: Inputs and assumptions for the financial analysis of the Coleto Creek power plant's water right with the number 18-5486.

GENERAL ASSUMPTIONS	
Water Right (Total)	
Diversion (AF/yr) 18-5486	20,000
Consumptive diversion (AF/yr)	12,500
Impoundment (AF)	35,000
Rates	
Discount Rate	0.051
Inflation Rate	1.025
BENEFITS	
Amount Leased (AF/yr)	12,500
Water Transfer (Lease) to Downstream Users	
Lease Price ($/AF)	
Municipal	1118.95
Industrial	426.72
Agriculture	134.41

PURCHASE COSTS	
Purchase Price	
Diversion ($/AF) low	46.81
Diversion ($/AF) high	7271.47
Diversion ($/AF) average	1400
Purchase / Sale of Water Rights	
Legal and Consulting Fees ($)	$2,000,000
Short-Term Lease of Water Rights to Downstream Users	
Legal and Consulting Fees	0.02
OPERATING COSTS	
Fixed Costs (Annual)	
Operating Expenses	$133,909.08
Maintenance and Repairs	$31,986.15

Public/Private Funding

In order to understand the feasibility of a water right purchased with public/private funding, associated costs were estimated. These costs include the price of the water right itself as well as transaction costs and costs associated with maintenance of existing infrastructure associated with the water right.

Water right purchases in Texas range from $46/acre-foot to $7,271/acre-foot with an average of $1,400/acre-foot (Table 5). Additionally, the legal and consulting fees associated with the transaction are estimated to be $2,000,000 and borne by the water right buyer (Table 5). The legal and consulting fees also include funds to negotiate with and/or appease downstream users who may be opposed to the acquisition.

Since Coleto Creek Power, LP jointly owns the Coleto Creek Reservoir with GBRA, it is assumed a new water right owner would be responsible for a portion of the reservoir maintenance and repair costs. As of 2017, the reservoir and maintenance and repairs costs were $31,986/year, which is $630,713 in perpetuity using 5.1% discount rate.[41] Although GBRA will likely cover some of the maintenance costs, their contribution was not included and so this cost represents the upper-limit of potential maintenance and repair costs.

While large price disparities exist in previous Texas water transactions, our analysis assumed a purchase price of $1,400/AF. A sensitivity analysis shows the impact of different purchase prices on the financial feasibility of a transaction (Table 6). At $1,400/AF acquiring the 12,500 AF/year diversion right and associated impoundment right costs approximately $30 million, including transaction and maintenance costs (Table 6). Importantly, the water right cost is the largest portion of the total costs and the cost with the largest variability. As such, understanding the actual purchase price for which TNC will be able to acquire the water right will be the largest dictator of financial viability.

Table 6: Total estimated cost of acquiring water rights from the Coleto Creek Power Plant under public/private funding model.

Public/Private Funding (Purchase)			
ESTIMATED COSTS	Low Purchase Price ($46.81/AF)	High Purchase Price ($7,271.47)	Average Purchase Price ($1,400/AF)
-Purchase Costs			
Diversion Right 18-5486	*$936,200*	*$145,429,400*	*$28,000,000*
Transaction Costs	*$2,000,000*	*$2,000,000*	*$2,000,000*
-Operational Costs			
Maintenance & Repairs (Yearly)	*$31,986*	*$31,986*	*$31,986*
Maintenance & Repairs (Perpetuity)	*$630,713*	*$630,713*	*$630,713*
Total Estimated Costs	***$2,968,186***	***$147,461,386***	***$30,031,986***
Net Present Value	**-$3,598,899**	**-$148,092,099**	**-$30,662,699**

Impact Investing

In addition to using public/private funds as a purchase strategy, the potential to use impact investing was also analyzed. All of the estimated costs under public/private funding exist for impact investing as well. Additional monetary benefits arise, however, under the impact investing scenario as well as additional transaction costs associated with leasing a portion of the water right and negotiating the sale of the water right at the end of the impact investing fund. Under the impact investing model, a percentage of the consumptive portion of the water right is leased to downstream users in order to generate returns for investors. The water that is not leased is left in stream to benefit the environment.

State water market analysis informs the purchase price of water rights. Water rights may be purchased at a low ($46.81/AF), average ($1,400/AF), or high price ($7,271.47/AF) and leased to downstream agricultural ($134.41/AF, light blue), industrial ($426.72/AF, green), or high ($1,118.95/AF, dark blue) users. The following assumptions were made for the impact investing model:

1. TNC leases the full consumptive portion of the Coleto Creek water right.
2. TNC leases water at a constant price of $134.41/acre-foot.
3. The length of fund is 10 years, and the term of each lease is one year.
4. The water right appreciates at a rate of 5.1% per year.
5. Annual lease prices are static, and the water right is sold in the 11th year.
6. The discount rate is 5.1%, and transaction costs associated with lease negotiations are 2% of the lease revenue.

Table 7 summarizes the impact investing results when a purchase price of $1,400/AF is used. Lease prices ranged from $1,119/AF for municipal users to $134/AF for agricultural users and the amount of water leased was varied between 7,500 AF and 12,500 AF.

Table 7: The net-present value (NPV) and internal rate of return (IRR) associated with high, medium, and low lease prices and different amounts of water leased. The lease price required to obtain an 8% return for each lease amount is also summarized.

Purchase Price: $1400/AF				
Volume Leased	**Lease Price**	**NPV**	**IRR**	**Lease price to generate 8% ROI**
12,500 AF	$1,118.95	$102,670,563	46.12%	$114
	$426.72	$37,418,198	19.31%	
	$134.41	$9,863,890	8.72%	
10,000 AF	$1,118.95	$81,575,224	37.26%	$143
	$426.72	$29,373,332	16.16%	
	$134.41	$7,329,885	7.77%	
7,500 AF	$1,118.95	$60,479,884	28.57%	$190
	$426.72	$21,328,465	13.06%	
	$134.41	$4,795,880	6.83%	

Impact investing is a financially viable investment choice when the entire water right is leased to downstream users for at least $114/AF, at which point the internal rate of return (IRR) is 8% is greater. However, in order for TNC to validate the purchase of this water right, a certain amount of the consumptive portion of the water right needs to create an environmental benefit for investors as well as a financial benefit.

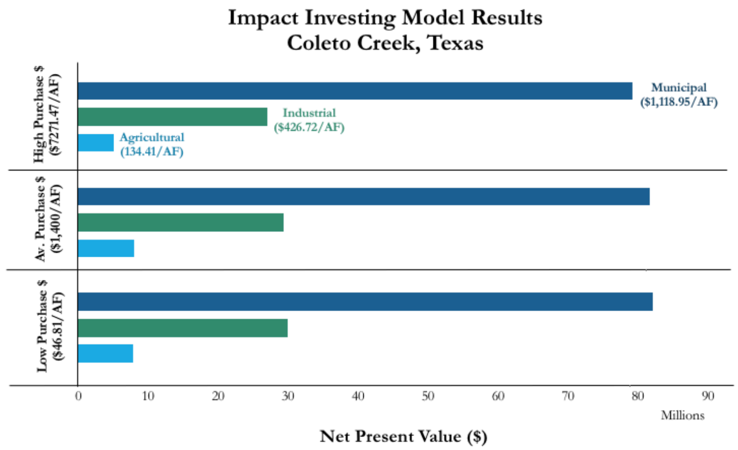

Figure 13: Impact investing model results for acquisition of water rights held for the Coleto Creek Power Plant.

If only 7,500 AF are leased (leaving 5,000 AF/year for the environment) the minimum lease price increases to $190/AF, which still falls within the average lease price in Texas. As such, impact investing could be a viable investment strategy if TNC is able to find a downstream user willing to lease 7,500 AF/year for $190/AF. If an environmental benefit can be achieved while leasing more water, then the necessary lease price will fall. The lease price will largely be determined by the user type of the water, since different users have very different water demands.

Instream Flow Augmentation

The Guadalupe River runs from north to south in Texas, passing the cities of Victoria and Bloomington before meeting with the San Antonio River and draining into the San Antonio Bay. The Aransas National Wildlife Refuge (ANWR) boarders San Antonio Bay (the Bay) and is impacted by the Bay's freshwater inflows. Since the water right associated with Coleto Creek Power, LP allows for the diversion of 12,500 AF annually from Guadalupe River and the storage of a maximum of 35,000 AF, the water right owner can control flows into the Guadalupe River. While historical TCEQ data shows that discharge from the reservoir is typically between 1,500 and 1,800 cubic-feet per second (cfs) in the fall months, it fell to between 500 and 800 cfs during the 2008/2009 drought.[42] Such drought conditions can affect the salinity levels in San Antonio Bay.[28]

As outlined earlier, whooping crane's main food sources, wolfberry fruit and blue crab, rely on stable salinity levels during the spring and fall months that are buffered by freshwater inflows. During drought periods, however, salinity levels in the Bay can increase as decreased precipitation leads to less surface flows. Consequently, being able to not only supplement freshwater flows into the San Antonio Bay but also time the release of such flows during a drought could substantially benefit blue crab and wolfberry fruit populations. Since blue crab and wolfberry fruit both benefit from low salinity levels during the fall and spring seasons, timing increased flows during this period would likely provide the greatest benefit for the whooping crane by ensuring an adequate food supply for their winter arrival.

The following analysis simulates adding an additional 12,500 AF to Guadalupe River from the Colteo Creek Reservoir over a 60-day period. Based on the blue crab and wolfberry needs, this could be done in the fall or spring, but fall augmentation is summarized below. The release of the consumptive portion of the water right (12,500 AF) consistently over 60 days translates into a flow rate of 105 cfs. While this is the amount of water released from the reservoir, some of the water is lost as it flow to San Antonio Bay. On average, between 10 cfs and 31.4 cfs of water is lost under moderate and severe drought conditions respectively, as water travels from Coleto Creek to Guadalupe River and into San Antonio Bay.[43] A hydrograph was made displaying the possible instream flow augmentation using the 2008-2009 drought conditions for comparison (Figure 14). In effect, during a drought the water right held by Coleto Creek Power, LP can add an additional 73.6 cfs over 60 days to San Antonio Bay.

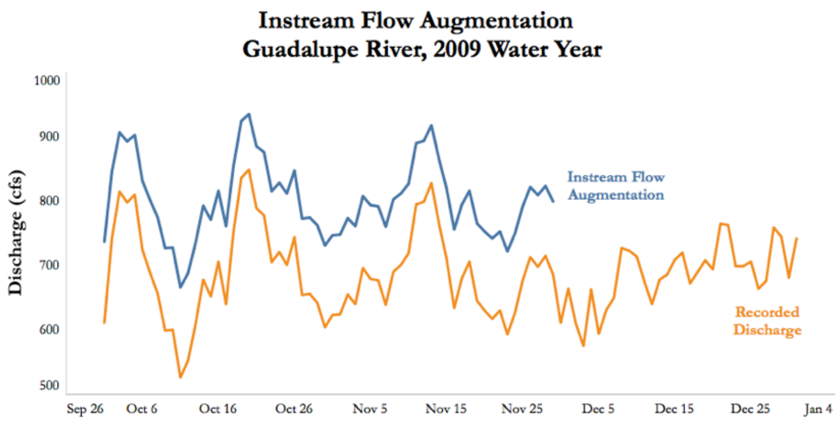

Figure 14: Recorded discharge (orange) and potential instream flow augmentation from Coleto Creek water rights (blue). Potential instream flow augmentation represents an additional 73.6 cfs from the Coleto Creek water right. Data obtained from USGS stream gauge 08188800.

In addition to the amount of water lost, it is also important to consider the time it takes for water to travel in stream from the Reservoir to the Bay. This will impact the flexibility of the water right and the degree to which the release of water will immediately impact the Bay ecosystem. On average, it takes about 3 days for water to travel from the Reservoir to the Bay, which is important for TNC to consider when deciding when to release water.[43] Consequently, TNC will only have to plan a few days in advance and the water right can be flexible enough to react to immediate environmental changes. This travel time is also an important factor if TNC is considering leasing water to or impounding water for downstream users as it provides a window in which water can be physically transferred to other parties.

While the previous analysis outlines the physical constraints of the water right, it is important to understand what impact it will have on the environment. The Texas Water Development Board (TWDB), a state agency tasked with aiding in the conservation and responsible development of water for Texas, outlines Strategic Target Frequencies (STF) of freshwater inflows for the Bay. In order to create the STF, historical flows were analyzed to understand how often target environmental flow standards were not met. It was found that an additional 90,000 AF of water annually will reduce the number of years in which flows fall below the environmental targets to 5 out of the 55 years that were examined.[44] Consequently, taking into account the water loss between the Reservoir and the Bay, the Coleto Creek, LP water right can provide between 8.9% and 12% of the 90,000 AF target. While the water right will not fulfill to the entire deficit needed to reach the environmental flow standards outlined by TCEQ, it provides some of the water that is needed. As such, TCEQ may be interested in leasing a portion of the water right when instream flows are insufficient to meet the environmental flow standards.

A substantial amount of water will make it to the Bay when released from Coleto Creek Reservoir, but in order to positively benefit the endangered whooping crane population, the released water also needs to buffer salinity levels. A study prepared by Trungale Engineering & Science for The Aransas Project (TAP) concludes that the Bay's salinity level is sensitive to an additional, or lack of, 100,000 acre-feet of freshwater annually.[45] This study is consistent with the finding that 90,000 AF of water annually is needed for the Bay to maintain stable salinity levels for its ecosystem.

Considering the aforementioned conditions, the water and storage right associated with the Coleto Creek Power Plant can aid in the stabilization of salinity levels in San Antonio Bay. This will ensure blue crab and wolfberry fruits populations are in abundance when the whooping crane arrives for its wintering mating season. The water right can cover between 8% and 12% of the 100,000 AF of water annually needed to stabilize salinity levels in the Bay. While the water right is not enough on its own to ensure full does not cover the entire amount, it represents a water source that will help protect environmental flows in Guadalupe-Blanco River Basin that can be paired with other water transactions to reach the entire environmental target. Additionally, it acts as an insurance mechanism against future droughts, which may once again jeopardize the survival of wintering whooping crane populations.

Conclusion

The Coleto Creek Power Plant represents an interesting case study, particularly because of its storage capability that allows for the timed release of water. In addition, the plant's proximity to an endangered species is a concrete environmental benefit that can be gained from such a water transaction. The following sections outline the known (1) risks and (2) rewards associated with pursing the procurement of the Coleto Creek Power Plant water right and concludes with a recommended course of action for TNC.

Risks

The uncertainties present when assessing the acquisition of a water right create inherent risk in any decision. The most pertinent and quantifiable of those risks include: (1) willing participation from the Guadalupe-Blanco River Authority (GBRA), (2) large upfront costs paired with uncertain future benefits, and (3) feasibility of negotiating with downstream water leases.

(1) Coleto Creek Reservoir is jointly managed by Coleto Creek Power, LP and GBRA, so any decision to release water from the reservoir is likely to need buy-in from GBRA, whether through formal or informal institutions. Even if no formal avenue for GBRA to prevent TNC from releasing water from the reservoir exist, it is likely not beneficial for TNC to act against their will in order to maintain a positive reputation and relationships in the region. While the likelihood of cooperation from GBRA is unknown, they manage the reservoir as a recreation area so taking into account necessary water levels to sustain such activities will be important.

(2) Since the financial costs associated with acquiring these water rights is likely to be large ($30 million investment on the upper end), an equally large environmental benefit will be needed to offset such costs. Although economic valuations of the whooping crane resource were provided, TNC will have to decide the benefit from conserving the whooping crane population. The environmental benefits and potential monetary benefits from leasing the water right is garnered into the future but since the magnitude of those benefits is uncertain, the ability to justify a large upfront investment is difficult.

The whooping crane is a charismatic species and reports suggest that adding this water to the basin will help their struggling populations, but the magnitude of the benefit is not clear. There is a possibility that the additional water from this water right will not have a meaningful impact on the whooping crane population in the Aransas National Wildlife Refuge, especially if future drought scenarios are considered. However, it is important to note that TNC as an institution places value on transformational change and this water right transaction may be beneficial in pushing forward future environmental water transactions and the establishments of water markets that benefit instream flows.

(3) The impact investment strategy requires negotiating leases with downstream water users. While downstream water users are present, they are few in number and largely represent small low-value agriculture, which will have a low WTP for water. As such, it is uncertain if TNC can lease water at a price that will cover the purchase costs and provide investors with a suitable return on investment. Additionally, the amount of water needed to be leased in order to cover purchase costs does not leave a substantial amount of water for the environment. If an environmental benefit can be gained between the Reservoir (where water is released) and the diversion point of lessees, it would not matter if water was leased for consumptive use since there would still be more water in stream for a longer stretch of the river. This was not found to be the case for Coleto Creek or Guadalupe River.

Rewards

While this project poses considerable risk, it presents numerous benefits. The most pertinent of which include: (1) a relatively large water right and storage capability that allow for the timed release of water, (2) the wintering habitat of a large charismatic endangered species located downstream of the power plant, and (3) state water law that allows for a private entity to hold an environmental flow water right in perpetuity.

(1) Having the ability to store water and time its release allows for the concentration of flows at particular times when the environment needs it most. If storage does not exist, the benefit of adding water to the environment is averaged over the entire year. In addition to storage, the water right also allows for substantial consumptive use, 12,500 AF/year of the 20,000 AF/year that can be diverted. This is important for two reasons: (1) only the consumptive portion of a water right can be leased to downstream users with low risk injuring downstream users and (2) the environment has historically been exposed to the non-consumptive portion of the water right already and so would not represent an additional amount.

(2) The whooping crane is a large endangered species with fewer than 500 individuals left in the world and the wintering population in San Antonio Bay is the last wild population. This wintering habitat is located less than 100 miles downstream from Coleto Creek Power Plant and so is in an ideal location to benefit from the release of water. Additionally, since the whooping crane's main food source relies on stable salinity levels, there exists an important connection between how the water in Coleto Creek and Guadalupe River can benefit a high-priority species. Investing in water rights from CFPPs can improve habitat conditions as an alternative, or supplement to, conventional conservation methods, such as land purchases.

(3) State-specific water law also plays a large role in determining whether this type of transaction can work. Some states do not allow a private entity to hold an environmental flow water right. In Texas, however, TNC would be able to hold a water right meant to benefit the environment in perpetuity. In addition, environmental flow requirements, set by TCEQ, ensures that the state supports

environmental flows and increases the likelihood of the water right transaction approval since it aligns with the agencies internal goals. A partnership between TNC and TCEQ may be beneficial to the parties in protecting environmental flows.

TNC should also consider the potential to use restoration funds provided through the Gulf Coast Ecosystem Restoration Council (the Council) to fund the water right acquisition. Following the Deepwater Horizon oil spill in 2010, President Obama signed into law the RESTORE Act, which provides federal funds to "restore the long-term health of the valuable natural ecosystems and economy of the Gulf Coast Region."[46]

While showing the quantifiable environmental benefit of purchasing the water held for Coleto Creek Power Plant, there are a number of elements of the project that make it ideal for RESTOR Act funds. For example, the Council identified ten priority watersheds and estuaries for funding, of which is Galveston Bay and includes the Aransas National Wildlife Refuge.[47] Additionally, the Council outlined seven objectives it wishes to accomplish through funding restoration projects. The Coleto Creek water right acquisition scenario satisfies 6 of the 7 objectives and include:

(1) Restore, enhance, and protect habitats
(2) Restore, improve, and protect water resources
(3) Protect and restore living coastal and marine resources
(4) Restore and enhance natural processes and shorelines
(5) Promote natural resource stewardship and environmental education
(6) Improve science-based decision-making

Because of the applicability of the water right acquisition with known federal funding, TNC should consider structuring a transaction in a way that focuses on and highlights the Council's objectives.

Recommendation

While uncertainties exist in terms of the purchase price of the water right, ability to lease to downstream users, and quantifying concrete environmental benefits, it is recommended that TNC consider the purchase of the water right associated with Coleto Creek Power Plant because of the numerous advantages present. The storage benefit and proximity of whooping crane habitat provide a scenario not likely to be found in other water right transactions. Overall, the water availability from the retirement of Coleto Creek Power Plant provides a unique conservation opportunity to improve whooping crane habitat by fortifying their food availability. Although the environmental benefit of such an action is uncertain, it is an action TNC can take to create a buffer against future climatic uncertainties. Although climate change was not directly analyzed in our study, it is likely that drought conditions and water scarcity issues will continue to be an issue for the arid west, and Texas in particular. As such, the water right can act as an insurance mechanism against future droughts. For this reason, we recommend that TNC pursue this opportunity specifically under a public/private investment strategy. While the upfront costs are large, creating a partnership with TCEQ allows TNC to own the water right and potentially lease a portion to an alternative environmental user. This is a win-win scenario as TNC can generate funds to reinvest in whooping crane habitat protection while not losing any of the potential gains from keeping water instream until the Bay. Alternatively, impact investing is only a viable investment strategy if a consistent downstream user is identified, who is also willing to pay approximately $190/acre-foot of water and the remaining consumptive portion of the water right is determined to have a substantial environmental benefit.

Montana Case Studies

The CFPPs in Montana were selected for further analyses, because the state water law allows a private institution to own an environmental water right, further investigation is the state was permitted by the Montana TNC region, and both plants are owned by the same company and are retiring on similar timelines. Because both plants are owned by the same company, there is an opportunity to acquire water from multiple retiring CFPPs under a single transaction. Both of the plants also have different diversion and cooling types and so exemplify the diversity of possible retirement scenarios.

The Montana Case Study section includes a brief overview of Montana-specific water law, conservation objectives in Montana, and an analysis of the water rights held by two CFPPs in Montana that divert water from the Yellowstone River.

Montana Water Law

While many of the previous generalities from the aforementioned Water Law section apply to Montana, there are important Montana-specific water law aspects and history that are worth noting. The Montana Water Use Act of 1973 put in place a procedure for acquiring and changing water rights, which are administered by the Montana Department of Natural Resources and Conservation (DNRC).[14] While water rights prior to this act are recognized, changes to any water right must be approved by DNRC. Similar to other forms of property rights, water rights are legally protected and are afforded protection under the United States Constitution and the Montana State Constitution.[14]

It is also important to note specific restrictions placed on environmental flow water rights in Montana. While the state recognizes water used in stream for the environment as a beneficial use, it is difficult for a private entity to own that right in perpetuity. For example, unless a water right is held by the state, water can only be temporarily converted for instream use in the following ways:[15]

(1) Lease all or a portion of a water right to the Montana Department of Fish, Wildlife, and Parks (FWP);
(2) Lease the water right to another party interested in holding the right for the fishery; or
(3) Convert the water right to an instream use without a lease.

Additionally, any conversion to an instream use requires a temporary change in authorization from the DNRC that must be reassessed after 10 years and show to benefits to a fishery.[15] While these restrictions should not prevent a transaction from occurring in Montana, it is important to note future uncertainties in the water right because of the water law structure.

Finally, Montana also has in place water reservations that are granted to the state of Montana, other political subdivisions, state agencies, or the United States and any of its agencies for future beneficial uses and to maintain minimum stream flows or quality of water.[15] DNRC oversees this process but although reservations for instream flows are in place, they do not always accomplish the goal of protecting fisheries and so private action may be necessary to work the state in securing additional water for the environment.

Yellowstone River Conservation Objectives

Yellowstone River, which provides water for both JE Corette and Colstrip Power Plant, is home to several fish species of concern, including the pallid sturgeon *(Schaphirhynchus albus),* blue sucker *(Cycleptus elongatus),* paddle fish *(Polyodon spathula),* sturgeon chub *(Macrohybopsis gelida),* and Yellowstone cutthroat *(Oncortynchus clarki bouvieri).*[48] While only the pallid sturgeon is a federally listed endangered species, all of their life cycles directly depend on the river's health. In addition, the Yellowstone River supports multiple recreational activities, such as fishing and boating, that add strong tourism value to the region. For the Montana case studies, the pallid sturgeon was identified as the major conservation objective. Other species of concern and recreational activities are also briefly discussed but will require further research by TNC if a transaction along the Yellowstone River is pursued.

Pallid Sturgeon

The pallid sturgeon was chosen as the main species of concern that could benefit from the retiring of CFPPs in Montana because of its status as a federally listed endangered species. This section summarizes the pallid sturgeon's biology and non-use value.

Biology of the Pallid Sturgeon

The pallid sturgeon is a bottom-dwelling fish that prefers silty rivers and swift currents.[49] It is native to Missouri and Yellowstone rivers, but demonstrates spawning behavior and migrates along the Missouri River and its tributaries during different seasons. For example, it mainly inhabits the lower Yellowstone River rather than Lower Missouri River during spring and summer months,[50] when the flow rates in the river begin to decline. As a migratory fish species, the pallid sturgeon requires a long and undisturbed water flow to complete its migratory and reproductive cycles. The main factors contributing to the decline of the pallid sturgeon, therefore, are the loss of connectivity due to dams and an altered hydrology primarily due to water development.[48] While the Yellowstone River is the longest free-flowing river in the conterminous United States, pallid sturgeon rely on tributaries of the Yellowstone River that often contain human-built infrastructure, such as the Yellowstone River Diversion Dam, also known as the Intake Diversion Dam. Such stationary water reservoirs prevent fish larvae from moving downstream and obstruct the mating behavior of fish. As a result, the fish's habitat is either restricted to an unsustainably short migratory span or the individuals are forced to migrate to unsuitable habitats further downstream. In addition to dams, channelization and river alterations are regarded as the most serious threats to pallid sturgeon habitat. Some solutions, such as rock ramps and by-pass challenges, have been proposed to overcome the problem. However, despite these attempts, the pallid sturgeon populations have continued to decline since its designation as an endangered species in 1990.[51] This decline is largely the result of anthropogenic activities, such as impoundments and diversions, which have altered the hydrograph, temperature, and turbidity of rivers.[49]

An information gap exists regarding the quantity of water required for the pallid sturgeon to reach maturity, which poses a conservation challenge since it is unclear how much additional water would contribute to the recovery of the pallid sturgeon. Therefore, streamflow is not currently emphasized as a direct threat to the species' habitat restoration and improvement, yet there are concerns within the state administration that over allocation of the Yellowstone River negatively impacts the pallid sturgeon. In a 2016 memorandum, Montana Fish, Wildlife and Parks expressed grave concerns to Montana Department of Natural Resources and Conservation regarding the potential imperilment of the species, asserting that Yellowstone Basin water reservations do not meet their instream flow needs. In the memorandum, it was also stated that further depletion of water in Yellowstone River would threaten the aquatic habitat of, not only pallid sturgeon, but also other endangered species as well.[51] Furthermore, if the damage to the endangered species habitat is ruled as a "taking" under the Endangered Species Act, senior water right holders along the Yellowstone River, mainly agricultural users, may be asked to cut their consumptive use. Therefore, the Montana state officials recognize that there is certainly a need to preserve flows, although actual amount are unknown, in the Yellowstone River in order for pallid sturgeon conservation efforts to succeed.

Pallid Sturgeon Recovery Expenditures

Prior to the acknowledgement that the environment is a beneficial use of water in Montana, water right owners were compelled to maximize their diversions, which drove unusually low water levels and, consequently, resulted in the degradation of aquatic environments.[52] Despite recovery initiatives, the fate of numerous species is uncertain. The pallid sturgeon serves as a striking example. In a revised recovery plan published in 2014, the U.S. Fish and Wildlife Service estimated the cost of fully recovering wild pallid sturgeon populations and delisting the species as $239,170,000 (not adjusted for inflation).[53] That Montana Department of Fish, Wildlife & Parks estimates that the Montana pallid sturgeon could go extinct as soon as 2018,[54] and so the recovery costs can help decision makers understand the value lost due to the disappearance of such populations.

While not based in Montana, a set of studies conducted in 1998 surveyed individuals from Utah, Arizona, New Mexico, and Colorado concerning their WTP to protect instream flows in six rivers. These instream flows would contribute to the conservation of nine endangered fish species. On average, participants were willing to pay $265/household as a one-time payment to avoid the extinction of a species.[55] When considered within the context of pallid sturgeon in Montana, these studies show that there is not only a social or cultural value, but also a significant financial value in instream flow augmentation to protect endangered species. The value placed by people to protect minimum instream flow demonstrates a collinearity with the presence of endangered species, However, further research concerning the instream flow needs of the pallid sturgeon is necessary to quantify the economic value of instream flows.

Other Species of Potential Concern

It is important to note that other species of concern, such as the blue sucker, paddle fish, sturgeon chub and Yellowstone Cutthroat may benefit from instream flow augmentation, as well.

The Yellowstone Cutthroat is native to the southwest and south-central portions Montana.[56] The primary threats to the Yellowstone Cutthroat include non-indigenous species, habitat degradation, and global climate change. More specifically, habitat degradation due to surface water diversions negatively impact the Yellowstone Cutthroat. Many of the spawning areas in the tributaries of the upper portion of the Yellowstone River have been lost to heavy water withdrawals from irrigation, which dewaters streams before spawning occurs in July and August.[56] The improvement of fish passage, limiting entrainment into irrigation systems, preventing the invasion of non-native species, and restoring stream channels and riparian habitats are all ways to help conserve the Yellowstone Cutthroat.[57] Some of these actions can be directly addressed through the acquisition and control of water rights.

Historically, the fluvial population, as opposed to lake-dwelling populations, of Yellowstone Cutthroat were common in large rivers, such as the Yellowstone near Livingston, MT. Many large river populations have declined or disappeared over the years, however, in part, because of increased river diversions.[58] Habitat degradation for the Yellowstone cutthroat trout occurs more frequently on non-federal lands at lower elevations where reduced discharge, barriers to migration, more sediment deposition, increased water temperature, and pollution is more frequent.[58]

The other fish species mentioned likely have similar primary threats and would benefit from instream flow augmentations as well, but further research should be done. In addition to fish species, the least tern and piping plover also use the Yellowstone River for breeding and nesting habitat and are federally endangered and threatened species, respectively.[48] These species may also benefit from an improved riparian habitat since they prefer sparsely vegetated sandbars along the river, which are created by historic flow regimes that are impacted by water diversions.

Water Demands in Yellowstone Basin

The value of water rights from CFPPs comes from not only the potential conservation benefit associated with the water right but also other regional water demands. If the demand for water is high (1) it may be more important to protect water for the environment before it is all spoken for and (2) there may be an opportunity to lease water to downstream users in order to fund the conservation project, which is an example of impact investment.

In Montana, agriculture is the state's leading industry, bringing in $4.5 billion in 2015 to approximately 27,500 farms and ranches in the state.[59] Agriculture is also the largest consumptive use of water in the Yellowstone Basin.[60] Industrial uses of water in the Yellowstone Basin amount to about 1,800 AF/year.[60] Municipal water use in the basin is relatively small, amounting to only about 1.6% of annual consumption.[60] Because of irrigation water needs along the Yellowstone, as well as municipal diversions, the natural flow leaving Montana would be about 10 million AF/year if no diversions existed but is instead about 7.7 million AF/year.[60] A majority of the irrigated agriculture is located on the lower portions of the Yellowstone River as it flows into North Dakota.

Case Study: J.E. Corette Power Plant, MT

A subsidiary of Talen Energy,[61] the J.E. Corette Power Plant (J.E. Corette) is located in Billings, Montana and situated immediately adjacent to the Yellowstone River. The 173 MW power plant commenced operations in 1968 and closed in 2015 as a result of high compliance costs associated with stricter environmental standards.

Water Rights Associated with J.E. Corette Power Plant

Talen Energy holds two diversion rights for J.E. Corette that total 140,00 AF/year.[24] Statements of claim submitted to the Montana Department of Natural Resources and Conservation (DNRC) indicate that water use for J.E. Corette is "largely non-consumptive." Filed prior to 1973, the statements of claim are considered *prima facia* ("proof of itself") and so have not been examined to the extent of determining consumptive use.[25] However, a study conducted by the Union of Concerned Scientists found that CPFFs with once-through cooling systems consume, on average, 2% of withdrawal.[26] Collective consumptive use of J.E. Corette, therefore, could be as high as 2,800 AF/year.

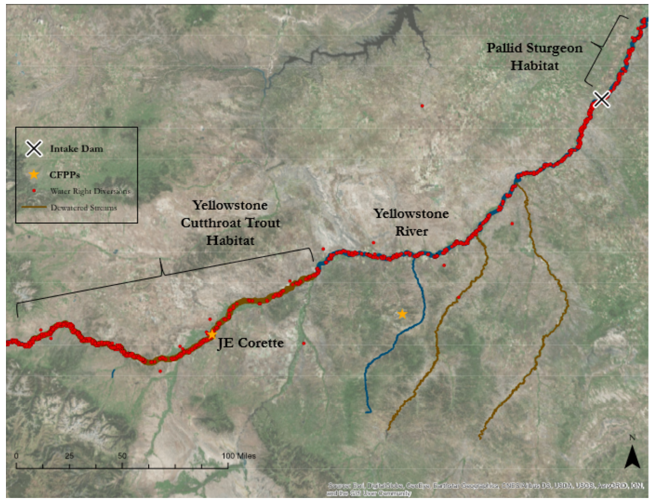

Figure 15: Map indicating the location of the J.E. Corette Power Plant, potential downstream users, and habitat of the pallid sturgeon and Yellowstone cutthroat trout.

Financial Analysis

The following sections aim to provide a preliminary financial assessment associated with acquisition of J.E. Corette water rights under two of funding models: (1) public/private, and (2) impact investing.

Table 8: Assumptions used to inform financial analyses for acquisition of water rights 43Q 94420-00 and 43Q 94422-00 held by Talen Energy for the J.E. Corette Power Plant.

GENERAL ASSUMPTIONS	
Water Right (Total)	
Diversion (AF/yr) 43Q 94420-00	52,500
Consumptive (AF/yr)	1,050
Diversion (AF/yr) 43Q 94422-00	85,000
Consumptive (AF/yr)	1,700
Rates	
Discount Rate	0.028
Appreciation Rate	0.028
BENEFITS	
Short-Term Lease of Water Rights to Downstream Users	
Low ($/AF)	$3.19
High ($/AF)	$328.29
Average ($/AF)	$47.16

COSTS	
Purchase of Water Rights	
Low ($/AF)	$70.50
High ($/AF)	$8,275.41
Average ($/AF)	$1,701.09
Long-Term Lease of Water Rights	
Low ($/AF)	$5.41
High ($/AF)	$1,138.49
Average ($/AF)	$203.57
Purchase/Sale of Water Rights	
Legal and Consulting Fees ($)	$2,000,000
Short-Term Lease and Resale of Water Rights	
Legal and Consulting Fees (%)	0.02

Data were obtained from multiple sources, including TNC, WestWater Research, and academic publications, and were inflation-adjusted to reflect the 2017 values.

Table 8 provides the complete set of assumptions used to inform the analyses.

Public/Private Funding

Under the public/private funding model, costs incurred by TNC include: (1) initial procurement of the water rights, and (2) administrative and legal services associated with the transaction. Current provisions of the Montana Water Use Act state that owners (with the exception the FWP) may only temporarily convert or lease their water right for instream flow. The term is generally designated for up to 10 years but can be renewed an indefinite number of times. Thus, in the case of public/private funding, TNC is most likely to procure the water rights under a long-term lease, but financial analyses on the purchase of water rights are also included for comparison. Prices for the long-term lease of the water rights range from $5.41/AF/year to $1,138.49/AF/year; and prices for purchase of the water rights range from $70.50/AF to $8,275.41/AF.[62] Transaction costs associated with the procurement of the water rights are assumed to be $2 million. This value reflects the anticipated costs of technical and legal services, as well as those associated with negotiations to prevent allegations of injury by downstream users.

Table 9: Estimated costs incurred by TNC to procure the water rights held by Talen Energy for the J.E. Corette Power Plant under low ($5.41/AF), high ($1,138.46/AF), and average ($203.57/AF) long-term lease price scenarios.

Public/Private Funding (Long-Term Lease)			
ESTIMATED COSTS	Low Purchase Price ($5.41/AF)	High Purchase Price ($1,138.46/AF)	Average Purchase Price ($203.57/AF)
-Purchase Costs			
Water Right 43Q 94420-00	$284,025	$59,770,725	$10,687,425
Water Right 43Q 94422-00	$459,850	$96,771,650	$17,303,450
Transaction Costs	$2,000,000	$2,000,000	$2,000,000
-Diversion Modification Costs	--	--	--
Total Estimated Costs	$2,743,875	$158,542,375	$29,990,875
Present Value Costs	***$2,743,875***	***$158,542,375***	***$29,990,875***

Table 10: Estimated costs incurred by TNC the water rights held by Talen Energy for the J.E. Corette Power Plant under low ($70.50/AF), high ($8,275.41/AF), and average ($1,701.09/AF) purchase price scenarios.

Public/Private Funding (Purchase)			
ESTIMATED COSTS	Low Purchase Price ($70.50/AF)	High Purchase Price ($8,275.41/AF)	Average Purchase Price ($1,701.09/AF)
-Purchase Costs			
Water Right 43Q 94420-00	$3,701,250	$434,459,025	$89,307,225
Water Right 43Q 94422-00	$5,992,500	$703,409,850	$144,592,650
Transaction Costs	$2,000,000	$2,000,000	$2,000,000
-Diversion Modification Costs	--	--	--
Total Estimated Costs	$11,693,750	$1,139,868,875	$235,899,875

Present Value Costs	*$11,693,750*	*$1,139,868,875*	*$235,899,875*

Model outcomes indicate that the cost for TNC to procure the right to divert 140,000 AF/year from Talen Energy under a long-term lease ranges from approximately $2.7 to $158.5 million; and the costs associated with purchasing the water rights range from approximately $11.7 million to $1.14 billion. Wide variability in the estimates is largely a result of the uncertainty associated with the transaction price of a water right, which is influenced by numerous factors, including the type of buyer, type of seller, quality of water, seniority of the right, and conditions of the basin.

Impact Investing

The expected costs incurred by TNC under a public/private funding model could be circumvented if impact investing can prove a sound financial strategy. In this case, TNC would leverage investor capital to fund procurement of the water rights from Talen Energy, and then lease those rights to downstream users (Figure 15).

This section presents the findings of multiple impact investing models, which included the following assumptions:

(1) The full consumptive amount of water right 43Q 94420-00 (1,050 AF/year) and water right 43Q 94422-00 (1,700 AF/year) is purchased by TNC using investor funds; and the collective consumptive amount (2,750 AF/year) is leased to the highest-paying downstream user.
(2) Water rights are leased annually for 10 consecutive years and re-sold in the 11th year.
(3) The discount rate is 2.8%, which is calculated by dividing by the lease price by the average purchase price.[63]
(4) Water rights appreciate at the discount rate, which is 2.8%.
(5) An 8% ROI (return on investment) must be generated for the transaction to be considered a sound investment.

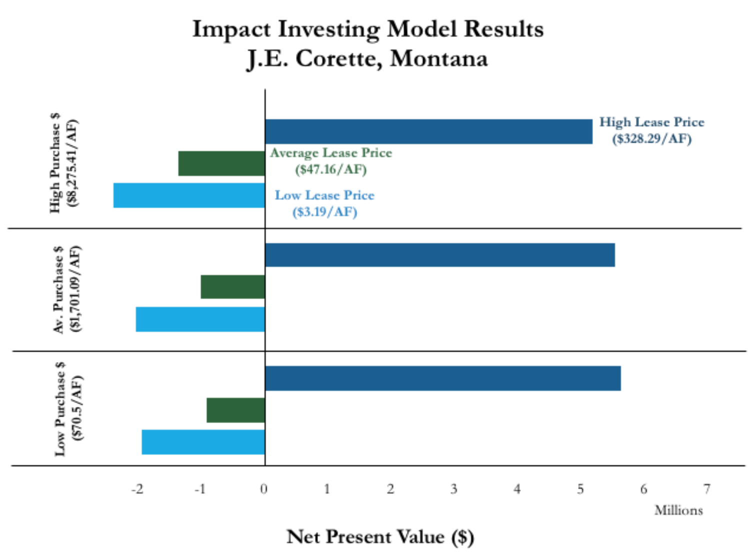

Figure 16: Impact investing model results for acquisition of water rights held for J.E. Corette Power Plant.

State water market analysis reveals that water rights may be purchased at a low ($70.5/AF), average ($1,701.09/AF), or high price ($8,275.41/AF) and leased to downstream users at a low ($3.19/AF, light blue), average ($47.14/AF, green), or high ($328.19/AF, dark blue) price.

Unlike the assumptions included in Coleto Creek case study, it is expected that the *entire* collective consumptive amount (2,750 AF/year) of the water rights held by Talen Energy is leased to users downstream of J.E. Corette. The reason for this is two-fold: First, there are several potential high-paying off-takers on reaches of the Yellowstone River beyond the pallid sturgeon habitat (Figure 16). Thus, it would be possible for TNC to augment instream flows for the pallid sturgeon *and* provide the full consumptive amount to users downstream of the species' habitat. Second, the Yellowstone Cutthroat habitat is located directly upstream of J.E. Corette. If the Yellowstone Cutthroat is identified as the species of concern (rather than the pallid sturgeon), TNC could drive conservation benefits by making a "call on the river" to fulfill habitat needs *and* lease the entire consumptive portion of the water rights held by Talen Energy to any user downstream of J.E. Corette.

Model outcomes illustrate that the lease price is the primary driver of NPV for the acquisition of water rights from J.E. Corette under impact investing. In all scenarios in which the lease price is $328.29/AF (orange), that is, whether the purchase price is $70.5/AF, $1,701.09/AF, or $8,275.41/AF-an NPV upwards of $5 million is generated. Conversely, impact investing produces a negative NPV in all scenarios in which the lease prices is $3.19/AF or $47.14/AF. Financial analyses further indicate that a lease price of $223/AF would be required to ensure an 8% ROI to investors.

Instream Flow Augmentation

Understanding the financial implications of the investment opportunity is only useful if it can be weighed against the potential delivery of conservation results. Given its longstanding status as an endangered species,[49] the pallid sturgeon is an obvious conservation objective, and instream flow augmentation is one metric by which TNC may assess outcomes from acquisition of J.E. Corette water rights.

To determine the magnitude of instream flow augmentation, the consumptive portion of the J.E. Corette water rights were measured against annual 7-day minimums in the Yellowstone River at Billings, Montana. The following calculations were then conducted:

(1) The consumptive portion of the J.E. Corette diversion right was converted from 2,800 AF/day to 3.87 cfs. For the rest of the analysis we will round up to 4 cfs. This number provides a rough estimate of the added flow rate of water in the Yellowstone River.
(2) The increase in flow rate, 4 was divided by the average flow rate for the year and turned into a percentage.
(3) The average annual 7-day minimum flow at the J.E. Corette was calculated from the USGS data.
(4) The percent contribution to instream flows in the Yellowstone River during the annual 7-day minimum was calculated by dividing the results from step 1 by the results from step 3.

Over the nearly 10-year timeframe, potential instream flow augmentation ranged from 0.03% to 0.08% during average flow rates and from 0.2 to 0.49%, with an average of 0.27% during low flow conditions (Table 11, Table 12). The results indicate that acquisition of the J.E. Corette water rights would likely have a negligible impact on the pallid sturgeon, the habitat of which begins approximately 150 km downstream (Figure 16).

Table 11: Percent instream flow augmentation to Yellowstone River. Average percent flow contribution from 2006 to 2015 is 0.06%. Data was obtained from USGS gauge 06214500 on the Yellowstone River at Billings, Montana.

Date	Average Flow (cfs)	Average Flow + 4 cfs (cfs)	% Change
2006	5816	5820	0.07%
2007	5048	5052	0.08%
2008	7812	7816	0.05%
2009	8012	8016	0.05%
2010	6614	6618	0.06%
2011	11300	11304	0.03%
2012	6389	6393	0.06%
2013	5278	5282	0.07%
2014	9827	9831	0.04%
2015	6511	6515	0.06%

Table 12: Percent instream flow augmentation to Yellowstone River during annual 7-day minimum. Average percent flow contribution from 2006 to 2015 is 0.27%. Data was obtained from USGS gauge 06214500 on the Yellowstone River at Billings, Montana.

Date	Average Low Flow (cfs)	Average Flow + 4 cfs (cfs)	% Change
2006	1920	1924	0.20%
2007	1810	1814	0.21%
2008	1850	1854	0.21%
2009	1430	1434	0.27%
2010	1640	1644	0.24%
2011	1870	1874	0.21%
2012	2020	2024	0.19%
2013	1740	1744	0.22%
2014	794	798	0.48%
2015	794	798	0.48%

Conclusion

The procurement opportunity in Billings, Montana demonstrates large risks but limited rewards, suggesting that the acquisition of a water right held for J.E. Corette is not advisable unless additional benefits are identified.

Risks

Montana state water law prevents TNC from holding rights for environmental flow in perpetuity. Therefore, TNC would be obligated to renew ownership of the water rights at the conclusion of the 10-year term, at which point "other parties can bring forth new evidence of adverse effect to their water rights that was not previously considered."[64] If current drought conditions throughout the state portend future basin availability, there is a considerable possibility that regional stakeholders will ultimately challenge TNC's ownership of the water rights and thus undermine the organization's capacity to deliver long-term conservation results. Additionally, water transactions in general present a number of uncertainties since DNRC must approve any change in ownership of the water. The likelihood of approval can be mitigated for by presenting conservative consumptive use numbers on the water right change and showing quantifiable benefits to a fishery.

The local political landscape also represents a considerable risk. In an email correspondence with a representative from the Montana Department of Fish, Wildlife & Parks (FWP), it was discovered that allocation of the water rights to the city of Lockwood—rather than to instream flow—could, in fact, *benefit* the Yellowstone River. The reason for which was cited as "strategic and bureaucratic in nature."[64] Instream water reservations (i.e., water rights designated for instream flows) that are held by the FWP are subject to potential reallocation for other "qualified uses." Lockwood, which is immediately adjacent to the southeast corner of Billings, has been subjected to water reductions in recent years due to its junior priority of water rights and, consequently, could be considered such a qualified use. Reallocation would not be easy, but if successful it could "open the door to more reallocation of instream flow reservations in the Yellowstone and across Montana."[64] Thus, by forgoing this procurement opportunity, TNC may provide greater overall benefits to the Yellowstone River at Billings, Montana.

The limited potential for the delivery of conservation results is perhaps the most immediate and direct risk. The findings suggest that reallocation of water rights held for J.E. Corette to the Yellowstone River would increase instream flow by an average of about 0.27% during the annual 7-day minimum. During average conditions, instream flow augmentation would likely not exceed 0.08%. Therefore, it is not expected that reallocation of the water rights held for J.E. Corette to the Yellowstone River would to reap meaningful environmental benefits with respect to regional species of concern.

Rewards

Impact investing offers the most promising reward with respect to the procurement opportunity at Billings, Montana. The findings indicate that TNC could generate more than 8% ROI if the water rights were purchased at an average price ($1,701.09/AF) and leased to downstream users at a high price ($328.29/AF)—a scenario that is not unreasonable given the proximity of potential high-paying off-takers. Furthermore, TNC could generate an 8% ROI even if the lease price was lowered by nearly one-third, to $223/AF. These robust results suggest that J.E. Corette could serve as a valuable pilot site for leveraging impact investing to reallocate water from retiring CFPPs to instream flows not only in Montana but across the western United States. It is unclear, however, what environmental benefits would be achieved under such an impact investment scenario. Directly downstream of J.E. Corette exists a highly dewatered portion of the Yellowstone River. As such, leasing to users past this point ensures that water historically diverted at J.E. Corette remains instream through the critically dewatered portion of Yellowstone River. The magnitude of environmental benefits, however, is unknown. Additionally, although the water right held for J.E. Corette has a small consumptive portion, the diversion itself is large. Ownership of the water right can be used "call" water downstream, ensuring water stays instream until J.E. Corette's historical diversion point and through critically dewatered portions of Yellowstone River used by Yellowstone cutthroat trout.

Recommendation

There are notable risks associated with the legal, political, and environmental dimensions of the investment opportunity at Billings, Montana. The potential rewards, on the other hand, are limited. Thus, it is recommended that TNC does not pursue acquisition of the Talen Energy water rights held for the J.E. Corette Power Plant unless the potential environmental benefits are better assessed.

Case Study: Colstrip Power Plant, MT

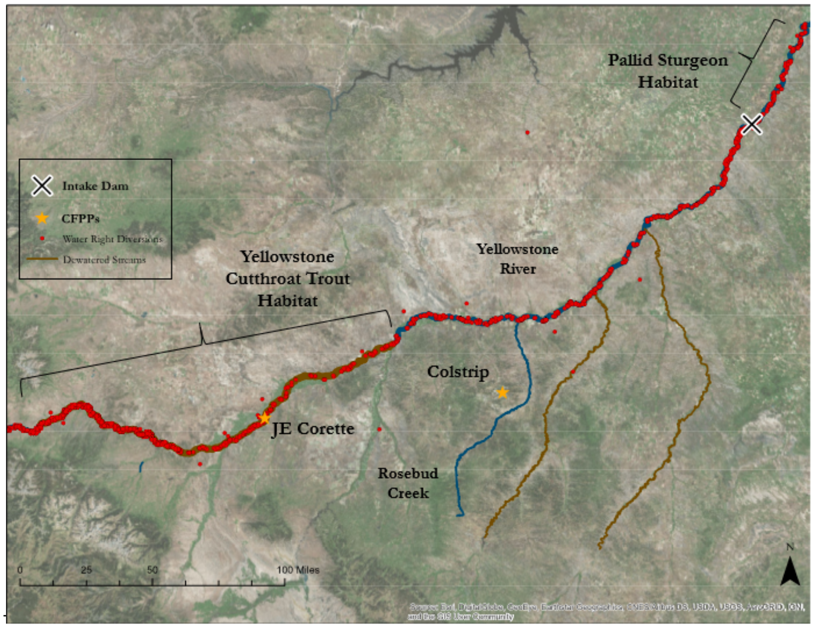

Figure 17: Map of Colstrip in relation to J.E. Corette, other water diversions, and habitat of Yellowstone cutthroat trout and pallid sturgeon.

Colstrip Power Plant (Colstrip) is a four-unit, 2,100 MW CFPP—the second largest in capacity west of the Mississippi. Colstrip is a zero-discharge facility, which uses a recirculating cooling system with induced draft cooling towers. Units 1 and 2 were built in the 1970s, each with net generation of 307 MW; units 3 and 4 were built in the 1980s and each generate 740 MW.[65]

Units 1 and 2 are scheduled to close on July 1, 2022, which will have serious economic impacts on the community, which plant owners are now expected to address. Decommissioning the first two units will result in a loss of approximately 30% of Colstrip's historic net generating capacity. Puget Sound and Talen Energy each own 50% of units 1 and 2, while units 3 and 4 are owned by a conglomerate of energy companies—Avista Corporation, Northwestern Corporation, Pacificorp, Portland General Electric, Puget Sound Energy, and Talen Montana LLC—with Puget Sound Energy owning the largest shares in the two units.

Water Rights Associated with Colstrip Power Plant

There are several different consumptive use and storage water rights associated with Colstrip Power Plant, which offer diverse opportunities for investment in streamflow augmentation. Avista Corporation, Northwestern Corporation, Portland General Electric, Puget Sound Energy, and Talen Montana LLC are all partial owners of the water rights associated with Colstrip.

Table 13: Water rights associated with Colstrip Power Plant. Total volume of diversions (sum of all water rights) is 50,649.92 AF. Total surface water flow rate is 67.27 cfs and total volume of surface water diversions is 50,151.00 AF. Total groundwater flow rate is 388 cfs and total volume of permitted groundwater extraction is 498.92 AF.

Water Right #	Priority Date	Source Name	Means of Diversion	Flow		Volume	Period of Diversion / Use
				GPM	cpf	AF	
Surface Water - Use: Industrial							
42KJ 94423	12.16.70	Yellowstone River	Pump		69.27*	50,151.00	Jan. 1 - Dec. 31
Groundwater - Use: Industrial							
42KJ 94428	6.22.71		Well	300.00		484.20	Jan. 1 - Dec. 31
Groundwater - Use: Stock							
42A 19827	08.10.78		Well	8.00		2.70	Oct. 1 - May 31
42A 39199	12.09.81		Well	10.00		1.75	Jan. 1 - Dec. 31

42A 48616	07.20.82		Well	10.00		1.00	Jan. 1 - Dec. 31
42A 83584	01.28.93		Well	9.00		3.40	Jan. 1 - Dec. 31
42A 146426	01.01.55		Well	7.00		NA	Jan. 1 - Dec. 31
42A 173935	10.31.47		Well	7.00		(a)	Jan. 1 - Dec. 31
42A 173940	09.15.46		Well	7.00		(a)	Jan. 1 - Dec. 31
42A 173941	04.30.56	Parkins Spring / UT, Cow Creek	Spring Box / Direct	10.00		(a)	Jan. 1 - Dec. 31
42A 30052376	12.14.11		Well	5.00	10.32	1.70	Jan. 1 - Dec. 31
42A 30071717	10.21.14		Well	15.00		4.17	Jan. 1 - Dec. 31
Surface Water - Use: Stock				88.00		14.72	
42A 108297	07.05.68	U.T, Cow Creek	Dam			(a)	Jan. 1 - Dec. 31
42A 108308	05.25.43	Cow Creek, South Fork	Dam			(a)	Jan. 1 - Dec. 31
42A 108317	07.05.68	UT, Cow Creek	Dam	(b)	(b)	(a)	Jan. 1 - Dec. 31
42A 173944	04.30.56	UT, Cow Creek	Dam	(b)	(b)	(a)	Jan. 1 - Dec. 31
42A 173945	01.01.41	UT, Cow Creek	Dam	(b)	(b)	(a)	Jan. 1 - Dec. 31
42A 173947	01.01.46	UT, Cow Creek	Dam	(b)	(b)	(a)	Jan. 1 - Dec. 31

Legend: UT refers to Unnamed Tributary; (a) signifies the amount of water consumptively used for stock watering purposes at the rate of 30 gallons/day/animal unit, which are based on reasonable carrying capacity and historical use; (b) indicates that the flow rate is not decreed from onstream reservoir and is limited to the minimum amount historically necessary to sustain this purpose; * denotes that flow rate for municipal portion of water right may not exceed 2 cfs.

The largest water right associated with Colstrip is a 50,151.00 AF surface water diversion (maximum flow rate of 69.27 cfs) from the Yellowstone River, approximately 30 miles north of Colstrip (water right number 42KJ 94423-00). In addition to the energy companies listed above, the City of Colstrip also owns this water right—a total of seven owners. The stated uses are industrial and municipal, with no more than 2 cfs of flow permitted for municipal use. This water is pumped from the Yellowstone River (approximately 6 miles west of Forsyth, MT and 30 miles north of the City of Colstrip, MT) to Castle Rock Lake—water from the lake flows by gravity either to Colstrip for industrial use or to the City of Colstrip's water treatment plant for municipal distribution.[66] Because Colstrip is a zero-discharge facility and the water right does not specify a point of return, it is assumed that the entire volume of the water right is permitted for consumptive use.

Additionally, the above six energy companies own a cluster of 17 surface and groundwater rights permitting storage and industrial uses of local water supplies (Table 13). There are six surface water storage rights, although the volume and flow rate are not explicitly stated on these water rights but are limited to reasonable carrying capacity and historic use of the area (Table 13). Ten groundwater rights are for stock use, with a combined total volume of 14.72 AF and flow 88.00 GPM; Talen Montana LLC owns four of these water rights independently—the total combined flow permitted by these water rights is 38 GPM and total combined volume is 10.32 AF. Additionally, one groundwater right permits the use of 484.20 AF (300 GPM) for industrial uses (
Table *13*); this groundwater right is larger than the combined totals of groundwater storage rights associated with Colstrip; these wells are located directly adjacent to small, unnamed tributaries to Cow Creek. Six surface water rights are associated with dams located on unnamed tributaries to Cow Creek.

These water rights will not be included in the financial assessment of Colstrip, primarily due to an insignificant volume of water being contributed back instream. Additionally, surface water rights have been eliminated from the assessment because they are tied to surface storage, which has been secured in Colstrip's Wastewater Facility Closure Plan (July 2017). Groundwater rights present significant legal risk due to the existing lawsuits surrounding groundwater contamination from Colstrip.

Financial Analysis

When Colstrip units 1 and 2 close in 2022, the plant will lose almost 30% of its net generating capacity and, therefore, require approximately 30% less water than historically required for operations. This section includes a preliminary financial assessment of the costs associated with acquiring approximately 30% (14,281 AF, maximum flow rate of 20 cfs) of Colstrip's water right on the Yellowstone River (WR# 42KJ 94423-00) using public/private funding and impact investing.

Public/Private Funding

The following is an analysis of the costs associated with the partial purchase or long-term (10-year) lease of 14,281 AF of Colstrip's water right on the Yellowstone River using a combination of public grants and private donations. The primary costs associated with this financing strategy include the partial water right purchase or lease, transaction and negotiation fees, and infrastructure modification. The following assumptions were made regarding the public/private financing model:

(1) TNC may acquire the water right via a permanent purchase or a long-term (10-year) lease.
(2) The purchase price of water in Montana ranges from $70.50/AF to $8,275.41/AF, with an average of $1,701.09/AF.
(3) The long-term lease price of water in Montana ranges from $5.41/AF/year to $1,138.49/AF/year, with an average of $203.57/AF/year.
(4) Transaction costs associated with procuring the water rights are assumed to be $2 million

The cost of purchasing 14,281 AF of Colstrip's water right ranges from $3.1 million to $120.2 million—on average, $26.3 million (

Table ***14***). Because long-term lease prices are significantly lower than purchase prices, the projected cost to lease the water ranges from $2.1 million to $18.3 million, and on average, $4.9 million (Table 15).

Table 14: Low, high, and average costs projected for the partial purchase of 14,281 AF of Colstrip's water right under a public/private funding model.

Private/Public Funding (Purchase)			
ESTIMATED COSTS	Low Purchase Price ($70.50/AF)	High Purchase Price ($8,275.41/AF)	Average Purchase Price ($1,701.09/AF)
-Purchase Costs			
Partial Water Right 42KJ 94423-00	$1,006,785	$118,178,113	$24,292,646
Transaction Costs	$2,000,000	$2,000,000	$2,000,000

-Diversion Modification Costs	--	--	--
Total Estimated Costs	$3,006,785	$120,178,113	$26,292,646
Present Value Costs	***$3,006,785***	***$120,178,113***	***$26,292,646***

Table 15: Low, high, and average costs projected for the partial, long-term (ten-year) lease of 14,281 AF of Colstrip's water right under a public/private funding model.

Private/Public Funding (Long-Term Lease)			
ESTIMATED COSTS	Low Lease Price ($5.41/AF)	High Lease Price ($1,138.46/AF)	Average Lease Price ($203.57/AF)
-Purchase Costs			
Partial Water Right 42KJ 94423-00	$77,258	$16,258,361	$2,907,109
Transaction Costs	$2,000,000	$2,000,000	$2,000,000
-Diversion Modification Costs	--	--	--
Total Estimated Costs	$2,077,258	$18,258,361	$4,907,109
Present Value Costs	***$2,077,258***	***$18,258,361***	***$4,907,109***

The projected costs are likely an underestimation of actual outcomes. Transaction and negotiation fees are likely to be higher than estimated for this analysis because transfer of the water right requires the approval of all owners listed on the right (CO Rev Stat § 37-92-302); this water right includes seven owners—Pacificorp, Avista Corp, Puget Sound energy Inc, Portland GE, Northwestern Corp, Talen Montana LLC, and the City of Colstrip—and would require the approval of all parties. Additionally, due to Colstrip's complex infrastructure, it is difficult to predict infrastructure modification or monitoring costs; therefore, it is assumed that proposed costs are an underestimation of actual costs.

Engaging in a long-term lease of 30% of Colstrip's water right is projected to cost TNC $0.9 million to $101.9 million less than purchasing the water right. Although TNC would reduce costs by leasing the water, TNC would only be able to provide conservation benefits instream during the ten-year lease period. Although leasing is presented as the more financially viable option based on the range of purchase and lease prices, TNC may still seek to purchase water rights to ensure investments in infrastructure changes are secure and ensure conservation benefits in perpetuity, which have not been quantified in this analysis. TNC also has an option to negotiate an extension of the lease agreement with the listed owners on the water right, but there in increased uncertainty about the long-term security of environmental benefits.

Impact Investing

TNC may also purchase a portion of Colstrip's water using impact investment funds, which would enable the leasing of water to downstream users to generate return on investment. It would also provide conservation benefits from instream flow augmentation from the original point of diversion at Forsyth, MT, to the lessee's point of diversion downstream.

Table 16: Inputs and assumptions for financial analysis of partial water right (14,281 AF) associated with Colstrip (42KJ 94423-00).

GENERAL ASSUMPTIONS		COSTS	
Water Right (Total)		*Purchase of Water Rights*	
Water Right (AF/yr) 42KJ 94423-00	50,151	**Low ($/AF)**	$70.50
Consumptive Use (AF/yr)	50,151	**High ($/AF)**	$8,275.41
Permitted for Industrial Use (AF/yr)[1]	48,703	**Average ($/AF)**	$1,701.09
Percent generating capacity lost (%)[2]	29.32%		
Water available for purchase (AF/yr)	14,281	*Long-Term Lease of Water Rights*	
		Low ($/AF)	$5.41
Rates		**High ($/AF)**	$1,138.49
Discount Rate	0.028	**Average ($/AF)**	$203.57
Appreciation Rate	0.028		
		Purchase/Sale of Water Rights	
BENEFITS		**Legal and Consulting Fees ($)**	$2,000,000.00
Short-Term Lease of Water Rights to Downstream Users			
Low ($/AF)	$3.19	*Short-Term Lease of Water Rights to Downstream Users*	
High ($/AF)	$328.29	**Legal and Consulting Fees (%)**	0.02
Average ($/AF)	$47.16		

[1] Water right includes industrial and municipal uses; specifies no more than 2 cfs of maximum flow rate (69.27) permitted for municipal use.

[2] Currently, total net generation at Colstrip is 2094 MW. Units 1 and 2 are decommissioning (307 MW generating capacity each; combined 614 MW). Units 3 and 4 (740 MW generating capacity each, combined 1480 MW) will remain in operation.

Data on water right transactions in the state of Montana were obtained from WestWater Research and inform the purchase price and lease price values included in our analyses. All data were adjusted to reflect 2017 values. The following assumptions were made:

(1) The purchase price for water rights in Montana ranges from $70.50/AF to $8,275.41/AF, with an average of $1,701.09/AF.
(2) The short-term lease price of water in Montana ranges from $3.19/AF to $328.29/AF, with an average annual lease price of $47.17/AF
(3) Water rights are leased annually for 10 consecutive years to the highest-paying downstream user and sold in the 11th year at the original price of acquisition.
(4) Transaction costs associated with the annual lease of water rights to downstream users are 2% of total lease price.
(5) The discount rate is 2.8%, as calculated by dividing by the lease price by the average purchase price.[63]
(6) Water rights appreciate at the discount rate, 2.8%.
(7) An 8% return on investment (ROI) must be generated for the transaction to be considered a sound investment.

To analyze costs and benefits of using impact investment funds to acquire a portion of the water rights associated with Colstrip, the following assumptions have been made:

(1) TNC is legally allowed to purchase a water right, change the beneficial use of water right to environmental, and later lease that water for other uses.
(2) TNC leases annually for 10 consecutive years to the highest-paying downstream user—downstream municipality of Miles City, MT.
(3) TNC leases the full consumptive use portion acquired from Colstrip (14,281 AF). Because TNC does not have storage infrastructure to control the flows to downstream lessees, the maximum daily diversion volume would be 39 AF.
(4) Downstream lessees would be able to divert no more than half of the flow rate associated with this right (20 cfs).

The proposed financial model includes several impact investing scenarios to inform TNC of the costs and benefits associated with acquiring 14,281 AF of Colstrip's water right, annually leasing the total volume of this water right to downstream users for ten years, and then selling the water rights after ten years. Each of the above purchase prices was combined with one of the above lease prices to project the net present value of impact investing strategy under nine financial/market scenarios (

Table *17*).

Table 17: Sensitivity analysis on the NPV and ROI of a partial acquisition of Colstrip's water right (14,281 AF) under impact investing scenario. Green indicates a ROI greater than 8%.

	Low Lease Price ($3.19/AF/year)	**Average Lease Price ($47.14/AF/year)**	**High Lease Price ($328.29/AF/year)**
Low Purchase Price ($70.50/AF)	- $1,634,849.22 (-5%)	$3,675,823.66 (19%)	$37,630,553.40 (153%)
Average Purchase Price ($1,701.09/AF)	- $2,100,566.44 (2%)	$3,210,106.44 (4%)	$35,287,126.84 (6%)
High Purchase Price ($8,275.41/AF)	- $3,978,275.78 (2%)	$1,332,397.10 (3%)	$37.164836.17 (18%)

Figure 18 shows the results of the impact investing scenario for Colstrip; water rights may be purchased at a low ($70.5/AF), average ($1,701.09/AF), or high price ($8,275.41/AF) and leased to downstream users at a low ($3.19/AF, light blue), average ($47.14/AF, green), or high ($328.19/AF, dark blue) price. TNC will yield the greatest returns on investment ($35.9 million) if the purchase/sale price is low ($70.50/AF) and annual lease prices are high ($328.29/AF) (

Table *17*). Additionally, this financial analysis shows that high value leases signal greater returns on investment, compared to purchase prices; this is likely due the assumption that TNC can sell this water right for the full purchase price. As shown in this financing strategy is projected to exceed 8% return on investment under three market scenarios—low purchase price and average lease price, low purchase price and high lease price, and high purchase price and high lease price. Furthermore, is average purchase price is assumed, TNC would need to lease water at $133/AF annually to generate an 8% return on investment from the water right purchase.

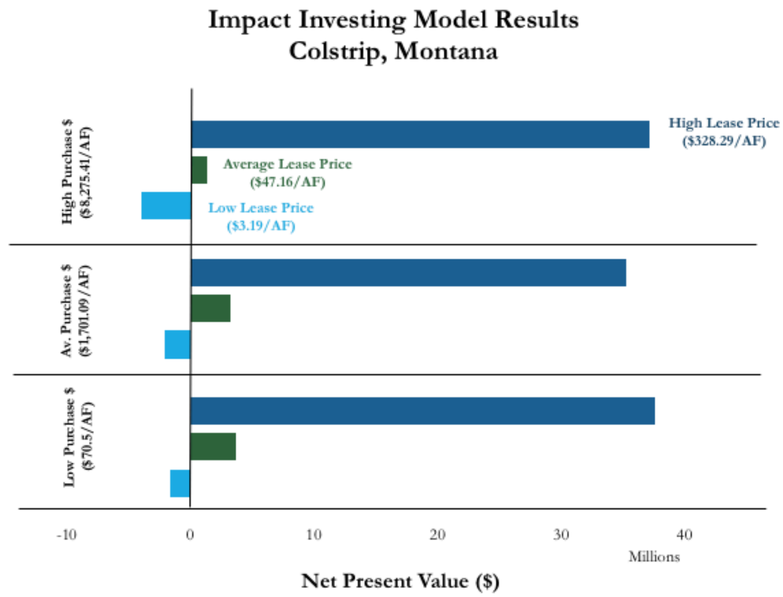

Figure 18: Impact investing model results for partial acquisition of water rights held for Colstrip Power Plant (14,281 AF).

Instream Flow Augmentation

This region has historically been interspersed with periods of drought. The instream flow benefit from acquiring this partial water right would protect an additional 14,281 AF/year at a maximum flow rate of 20 cfs in the Yellowstone River. Flow rate is assumed to be constant throughout the year because there is no existing storage infrastructure at the point of diversion on the river.

Although TNC would not be able to control releases to the river, the main instream flow benefit associated with this transfer is base flow augmentation. The value of this water right is primarily derived from TNC's ability to shepherd water upstream from the historic point of diversion at Forsyth; TNC can effectively prevent other users from diverting water that might cause injury to TNC's water right and ensure conservation benefits in that reach of the Yellowstone River.

Table 18: Average annual flows in Yellowstone River at Forsyth, MT, located downstream from Colstrip diversion point (2007–2016) and potential flow augmentation from partial Colstrip water right purchase. Stream gauge data obtained from USGS (site number 06295000).

Date	Average flow (cfs)	Avg. flow + 20 cfs (cfs)	% Change
2007	7,446.25	7,466.25	0.27 %
2008	11,470.57	11,490.57	0.17 %
2009	12,508.25	12,528.25	0.16 %
2010	10,754.85	10,774.85	0.19 %
2011	18,353.97	18,373.97	0.11 %
2012	8,369.54	8,389.54	0.24 %
2013	7,768.25	7,788.25	0.26 %
2014	14,689.89	14,709.89	0.14 %
2015	9,988.08	10,008.08	0.20 %
2016	8,297.92	8,317.92	0.24 %

Table 19: Annual 7-day low flows in Yellowstone River at Forsyth, MT, located downstream from Colstrip diversion point (2007–2016) and potential flow augmentation from partial Colstrip water right purchase. Stream gauge data obtained from USGS (site number 06295000).

Date	7-day low flow	Low flow + 20 cfs (cfs)	% Change
2007	3,415.71	3,435.71	0.59 %
2008	4,067.14	4,087.14	0.49 %
2009	4,594.29	4,614.29	0.44 %
2010	4,845.71	4,865.71	0.41 %
2011	4,771.43	4,791.43	0.42 %
2012	3,567.14	3,587.14	0.56 %
2013	3,491.43	3,511.43	0.57 %
2014	4,357.14	4,377.14	0.46 %
2015	5,057.14	5,077.14	0.40 %
2016	3,580.00	3,600.00	0.56 %

As shown in Table 18 and Table 19, the flow of water TNC would be able to conserve instream would increase the average flow in the Yellowstone River by 0.2% and increase the 7-day low flow by 0.5%.

Conclusion

When Colstrip Power Plant units 1 and 2 retire in 2022, the plant will lose approximately 30% of its generating capacity--resulting in 14,281 AF of water potentially becoming available for purchase or reallocation. Analysis of TNC's proposed public/private funding and impact investing strategies for the partial purchase of Colstrip's water right reveals opportunities to permanently purchase this water right and potentially generate return from impact investing.

Risks

The primary risks associated with acquiring 14,280 AF of Colstrip's water right on the Yellowstone River using funding from donor funds or impact investments are legal, physical, and financial.

The partial acquisition of the water right associated with Colstrip Power Plant includes three major legal risks. First, water transfers in Montana require approval from all owners listed on the water right. There are seven owners listed on Colstrip's water right—Avista Corporation, Northwestern Corporation, Portland General Electric, Puget Sound Energy, Talen Montana LLC, and the City of Colstrip. Because TNC would be required to negotiate a sale or lease with all seven listed owners, there is less certainty that the negotiating parties will come to an agreement and TNC may incur higher transaction costs. Additionally, Colstrip has been the subject of several recent lawsuits; this existing political tension surrounding Colstrip's impact on local water quality and supply may pose increased risks for TNC. Since 2008, environmental groups, local ranchers, and the City of Colstrip have pursued lawsuits against Colstrip owners from violating the Clean Water Act, causing injury to nearby water users and impairing municipal water supply. This shows that the community is engaged and invested in their water, which signals risks of local opposition to water rights transfers. Finally, Montana state law requires that the water right change applicant prove that additional instream flow provides benefit to a fishery resource, "as measured at a specific point" (Id. §85-2-408(3)). As shown in the instream flow analysis above, the partial water right acquisition would increase flows in the Yellowstone River by 20 cfs—less than 0.5% of annual average and low flows. Because instream flow augmentation is negligible, it is unlikely that TNC could quantify and justify benefits to fisheries; therefore, there is high risk that Montana DNRC will deny the negotiated change agreement.

Additionally, purchasing Colstrip's water right on the Yellowstone River represents notable logistical, or physical, risks due to the uncertainty of available water supplies and the complexity of existing infrastructure. First, Colstrip's owners have recently contracted with GeoSyntec Consultants to develop a remediation and closure plan (July 2017) to ensure that Units 1 and 2 comply with environmental regulations and prevent future contamination.[67] Although the closure plan does not specify how much water is required for remediation efforts or how this water will be supplied, it is likely that plant owners will commit surplus water historically used for cooling Units 1 and 2 once power generation is terminated. Colstrip's existing point of diversion near Forsyth, MT includes complex existing infrastructure and no visible storage. To conserve water instream, TNC would need to modify the existing diversion in a way that preserves the remaining 70% of flow (49.27 cfs) to Colstrip; and because the diversion infrastructure is physically complex, this is likely to be a substantial capital investment. Additionally, because the cost of modifications is highly uncertain, it was omitted from this analysis. Therefore, if TNC intends to commit to investing in infrastructure modification, then TNC is advised to permanently purchase this portion of Colstrip's water right. Additionally, no storage infrastructure currently exists at Colstrip's point of diversion on the Yellowstone River; therefore, TNC would not be able to control and time releases to strategically target conservation objectives and instead, instream flow benefits would be distributed across the year.

Rewards

Grant funding and impact investing strategies for partial acquisition of Colstrip's water right pose substantial financial risk to TNC. The proposed investment options for the partial acquisition of Colstrip's water right are associated with high projected purchase costs and low lease prices, which are subject to the uncertainty of local water market activity and drought conditions. Additionally, this analysis underestimates the actual costs associated with water right acquisition because it omits the costs of infrastructure modification, project monitoring, and outcome evaluation, due to a lack of available information.

In assessing the two public/private funding model strategies (i.e., purchase and long-term lease), TNC is advised to pursue the permanent purchase. Although the water right purchase is projected to cost substantially more than a long-term lease agreement, TNC would need to modify existing diversion infrastructure to ensure that purchased or leased water remains instream. Additionally, because existing diversion infrastructure is complex, any modification is likely to be a substantial investment into a permanent change in the system, which was not accounted for in this analysis. Therefore, it is recommended that TNC permanently purchase this water right, as opposed to lease.

Impact investing is projected to yield greater than 8% return on investment in three of nine market scenarios—when lease prices are high. Cost-benefit analysis of TNC's impact investing strategy reveals great uncertainty in projected returns on investment under various water market conditions, which indicates increased risk. Nonetheless, impact investing is a potentially viable strategy in this area, as there are many water users (municipal and agricultural) downstream from historic point of diversion who could be willing to lease water from TNC.

TNC is projected to generate return only when lease prices are in the high range (projected revenue between $28.5 million and $56.0 million); but when lease prices are average, return on investment is projected to be negative or slightly positive (projected revenue between -$26.9 million and $550,000). Furthermore, although sale prices have less impact on returns, negotiating low initial purchase (and final sale) prices will generate greater returns, for any given lease price. TNC is advised to assess current market conditions to more accurately assess projected sale and lease prices in the region.

Despite promising/positive projected returns on investment for several market scenarios, instream flow augmentation analyses reveal that contribution from conserving an additional 20 cfs would be negligible, compared to the average and low flows of the Yellowstone River.

Recommendation

Ultimately, there are substantial legal, physical, and financial risks associated with acquiring a portion of Colstrip's water right, which would render a maximum of 14,281 AF/year (20 cfs) added to the system, representing less than 1% of the change in flow of the Yellowstone River (Table 18 and Table 19). Because the additional instream flow is small relative to the average and low flows of the Yellowstone River, it is unlikely that TNC would be able to quantify environmental benefits associated from flow augmentation and TNC would be unable to monitor and evaluate the effectiveness of this investment in meeting conservation objectives. Therefore, it is recommended that TNC does not pursue partial acquisition of water rights associated with Colstrip Power Plant.

Chapter 4: Lessons Learned

Case study analyses provided valuable insight into the specific factors that determine whether an investment strategy is sound. Although it is clear that there is no one-size-fits-all approach, several overarching themes can be extrapolated to help inform future decision-making. They are related to (i) the ownership structure and physical nature of the power plant, (ii) respective state water law, (iii) potential environmental benefits, (iv) political landscape, and (v) financial implications.

Coal-Fired Power Plants (CFPPs)

The ownership structure of a CFPP can provide insight into whether a water right transaction is worth pursuing. Multiple energy companies can own a share of a CFPPs total output, thus involving multiple entities in the negotiation of a water right transaction. Consequently, the fewer ownership interests involved, the less complex the transaction negotiations will be. In addition, CFPPs are often composed of multiple units that retire individually rather than as a whole. Targeting entire plant closures rather than unit closures will likely reduce uncertainty over the amount of water available to be transacted from a partial water right.

Although the entire water right associated with a decommissioning CFPP is purchased during a transaction, only the consumptive use portion is used when determining the potential environmental benefits. This is because the consumptive use portion is the amount that is historically not returned to the environment. Additionally, this consumptive use portion is the maximum amount of water TNC can lease to downstream users. Downstream users may claim injury to their water rights if TNC claims that consumptive use is greater than the CFPP's actual historic consumptive use, and "calls on" water for environmental use or leases water to other users.

Water rights typically do not include consumptive use amounts; therefore, when transferring water rights, change applicants are responsible for estimating historic consumptive amounts. If consumptive use is not explicitly stated on the water right associated with the CFPP, historic consumptive use may be estimated based on U.S. Geological Survey (USGS)-estimated data or calculated based on the CFPP's cooling system. USGS reports estimated consumptive water use rates based on data reported to the U.S. Energy Information Administration (EIA); reported values for CFPPs decommissioning within the next 20 years can be found in Appendix A of this report. Additionally, consumptive use amounts may be calculated based on the physical nature of a CFPP's cooling system. The two most common cooling methods are (i) once-through cooling and (ii) recirculating systems. Although once-through cooling processes require significantly more water than recirculating systems (about 20,000 gallons/MWh compared to 500 MWh), consumptive use represents only a small percentage of the diversion. While return flow from a once-through cooling process can pose its own challenges (e.g. water temperature and quality), only about 2% of the diverted water is consumed, and the rest is returned to its source. Conversely, recirculating systems divert a much smaller amount of water but consumptively use about 70% of the diverted water. Understanding the cooling system of the retiring CFPP reveals more information about its actual consumptive water usage. If these two methods yield significantly different values, TNC should assume the more conservative consumptive use calculation to reduce uncertainty of a water rights acquisition scenario.

Finally, it is important to know if existing agreements are in place for use of the CFPP's water right and/or water infrastructure. Since CFPPs do not require high quality water for cooling, energy companies may contract with nearby municipalities to trade their high quality, secure water supplies for municipalities' effluent water. CFPP water rights already involved in such agreements will likely be much more difficult to aid in environmental flows since that water is already being consumptively used by a municipality. For example, Xcel Energy—which owns the Public Service Company of Colorado—exchanges approximately 5,000 AF of high quality water supplies from its Cherokee plant with the City of Denver for low quality effluent water that the city discharges into the South Platte River. Additionally, many states require plant owners submit a closure or remediation plan prior to plant shutdown; therefore, TNC should investigate if water rights are already committed to any future agreements. For example, Colstrip's wastewater facility closure plan (July 2017) includes plans for lining, capping, and sealing of the plant's wastewater storage infrastructure[2]; therefore, it is unlikely that TNC could acquire the plant's storage water rights.

Water Law

State-specific water law provides the framework for transferring water rights from a decommissioning CFPP. It is important to understand whether the state in which the retiring CFPP is located lends itself to (1) the ownership of environment flow water rights by a private actor, (2) the permanent transfer of a water right for environmental flows, and (3) the leasing of partial water rights to downstream users for impact investment scenarios.

While all western states recognize environmental flows as a beneficial use, the authorized duration and structure of transferring water rights to environmental use varies by state. The following list represents western states where TNC can legally hold water rights for environment flow purposes. Unless otherwise stated, such a water right can be held in perpetuity:

- Arizona (water right loses priority date, and buyer must own land rights in benefitting riparian corridor; no statutory laws for transfer process)
- California (conserved water can legally be set aside as an environmental flow)
- Montana (only for a 10-year time period at which point the water right must be renewed)
- Nevada (founded on a Supreme Court case, no statutory laws for transfer process)
- New Mexico (the original priority date may not be maintained; no statutory laws for transfer process)
- Texas
- Utah (private nonprofit fishing groups and state agencies are the only entities able to hold an instream flow; to date, only the Division of Wildlife Resources holds instream flow rights)
- Washington (only instream flow water rights held by the state are exempt from relinquishment or abandonment)

In the following states, environmental flows are recognized as a beneficial use, but only the state (or a political subdivision) can hold those water rights:

- Arizona (Arizona Department of Water Resources, if the water right is to hold its original priority date)
- Colorado (Colorado Water Resource Board)
- Idaho (Idaho Water Resource Board)
- Oregon (Oregon Water Resources Department)
- Wyoming (State of Wyoming)

TNC would not be able to hold an environmental flow water right in these states. However, they are still worth investigating, as negotiations can be made with state agencies to hold donated environmental flow water rights.

Additionally, the priority date and record of curtailment of the water right held by the retiring CFPP are important to consider. The priority date of a water right represents the date when a water right is first put to beneficial use. The date also serves as the order, in which water rights are fulfilled, if there is a water shortage. For example, if a CFPP holds a water right with a later priority date compared to other water rights in a basin, the water right may not be reliable due to the inconsistency between years. Identifying whether a CFPP has historically supplemented their water right or had their water right curtailed during extreme drought periods helps determine the reliability of a water right.

Environmental Benefits

Understanding the environmental benefits generated through a water rights acquisition is necessary for determining the salience and relevance of a transaction. TNC should understand the spatial and temporal distribution of potential environmental benefits the water right acquisition could provide. Such environmental benefits can include, but are not limited to, drought mitigation, wetland restoration, stabilization of river processes, and conservation of species of concern. Recreational uses, such as fishing and boating, can provide quantifiable benefits for TNC, as well.

Environmental benefits from water rights acquisition may be spatially and/or temporally distributed; therefore, TNC should consider the location of the power plant and its historic diversion and storage infrastructure. Spatially dependent conservation priorities may be upstream or downstream from the CFPP's historic point of diversion (POD). If conservation priorities are upstream from historic POD, TNC may call on water right to prevent upstream junior diverters from using water during droughts or low flow periods. Additionally, TNC should assess the impact of diversion and storage infrastructure of conservation objectives. Removing diversion infrastructure provides spatially distributed environmental benefits if infrastructure historically impaired fish migration or spawning habitat; in contrast, maintaining storage infrastructure allows TNC to strategically time flows if environmental needs are during specific periods of the year. Lastly, local customs or activities can be investigated to understand whether any of the aforementioned benefits are of particular concern to the local government, non-governmental organizations, or residents.

Although environmental benefits of acquiring a water right are difficult to quantify, TNC is able to calculate the increase in instream flow, compared to historic seven-day annual low flows and average annual flows. Water rights typically indicate maximum or average flow rates (cfs or GPM); this flow rate can be compared to the recorded discharge at the nearest downstream USGS stream gauge to assess the potential instream flow augmentation provided by TNC's water right acquisition.

Political Landscape

Understanding the political landscape is another critical component of assessing a water right acquisition opportunity. Tensions between interest groups that may underpin current water use and future demand could have significant implications for TNC decision-making. For example, some CFPPs—particularly those in small towns—serve as the primary source of employment for local residents. In the case of closure, bitterness towards drivers of the decline in coal consumption (e.g., stricter compliance measures) may translate into opposition towards a water right transfer for environmental purposes. Conversely, a CFPP may be notorious among community members for its role in the degradation of air quality and water supplies. In this case, negative public perceptions of a CFPP could serve as advantageous for TNC.

Regional water scarcity, too, could be an important component of the political landscape. If local communities are concerned about the security of their supplies, allocating water for instream flows may prove senseless and, indeed, dangerous. The water rights held by Talen Energy for the J.E. Corette Power Plant serves as a case in point: Appropriation of resources to the water-scarce city of Lockwood rather than for instream flows could, in fact, *benefit* the Yellowstone River if such an act prevents the potential for reallocation of environmental flows to other qualified (e.g. municipal) uses. J.E. Corette should serve as cautionary tale of the unintended consequences that may arise if there is not sufficient knowledge of the local political landscape.

Financial Implications

Water Market Analysis

Understanding water market conditions is necessary to inform the acquisition of water rights from decommissioning CFPPs under two financing mechanisms: public/private funding and impact investing. For both financing options, TNC has three options for acquiring a water right: (1) full water right from the retiring CFPP (only consumptive use portion may be "called on"), (2) partial water right from partial closure of CFPP (select units, only consumptive use portion may be "called on"), or (3) consumptive use portion of water right.

Water market conditions are spatially dependent—water laws are state-specific and water needs vary greatly by region—therefore, predicting the costs of acquiring and revenue from leasing and selling water involves great uncertainty. States such as Arizona, New Mexico, and Utah have less developed water transaction processes, which may increase transaction fees and contribute to the relatively low numbers of overall environmental water transfers. The lack of a robust water market may increase uncertainty about TNC's ability to lease water to downstream users (if TNC hopes to pursue impact investing). Additionally, the average price of water may be extremely different in neighboring watersheds—depending on the current size and projected growth of municipalities in the basin, the value of agriculture in the region, and the importance of environmental and recreational values. Furthermore, water markets may be more robust in some basins than others; in basins with few transactions, TNC may use transaction data from nearby basins or state-level data–keeping in mind the above factors may contribute to regional differences purchase and lease prices.

The price per acre-foot ($/AF) of water transfers also varies greatly based on the type of transfer and the buyer's beneficial use of the water. Permanent purchases tend to cost more per AF, compared to temporary leases. Water market analysis in both Texas and Montana indicate that permanent purchases are more expensive, per acre-foot ($/AF), than long- and short-term leases. In most basins, there have been a relatively small number of water transfers involving environmental buyers, and little publicly-available information about these transfers; therefore, there is great uncertainty associated with the range of purchase and lease prices. Nonetheless, water market analysis consistently indicates that municipal and industrial buyers are willing to pay more per AF than agricultural buyers, who are willing to pay more than environmental buyers.

Financing Strategies

TNC should fully understand the advantages and disadvantages of public/private funding and impact investing strategies to finance water rights acquisitions from decommissioning CFPPs. Additionally, TNC should prioritize transactions where multi-benefits can be acquired, such as CFPPs located near large and growing municipal needs that can act as financially secure lessors. Areas where this can be coupled with instream benefits until the lessors' point of diversion will be the most impactful transactions.

Using a combination of public and private grant funding, TNC may either permanently purchase or temporarily lease water rights from decommissioning CFPPs. Permanently purchasing the water right is the only acquisition scenario that provides environmental benefits in perpetuity and allows TNC to maintain, alter, or remove existing diversion or storage infrastructure to suit environmental objectives. If state water law limits environmental transfers to temporary transfers (Montana) or only allows state agencies to hold environmental flow rights (Arizona, Colorado, Idaho, Oregon, Wyoming), then TNC may be limited to this grant funded financing strategy. Leasing is likely to cost less than purchasing the water right but would only provide conservation benefits for the duration of the lease terms and TNC would not be able to permanently alter diversion infrastructure.

Impact investing provides a financing strategy to provide instream conservation benefits over the duration of the fund (typically ten years) and generate return on investment by annually leasing to downstream water users. To reduce risk of lawsuits and avoid injury to other downstream water users, TNC should only lease consumptive use portion of water right—using the most conservative estimate, reported or calculated—and the lessee's increase in diversion rate should not exceed the maximum flow rate stated on the original water right. Additionally, TNC faces uncertainty about return on investment from impact investing due to the increased uncertainty in downstream users' willingness to lease and variability in negotiated lease prices, which are subject to drought conditions and water supply shortage in the basin.

Furthermore, impact investing enables TNC to generate environmental benefits from increased flows instream between the CFPP's historic POD and the downstream lessee's new POD. Thus, TNC should define spatial and temporal distribution of conservation needs to optimize leasing strategies to maximize environmental benefits downstream from the lessee's POD and revenue from leases. As shown in Table 20, TNC should pursue annual leases if conservation objectives are spatially distributed. If critical conservation needs are primarily located instream up to the lessee's POD, TNC may lease its full water right to maximize revenue from leasing, but if additional conservation needs exist downstream from lessee's POD, TNC may lease only a portion of their water right. Often, conservation needs vary seasonally, in which case TNC should pursue seasonal leases to provide full environmental benefits downstream of lessee's POD during periods of critical need.

Table 20: Conservation objectives and outcomes associated with four leasing strategies: annual and seasonal leasing of full and partial water rights. Wet season indicates less environmental need, whereas dry season indicates a critical period for species of concern.

Conservation Objectives	Leasing Strategy (lease term, portion of WR)	Conservation benefit downstream from lessee's POD (Wet Season)	Conservation benefit downstream from lessee's POD (Dry Season)
Spatially-distributed	Annual, full WR	No benefit	
	Annual, partial WR	Partial benefit (portion not leased)	
Temporally-distributed	Seasonal, full WR	No benefit	Full benefit
	Seasonal, partial WR	Partial benefit (portion not leased)	Full benefit

Deciding on a Financing Strategy

Using public and private funds to finance water rights acquisition provides greater environmental benefit at a higher cost to TNC, compared to impact investing. TNC must acquire grant funding to fund the full cost of purchasing the water right and would not generate any revenue from leasing. The conditions under which public/private funding would be an advantageous financing strategy include:

(1) Acquiring water right results in quantifiable instream flow benefit to a state- or federally-listed species of concern—state and federal grants often available for conservation efforts benefitting endangered, threatened, or game species.

(2) Conservation objectives exist far downstream and/or persist year-round—downstream leases would impede flows from meeting objectives.

(3) Low demand for water in the region—small, slow-growing municipalities, low-value agriculture, and/or ample water supplies signal that potential lessees are willing to pay less for water or may not need to engage in leasing to supplement their supply.

Using impact investment funds to finance water rights acquisitions provides environmental benefits from conserving water instream while generating revenue from leasing and eventually selling the water right. TNC's impact investment strategy should project to generate at least 8% return on investment to justify acquiring the water right asset. Therefore, conditions under which impact investing would be an advantageous strategy:

(1) Conservation objectives are primarily located between the CFPP's historic POD and lessee's POD—full water right provides conservation benefit instream between CFPP's historic POD and downstream lessee's new POD.

(2) Conservation objectives are spatially or temporally distributed—TNC can target leasing strategies to suit environmental needs by leasing their full or partial water right on an annual or seasonal basis.

(3) High demand for water in the region—large municipalities, fast-growing industries, and high-value agricultural producers that to need to increase water supplies are potential lessees with high willingness to pay.

(4) Robust water market—market activity signals streamlined transfer processes and increased certainty that TNC can engage potential lessees.

Chapter 5: Conclusion

Water scarcity poses a significant environmental challenge in the western United States. As cities grow and agricultural operations expand, so do their diversions from rivers and lakes, leaving less water instream. The decline of coal energy production, however, may be the environment's unlikely answer to instream flow needs. Increased cost-effectiveness of alternative energy sources coupled with stricter environmental regulations are driving the decommissioning CFPP throughout the west—and, consequently, unleashing the enormous quantities of water that are required for their operations.

The Nature Conservancy has identified this changing energy landscape as an opportunity to improve instream flows and advance conservation objectives. If water transfers can successfully be leveraged to acquire water rights held by retiring CFPPs, critical resources could be reallocated back to the environment. Thus, the members of the Instream Impact team sought to address the question: *Is the procurement of water rights from retiring CFPPs for environmental purposes a sound investment strategy for TNC?* To offer an informed response, the team conducted three case study analyses in which the following dimensions were explored: (i) the role of state-specific water law in environmental flow transactions, (ii) the likely outcomes of discrete funding models, and (iii) the potential to deliver conservation results. The findings presented in this report indicate that TNC should strongly consider acquisition of the water rights held for Coleto Creek but not pursue either the J.E. Corette or Colstrip procurement opportunities without conducting further research on their potential to drive environmental benefits.

In addition to providing case-specific recommendations, the members of the Instream Impact team made several important discoveries that can inform future decision-making. First, state water law as well as the ownership structure, seniority, and consumptive use portion of the water rights held by a retiring CFPPs are critical factors in the determining the feasibility of a procurement opportunity. State water law, for example, may either permit (temporarily or in perpetuity) or deny non-governmental organizations from acquiring water rights for environmental flows; and ownership structure, seniority, and consumptive use are indicators of the magnitude of transaction costs, reliability of flows, and potential for driving conservation results, respectively.

Second, adopting a holistic approach to conservation benefits during the assessment of an acquisition opportunity is critical. The impacts of additional instream flows on both the quality and quantity of the downstream species' habitat, as well as the biology of species, should be carefully considered. The needs of priority species beyond instream flow augmentation--such as habitat area, availability of food sources, and removal of impediments to migratory pathways--should also be taken into account. To the extent that such needs are prevalent, augmented instream flows may be seen as buffer against climate change and other uncertainties that pose an existential threat to the persistence of the species.

Third, not all investment opportunities will prove feasible, but there are legal, financial, and environmental characteristics that improve the likelihood that TNC will be able to negotiate a transaction. These include the following:

(1) State legislation permits a non-governmental organization to hold a water right for environmental flows.
(2) The parent company of the retiring CFPP has not negotiated an agreement concerning the future of its water rights other parties.

(3) The consumptive use portion of the water rights relative to the receiving waterbody is large enough to have an instream impact.
(4) The priority date(s) of the water rights are senior relative to other basin users.
(5) The CFPP and its respective water rights are owned by a minimal amount of parent companies.
(6) A species of concern is within close proximity of the water diversion point and there is clear scientific evidence that links river flow to the health of the species' or its habitat.
(7) The political climate to water transfers is not hostile, and there is minimal opposition from basin stakeholders with water needs.

In conclusion, it is important to understand the complexities associated with acquiring water rights from retiring CFPPs for instream flows. As demonstrated in this report, the retirement of CFPPs can create novel opportunities to transfer water back to the environment, but each opportunity must be analyzed at the site level. When the right factors align, including enabling state water law, reasonable water prices, and the presence of priority species, the acquisition of water rights from CFPPs can ensure that the environment benefits from a changing energy landscape in the western United States.

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Appendices

Appendix A: Database of Decommissioning CFPPs in the West

See attached Excel spreadsheet for more detailed information about decommissioning CFPPs listed here.

Plant Name	Entity Name	Plant State	Generator ID	Nameplate Capacity (MW)	Technology	Cooling Technology	Prime Mover Code	Operating Month	Operating Year	Planned Retirement Month	Planned Retirement Year	Reported Withdrawal (AF/yr) (EIA)	Repoted Consumption (AF/yr) (EIA)	Reported Withdrawal (AF/yr) (UCS)	Repoted Consumption (AF/yr) (UCS)
Apache Station	Arizona Electric Pwr Coop Inc	AZ	ST3	204.0	Conventional Steam Coal	Recirculating	ST	1	1979			2,172	1,810	4545	3107
Apache Station	Arizona Electric Pwr Coop Inc	AZ	ST2	204.0	Conventional Steam Coal	Recirculating	ST	9	1979			2,172	1,810	3822	2613
Cholla	Arizona Public Service Co	AZ	2	288.9	Conventional Steam Coal	Cooling Pond	ST	6	1978	11	2015	0	0	69155	3083
Cholla	PacifiCorp	AZ	4	414.0	Conventional Steam Coal	Recirculating	ST	6	1981			8,760	8,760	7743	5293
H Wilson Sundt Generating Station	Tucson Electric Power Co	AZ	4	173.3	Conventional Steam Coal	Recirculating	ST	7	1967		2015	9,339	9,339	2493	1704
Navajo	Salt River Project	AZ	NAV1	803.1	Conventional Steam Coal	Recirculating	ST	5	1974		2019	9,267	9,267	17300	11826
Navajo	Salt River Project	AZ	NAV2	803.1	Conventional Steam Coal	Recirculating	ST	4	1975		2019	2,389	2,027	18399	12578
Navajo	Salt River Project	AZ	NAV3	803.1	Conventional Steam Coal	Recirculating	ST	4	1976		2019	0	0	18346	12541
ACE Cogeneration Facility	ACE Cogeneration Co	CA	GEN1	108.0	Conventional Steam Coal	Recirculating	ST	9	1990	10	2014	0	0	2321	1586
Colton Plant	California Portland Cement Co	CA	1	15.0	Conventional Steam Coal	na	ST	4	1985	4	2015	na	na	na	na
Colton Plant	California Portland Cement Co	CA	2	15.0	Conventional Steam Coal	na	ST	4	1985	4	2015	na	na	na	na
Rio Bravo Poso	Rio Bravo Poso	CA	UP8	38.2	Conventional Steam Coal	Recirculating	ST	9	1989	11	2014	0	0	896	613
Arapahoe	Public Service Co of Colorado	CO	3	40.0	Conventional Steam Coal	Recirculating	ST	6	1951	12	2013	2,100	1,738	856	585
Arapahoe	Public Service Co of Colorado	CO	4	112.5	Conventional Steam Coal	Recirculating	ST	6	1955	12	2013	0	0	1853	1267
Cameo	Public Service Co of Colorado	CO	1	25.0	Conventional Steam Coal	Once-Through	ST	0	1957	12	2010	0	0	29696	204
Cameo	Public Service Co of Colorado	CO	2	50.0	Conventional Steam Coal	Once-Through	ST	0	1960	12	2010	0	0	15477	106
Cherokee	Public Service Co of Colorado	CO	3	170.5	Conventional Steam Coal	Recirculating	ST	6	1962	8	2015	0	0	2829	1934
Cherokee	Public Service Co of Colorado	CO	4	380.8	Conventional Steam Coal	Recirculating	ST	6	1968		2028	0	0	7276	4974
Craig (CO)	Tri-State G & T Assn, Inc	CO	1	446.4	Conventional Steam Coal	Recirculating	ST	7	1980	12	2025	15,421	15,421	10339	7068
Hayden	Public Service Co of Colorado	CO	1	190.0	Conventional Steam Coal	Recirculating	ST	7	1965		2025	2,823	2,823	4588	3137
Hayden	Public Service Co of Colorado	CO	2	275.4	Conventional Steam Coal	Recirculating	ST	9	1976		2025	0	0	5967	4079
Martin Drake	City of Colorado Springs - (CO)	CO	5	50.0	Conventional Steam Coal	Recirculating	ST	11	1962	12	2016	724	652	1132	774
Martin Drake	City of Colorado Springs - (CO)	CO	7	132.0	Conventional Steam Coal	Recirculating	ST	7	1974			1,303	1,158	2651	1812
Nucla	Tri-State G & T Assn, Inc	CO	1	11.5	Conventional Steam Coal	Recirculating	ST	11	1959	12	2022	0	0	245	168
Nucla	Tri-State G & T Assn, Inc	CO	2	11.5	Conventional Steam Coal	Recirculating	ST	11	1959	12	2022	0	0	238	163
Nucla	Tri-State G & T Assn, Inc	CO	3	11.5	Conventional Steam Coal	Recirculating	ST	11	1959	12	2022	0	0	238	163
Nucla	Tri-State G & T Assn, Inc	CO	ST4	79.3	Conventional Steam Coal	Recirculating	ST	1	1991	12	2022	0	0	1415	967
Valmont	Public Service Co of Colorado	CO	5	191.7	Conventional Steam Coal	Cooling Pond	ST	5	1964	12	2017	6,516	3,620	44446	1981
W N Clark	Black Hills/Colorado Elec.Util	CO	1	18.7	Conventional Steam Coal	Recirculating	ST	9	1955	12	2013	0	0	334	229
W N Clark	Black Hills/Colorado Elec.Util	CO	2	25.0	Conventional Steam Coal	Recirculating	ST	1	1959	12	2013	0	0	489	334
Colstrip	Talen Montana LLC	MT	1	358.0	Conventional Steam Coal	Recirculating	ST	11	1975		2022	2,823	2,823	6937	4742
Colstrip	Talen Montana LLC	MT	2	358.0	Conventional Steam Coal	Recirculating	ST	8	1976		2022	2,823	2,823	6115	4180
J E Corette Plant	Talen Montana LLC	MT	1	172.8	Conventional Steam Coal	Once-Through	ST	6	1968	3	2015	57,990	145	114294	786
Four Corners	Arizona Public Service Co	NM	1	190.0	Conventional Steam Coal	Cooling Pond	ST	5	1963	12	2013	13,058	8,095	46419	2069
Four Corners	Arizona Public Service Co	NM	2	190.0	Conventional Steam Coal	Cooling Pond	ST	6	1963	12	2013	13,801	8,556	49059	2187
Four Corners	Arizona Public Service Co	NM	3	253.4	Conventional Steam Coal	Cooling Pond	ST	8	1964	12	2013	0	0	68017	3032
Four Corners	Arizona Public Service Co	NM	4	818.1	Conventional Steam Coal	Cooling Pond	ST	7	1969		2030	0	0	223114	9947
Four Corners	Arizona Public Service Co	NM	5	818.1	Conventional Steam Coal	Cooling Pond	ST	7	1970		2030	0	0	164284	7324
San Juan	Public Service Co of NM	NM	2	369.0	Conventional Steam Coal	Recirculating	ST	11	1973	12	2017	4,778	4,778	6977	4769
San Juan	Public Service Co of NM	NM	1	369.0	Conventional Steam Coal	Recirculating	ST	12	1976		2022	8,036	8,036	8896	6081
San Juan	Public Service Co of NM	NM	3	555.0	Conventional Steam Coal	Recirculating	ST	12	1979	12	2017	4,778	4,778	5948	4066
San Juan	Public Service Co of NM	NM	4	555.0	Conventional Steam Coal	Recirculating	ST	4	1982		2022	6,443	6,443	11093	7583
North Valmy	Sierra Pacific Power Co	NV	1	277.2	Conventional Steam Coal	Recirculating	ST	12	1981	12	2021	2,172	2,172	5095	3483
North Valmy	Sierra Pacific Power Co	NV	2	289.8	Conventional Steam Coal	Recirculating	ST	5	1985		2035	2,534	2,534	5826	3982
Reid Gardner	Nevada Power Co	NV	1	114.0	Conventional Steam Coal	Recirculating	ST	6	1965	12	2014	1,520	1,520	1795	1227
Reid Gardner	Nevada Power Co	NV	2	114.0	Conventional Steam Coal	Recirculating	ST	6	1968	12	2014	1,520	1,520	2099	1435
Reid Gardner	Nevada Power Co	NV	3	114.0	Conventional Steam Coal	Recirculating	ST	5	1976	12	2014	1,448	1,448	1914	1308
Reid Gardner	Nevada Power Co	NV	4	294.8	Conventional Steam Coal	Recirculating	ST	7	1983	3	2017	3,113	3,113	4544	3106
Boardman	Portland General Electric Co	OR	1	642.2	Conventional Steam Coal	Cooling Pond	ST	8	1980	1	2021	13,031	13,031	151864	6770
Coleto Creek	Coleto Creek Power LP	TX	1	622.4	Conventional Steam Coal	Cooling Pond	ST	6	1980			459,070	1,738	184953	8245
J T Deely	City of San Antonio - (TX)	TX	1	486.0	Conventional Steam Coal	Cooling Pond	ST	8	1977	12	2018	2,679	72	94300	4204
J T Deely	City of San Antonio - (TX)	TX	2	446.0	Conventional Steam Coal	Cooling Pond	ST	8	1978	12	2018	2,462	72	102800	4583
Welsh	Southwestern Electric Power Co	TX	2	558.0	Conventional Steam Coal	Recirculating	ST	4	1980	4	2016	37,468	37,468	10945	7482
Carbon	PacifiCorp	UT	1	75.0	Conventional Steam Coal	Recirculating	ST	11	1954	4	2015	1,231	1,231	1580	1080
Carbon	PacifiCorp	UT	2	113.6	Conventional Steam Coal	Recirculating	ST	9	1957	4	2015	1,593	1,593	2137	1461
Huntington	PacifiCorp	UT	2	496.0	Conventional Steam Coal	Recirculating	ST	7	1974		2035	6,516	6,516	10520	7192
Huntington	PacifiCorp	UT	1	541.3	Conventional Steam Coal	Recirculating	ST	6	1977		2035	7,312	7,312	11529	7881
Intermountain Power Project	Los Angeles Department of Water & Power	UT	1	820.0	Conventional Steam Coal	Recirculating	ST	6	1986		2025	9,991	9,991	21521	14712
Intermountain Power Project	Los Angeles Department of Water & Power	UT	2	820.0	Conventional Steam Coal	Recirculating	ST	5	1987		2025	10,063	10,063	23045	15753
Kennecott Power Plant	Kennecott Utah Copper	UT	1	50.0	Conventional Steam Coal	na	ST	1	1943	10	2016	na	na	na	na
Kennecott Power Plant	Kennecott Utah Copper	UT	2	25.0	Conventional Steam Coal	na	ST	1	1943	10	2016	na	na	na	na
Kennecott Power Plant	Kennecott Utah Copper	UT	3	25.0	Conventional Steam Coal	na	ST	1	1946	10	2016	na	na	na	na
Kennecott Power Plant	Kennecott Utah Copper	UT	4	82.0	Conventional Steam Coal	na	ST	1	1958			na	na	na	na
Transalta Centralia Generation	TransAlta Centralia Gen LLC	WA	1	729.9	Conventional Steam Coal	na	ST	12	1972	12	2020	na	na	na	na
Transalta Centralia Generation	TransAlta Centralia Gen LLC	WA	2	729.9	Conventional Steam Coal	na	ST	7	1973	12	2025	na	na	na	na
Dave Johnston	PacifiCorp	WY	3	255.0	Conventional Steam Coal	Once-Through	ST	12	1964		2027	0	0	198665	1366
Jim Bridger	PacifiCorp	WY	1	608.3	Conventional Steam Coal	Recirculating	ST	11	1974			0	0	11914	8144
Naughton	PacifiCorp	WY	3	384.0	Conventional Steam Coal	Recirculating	ST	10	1971	12	2017	0	0	7114	4863
Neil Simpson	Black Hills Power, Inc. d/b/a	WY	5	21.7	Conventional Steam Coal	Dry Cooled	ST	5	1959	3	2014	na	na	na	na
Osage (WY)	Black Hills Power, Inc. d/b/a	WY	1	11.5	Conventional Steam Coal	Recirculating	ST	1	1948	3	2014	0	0	247	169
Osage (WY)	Black Hills Power, Inc. d/b/a	WY	2	11.5	Conventional Steam Coal	Recirculating	ST	1	1950	3	2014	0	0	220	150
Osage (WY)	Black Hills Power, Inc. d/b/a	WY	3	11.5	Conventional Steam Coal	Recirculating	ST	1	1952	3	2014	113,446	1,303	216	147

Appendix B: CFPP Water Right Checklist

Coal-Fired Power Plant Water Right Acquisition Checklist

This document is intended to organize relevant data during discovery and inform users of risks and rewards associated with CFPP/WR characteristics and financing options; fill in as much information as is available to you.

Coal-Fired Power Plant: ____________________________ # of units: _______

Location: ________________________ Total net generating capacity **(A)**: _____ MW

Plant owner(s): ____

Units retiring/capacity: ____

Remaining capacity **(B)**: Total net generating capacity – capacity of retiring units = ____ MW

Coal cooling technology[1]: Tower (recirculating) Once-through

Pond Other: ______________

Water for retired plant **(C)**: Decommissioning → Water need = 0 AF

Transitioning to natural gas → *Cooling type* to estimate water need →

Cooling Type	Median Withdrawal (AF/MW)	Median Consumption (AF/MW)
Tower	1.7	1.3
Once-Through	76.5	0.7
Pond	40.0	1.6
Dry	~0.0	~0.0

Water need post-decommissioning:

Withdrawal: ____ (*40*) AF/MW x ____ MW = ____ AF

Consumption: ____ (*1.5*) AF/MW x ____ MW = ____ AF

Water Right[2]: WR#__________________ Beneficial use: ____________________

Means of diversion: __________________ Period of use: ____________________

Owners listed on water right: ____

Total Diversion: Volume **(D)**: ______ acre-feet (AF) Flow **(E)**: ____ cfs / ___ GPM

Consumptive Use (select *most conservative* value) **(F)**:

Historic (stated on water right):		AF
Reported[3]:		AF
Calculated: (Recirculating = 68% of total volume; Once-through = 0.7%; pond = 4.5%)		AF

State agency responsible for reviewing transfers: ______________________________

Any legal constraints on holding instream flow rights[4]? ___________________________

Relevant notes: ____

Volume of withdrawals available for instream flows **(G)**: **(D) x (1 – (B)) – (C)** = ______ AF

Volume of consumptive use available **(H)**: **(F) x (1 – (B)) – (C)** = _______ AF

Max. flow rate of withdrawals for instream flows **(I)**: **(E) x (G)/(A)** = _______ cfs/GPM

Max. flow rate of consumptive water for instream flows **(J)**: **(E) x (H)/(A)** = _______ cfs/GPM

CFPP Water Right Checklist (Page 2)

Environmental Objectives:

Species Conservation (species of concern, game species; fish, birds, etc.): ______________________

____

Additional Benefits: Drought mitigation Wetland restoration

Recreation Other: _______________

Nearest USGS Stream Gauges[5]:

Gauge #, upstream of plant: _______________

Gauge #, downstream from plant: _______________

Upstream Gauge	
Year	Average seven-day low flow (cfs/GPM)

Downstream Gauge	
Year	Average seven-day low flow (cfs/GPM)

Upstream Gauge + Instream Flow Augmentation **(**I**)**	
Year	Average 7-day low flow (cfs or GPM)

Downstream Gauge + Instream Flow Augmentation **(**J**)**	
Year	Average 7-day low flow (cfs or GPM)

1 EIA. Once-through cooling, recirculating, zero-discharge, etc.

2 Permits are publicly available and can be found of state water agency's website.

3 See Appendix A of report for CFPPs decommissioning in 20 years. Other US plants may be found at: USGS National Water Census, USGS National Streamflow Information Program. 2010. Withdrawal and Consumption of Water by Thermoelectric Power Plants in the United States.

4 Szeptycki, L., et al. 2015. Environmental Water Rights Transfers: A Review of State Laws. Water in the West. National Fish and Wildlife Foundation.

5 USGS Current Water Data for the Nation.