CONSTRUCTED WETLANDS FOR BRINE WATER MANAGEMENT

A CASE STUDY OF BULLARD REGULATING WETLAND (GOODYEAR, AZ)

INTRODUCTION

With a projected increase in population of 115,300 total residents by 2020 and 167,700 residents by 2030 (City of Goodyear, 2014), the city of Goodyear will need to meet the demands of potable water for its growing community. Given that the city currently depends solely on groundwater to meet this demand and will remain heavily reliant, future pressures of limited supply will require innovative and effective means of treating and reusing this supply throughout the city. In light of these challenges, the City of Goodyear has embarked upon an experimental wetland system as a potential means to treat brine concentrated wastewater to be discharged into surface waters. This brine wastewater is a byproduct of treating brackish groundwater for potable water purposes for Goodyear residents through the process of reverse osmosis (RO). Given the challenges for alternate means of treatment such as thermal driven evaporation processes or deep well injection, constructed wetlands presents an innovative, effective method for not only treating such brine wastewater, but providing a myriad of economic and social additional benefits as well.

This case study was developed as an initial report to inform the "scaling up" of the Bullard Wetland pilot project into a fully implemented wetland system. We present here an overview of the social, ecological, and economic components of such a system. In addition to presenting such analyses to inform full scale implementation, we have also developed an initial list of "social" indicators and sustainability targets to help the city assess the current state and track the future progress of its green systems and infrastructure as well as provide an overview of how such a full scale implementation can impact these systems. Finally, using these initial analyses, we present an initial recommendation of next steps to facilitate full scale wetland implementation in the future.

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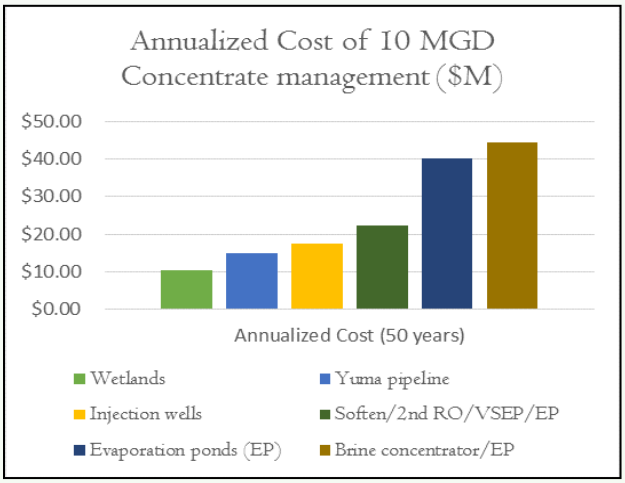

Table 1. Economic comparison of brine management alternatives.

ECONOMIC ANALYSIS

The US Bureau of Reclamation (USBR), carried out detailed cost analysis comparisons of six brine management options that could be implemented in the Valley of the Sun. The result of these comparisons showed that wetlands would be the most economical choice for handling large amounts of brine, as wetlands had the lowest annualized cost estimate among the options for managing 10 million gallons per day (MGD) of brine.

But when considering lower quantities of brine, the economic case for wetlands becomes less clear. A cost estimate by the Bullard wetland pilot project for a wetland to treat 0.5 MGD of brine calculated the capital cost to be $6.35 million. Comparing this with evaporation ponds (EPs), which according to a USBR estimate has a cost range of $1.4-$6.5 for managing 0.5 MGD of brine, the wetland capital cost would likely be higher. However, a wetland would require significantly less land area than EPs. Therefore, depending on land costs, wetlands could still be cheaper than EPs even with higher capital costs.

On the other hand, there are several common risk factors for wetland systems that could create additional secondary costs. These common risk factors include: 1) vegetation management, 2) management of invasive and disruptive species, and 3) liabilities from impacting protected species. Additionally, there is a risk factor particular to the proposed design for the Goodyear wetland, which is the frequency of wetland media replacement. If the media ends up requiring frequent replacement, or if any of the other risk factors manifest, then the cost of wetland operations could rise significantly. However, these risk factors can be successfully managed or completely avoided with proper wetland design and planning.

City of Goodyear Water Services Department | 190 N. Litchfield Road, Goodyear AZ 85338 | phone 623.932.3910

GOALS	INDICATORS
Reduce overall water consumption	Potable water
Reduce the urban heat island effect	Surface temperatures Asphalt surface parking
Improve the quality and quantity of green systems	Urban forest Parks and green open space Native natural environment Walking and biking trails

Table 2. Goals and indicators for sustainable green systems

SOCIAL ANALYSIS

Quantifying the social benefits for an ecological asset such as a wetland can be challenging. However, indicators, targets, and current data can provide assessment of the current state of green systems in Goodyear. The assessments of Goodyear against these indicators and targets can also be used to provide context in which the construction of a full scale wetland could help to meet or exceed these thresholds in the future.

For Goodyear, the percentage of parks and green open space currently exceeds the identified sustainability threshold. However, with the projected population growth of the city of 167,700 residents by 2030, these percentages are predicted to drop to an unsustainable threshold. In order to provide equitable access to parks and open spaces for their residents in the future, Goodyear must look to increase these public spaces to match this population growth. The addition of a wetland would provide augmented public space as an approach to meeting green spaces and walking/biking trails targets.

A flourishing urban forest is critical for the social, economic, and environmental health of a city. Goodyear does not meet the identified sustainable threshold for tree coverage, sitting at a 1.4% for the entire city. Without tree coverage, shade is minimal throughout Goodyear, creating areas of high surface temperatures. The construction of such a wetland in the city could contribute to a growing tree canopy and shade for the city.

Goodyear has recognized the threat of water scarcity throughout the city. Current levels of water use by Goodyear residents sit far above sustainable thresholds, however they meet the AZ Department of Water Resources efficiency targets. In addition, by the year 2085, the city will experience a large shortfall for groundwater and will need to treat and re-use large amounts of this water. The scaling up of the wetland project would produce a feasible option for treating and re-using this water for irrigation and landscaping purposes, reducing the overall demand for pumping groundwater to meet growing demand.

Finally, the Goodyear wetland can open up access to recreational activities such as bird watching, hiking, and fishing. A wetland for Goodyear that incorporates planned design for biological richness can contribute can contribute to an overall distinct and unique sense of place, making Goodyear one of the

ECOLOGICAL ANALYSIS

Based on several years of measuring the water quality outcomes of different wetland test bins to identify what combinations of wetland media and vegetation would best achieve brine treatment targets, the Bullard project has identified a wetland media combination that could successfully achieve required water quality standards, removing such harmful contaminants as arsenic, chromium, selenium and nitrates. However, due to negligible salt removal and high evaporation rates, it was also determined that a wetland system would not reduce brine Total Dissolved Solid (TDS) levels, which means that wetland outflow would have to be blended with lower TDS level water (most likely reclaimed wastewater from the 157th Ave Water Reclamation Facility) in a "mixing" pond or surface water wetland before it can be safely discharged into the Gila River.

Wetland establishment and the resultant outflow discharge into the Gila River is very likely to increase vegetative abundance and diversity of the immediate vicinity and attract a certain degree of increased wildlife habitation, although the degree of habitation increase will likely be affected by final wetland design. Therefore, if a wetland treatment system is established, careful ecological risk assessment and precautionary planning will need to be undertaken in order to ensure no wildlife is exposed to the accumulated toxins from brine treatment, otherwise incidences of wildlife poisoning might occur and result in serious legal and regulatory consequences for the City of Goodyear.

RECOMMENDATIONS FOR GOODYEAR

Given the ecological success of the pilot project, a full scale wetland would provide the city an effective means of treating increasing volumes of brine wastewater due to projected increases in water demand. The city may experience additional costs associated with a full-scale wetland implementation, but further scenario-based economic and ecological evaluations for the city would provide a pathway to anticipate and develop coping strategies for such barriers. Siting a full scale wetland in order to capitalize on existing infrastructure and foster a connected green system can also benefit Goodyear. For example, implementing the project in locality to the Estrella Mountain Park would not only expand the recreational opportunities for the area, but would attract a large amount of visitors and provide additional areas for educational and family-oriented programs. Moving forward, it is also recommended that the city evaluate the social benefits of the specific Goodyear wetland project using workshops and surveys. If designed carefully, this wetland could help define the city as a top destination in Arizona and help create a unique sense of place for Goodyear.

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