Considerations for the CERP ASR Contingency Plan

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The Comprehensive Everglades Restoration Plan (CERP) contained in the *Final Integrated Feasibility Report and Programmatic Environmental Impact Statement* (USACE, SFWMD 1999) was approved as a framework for modifications to the Central and Southern Florida (C&SF) Project by the United States Congress in Section 601 of the Water Resources Development Act of 2000.

The CERP contains 68 components that will make structural and operational changes to the C&SF Project in order to restore the south Florida ecosystem, including the greater Everglades ecosystem. This purpose has guided all aspects of the CERP's development and proposed implementation. The CERP also provides for other water resource-related needs of the region, including enhanced urban and agricultural water supply and current levels of flood protection.

Aquifer Storage & Recovery in CERP

The CERP relies significantly on aquifer storage and recovery (ASR) technology; the plan includes approximately 333 ASR wells with a total capacity of over 1.6 billion gallons per day. As per the CERP *Master Implementation Sequencing Plan* v 1.0 (USACE, SFWMD 2004), implementation of the proposed ASR facilities is expected to proceed incrementally over approximately the next 25 years.

Pilot studies currently underway are designed to validate the feasibility of ASR in selected locations, including sites near Lake Okeechobee, the Hillsboro Canal and the Caloosahatchee River. Following their scheduled completion in 2009 and a regional ASR study scheduled for completion in 2010, an informed decision can be made regarding the feasibility of ASR on the scale currently envisioned.

Aquifer Storage & Recovery Planning

The proposed large scale of ASR leads to significant uncertainties regarding its ultimate contribution to the restoration goals and water supply targets of the CERP. It is believed that ASR will work almost anywhere in southern Florida at some scale and some degree of efficiency. In the event, however, that ASR implementation in some (or all) areas is not feasible, contingency plans should be considered. In addition, ASR does not provide all of the restoration benefits of other CERP storage options.

The ASR Contingency Planning Study will investigate the impacts and alternative solutions if studies and pilot projects reveal that ASR projects will not perform at the scale proposed in the CERP. This article reviews ASR, along with other storage options that could be evaluated in the Contingency Plan for the CERP to make up for any ASR water storage shortfalls.

Why Storage Is Important to CERP

A major challenge of the CERP is the paucity of water available to the natural system, even though southern Florida receives an average annual rainfall of 60 inches. Increasing water storage within the existing C&SF system will have a dramatic impact on reducing this shortfall.

Currently, the principal storage options are Lake Okeechobee and the Water Conservation Areas. In the wet season, excess water is stored in Lake Okeechobee and the Water Conservation Areas until existing regulation schedules (stages at a specific time) are exceeded. At that time, excess water is shunted east to the Atlantic Ocean via the Saint Lucie Canal and west to the Gulf of Mexico via the Caloosahatchee River.

Each year, an average of 1.6 billion gallons per day of freshwater is lost to these sinks. These waters could be captured and stored if storage options were available, minimizing these high-volume discharges to ecologically sensitive areas.

In droughts, lack of storage has led to water supply shortages for both human and environmental users. With increased storage, this water would be available for the natural system. To solve this problem, the CERP proposes to add substantial new storage options to the water management system.

Storage Options Considered in CERP

Multiple storage options were investigated during the formulation effort in support of the CERP. These included typical above-ground reservoirs, atypical below-ground reservoirs (using existing rock quarries), and more technologically intensive ASR wells.

Each of these options provides a range of benefits, including water storage, water quality improvement, recreation, and system equalization. For instance, ASR provides water storage and some system equalization, while a large reservoir may provide for some benefits in all categories; therefore, it is important to weigh all the benefits provided by a particular option prior to reviewing costs. Storage options that provide numerous project benefits may be superior to ASR in some instances, even if the unit cost is higher for that particular option.

Other Potential Water Supply Options

Besides reservoirs and ASR wells, other storage or alternate water supply options should be considered as part of ongoing CERP efforts. Five alternate options considered in this article are discussed briefly below.

<u>Desalinization</u>

This technology removes dissolved chemicals from water via several methods. It has been utilized in arid areas such as the Middle East for decades. Recently Tampa Bay Water Utility constructed a large-scale plant to support regional water supply needs.

This project is cost-effective because it is linked with a cogeneration power plant for energy recovery and water treatment. Unit costs of between $2 and $2.50 per thousand gallons treated have been realized in the early stages of operation. Generally, the technology is applied to brackish water rather than seawater, because energy and capital requirements become economically prohibitive as salinity increases.

Desalinization has some promise in southern Florida, as the brackish Floridan Aquifer System (FAS) could be used via desalination. Of the several desalination technologies, reverse osmosis (RO) is the technology of choice for removing sodium and chloride ions. RO plant location would have to be optimized with the salinity of the FAS.

<u>Flow Ways</u>

This concept involves restoring historical (pre-drainage) flow paths. For the Everglades, the predevelopment, 100-mile-wide "river of grass" flow way comprised many smaller flow ways. Historically these stored water in very shallow depths and also involved some groundwater flow.

This method restores these remnant flow ways through hydrologic barrier removal and strategic land acquisition. Water treatment occurs through the natural processes of sedimentation, nitrification, denitrification and bio-adsorption.

Costs for this option would include real estate, small structures, and levees. Location of these features would have to be optimized with real estate costs, as these may be very high.

<u>Attenuation Ponds or Reservoir Assisted ASR (RAASR)</u>

This alternative utilizes small impoundments or reservoirs (on the order of a few hundred acres) optimized to catch run-off during the wet season. Size would be governed by ASR spacing and storage requirements; however, it is envisioned that these basins would be much smaller than proposed CERP storage reservoirs.

RAASR would principally serve as short-term storage, equalization, and recovery tanks for ASR wells, but would provide some water-quality and recreational benefits as well. Costs would consist of a combination of ASR and small reservoir infrastructure. Location would have to optimized in consideration of site hydrogeology and water quality requirements of the discharge location.

<u>Reuse</u>

South Florida has many regional wastewater plants that are strategically located at the coast where high demand exists for restoration of coastal wetlands as well as urban water supply. Reuse water would require high levels of treatment, but strategic locations of these facilities may offset other costs such as increased conveyance.

Obviously, the dominant cost in this option is the high level of water treatment required. Treatment would have to be optimized in consideration of water-quality requirements of the discharge location or urban user to be feasible.

<u>Raise Lake Okeechobee 1 Foot</u>

Currently Lake Okeechobee is the largest single storage option in the whole C&SF system. Attention has been focused on lake ecologic health improvement via the maintenance of an ecologically regulated stage of pools. This would permit ecological improvement via the development of 100,000 acres of Lake Okeechobee littoral marshes.

Raising the water control pool for Lake Okeechobee by one foot was considered for this article. This option must balance the trade-off of lost ecological benefits against lower cost of water supply. The costs would include improvements and additions to the Herbert Hoover Dike.

Evaluation & Conclusion

Due to varied real estate, construction, and O&M costs, each proposed component has different unit costs. Although it is recognized that the CERP functions as an integrated system, it is informative to compare the unit water costs ($/1,000 gallons supplied) and expected benefit categories for each option.

This review focused on storage options as presented in the C&SF Comprehensive Review Study (USACE & SFWMD, 1999), the ASR Pilot Project Design Report (USACE & SFWMD, 2004), and options developed for this article. Capital and O&M costs were extracted from the referenced reports and extrapolated over a 50-year project life.

For reservoir options, it was assumed that each component would be filled and emptied four times a year to allow for a normalized storage comparison. For the ASR well option, it was assumed that the wells would store water for 180 days and recover water for 126 days per year. For new options, costs were estimated based upon unit costs presented in the Comprehensive Review Study.

Table 1 depicts the average annual cost per 1,000 gallons supplied and expected benefit categories derived from each storage option considered.

The five alternative storage options that could be considered as part of the ASR contingency planning effort provide a range of benefits, some extremely economical when compared to existing CERP options. During the ASR Contingency Planning effort, trade-off evaluations should explore the appropriate mix of project benefits and costs that optimize the overall CERP effort. Hopefully, the options suggested in this article and others would provide additional information to aid in the decision process.

Table 1: Costs and benefits of water storage options (five alternative options in italics)

Water Storage Option	Average Annual $/1,000 gallons supplied	Benefit Category Derived from Option from Restudy
CERP ASR	1.00 to 2.00	Multi-year storage, water available during dry season
Wastewater Reuse (2 proposed plants combined)	*1.50 to 2.00*	Water storage and available for coastal and upland wetland restoration demands
Desalinization	*2.00 to 5.00*	Water storage and available for coastal and upland wetland restoration demands
Raise Lake Okeechobee 1 foot	*3.00 to 4.00*	Central storage point to provide water for all regions of the Everglades
Above-ground Surface Reservoirs	3.20 to 8.01	Permits benefits of water storage, water quality improvement, salinity management, recreation, and system equalization
Attenuation Ponds with ASR	*4.00 to 6.00*	Multi-year storage
Flow-ways	*8.00 to 12.00*	Natural Storage & WQ benefits
Below-ground Surface Storage Reservoirs	12.00 to 15.00	Permits benefits of water storage, water quality improvement, and system equalization