City of Sedona

Effluent Injection Well Permitting Project

TECHNICAL MEMORANDUM NO. 1

WATER CREDIT ANALYSIS

DRAFT
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1.0 INTRODUCTION

The City of Sedona (City) is conducting a study to evaluate potential options to update its current effluent management practices at the Sedona Wastewater Reclamation Plant (WWRP). The 2 million gallons per day (mgd) design capacity WWRP is currently operating at a capacity of approximately 1.2 mgd. Effluent generated by the facility is disposed of through spray irrigation on adjacent City property. A variety of factors, including growth, land values/alternative utility, effluent disposal limitations, and other social, political, economic, and environmental factors have prompted the City to develop a comprehensive effluent management strategy.

A previous study completed for the City recommended further evaluation of effluent injection as a potential effluent management option. In an effort to identify the best overall strategy to meet the City's goals, the Wastewater Effluent Disposal and Land Use Task Force (WEDLU) also investigated other effluent management and disposal alternatives, which include but are not limited to constructed wetlands, mechanical evaporators, and direct discharge to a surface waters, including the Verde River. Ultimately, the selected effluent management strategy should incorporate the alternative, or combination of alternatives, which provide a robust and flexible solution to meet the City's technical, economic, social and sustainable objectives.

The evaluation of effluent management alternatives includes a wide variety of factors. While the primary objective of the effluent management evaluation is "disposal" of the effluent, the potential "value" of the effluent as an immediate or future internal or external resource cannot, and should not be ignored. Storing/banking of effluent credits could provide the City with an alternate or supplementary water source in the future, affording water resource flexibility. Should the City not need all or a portion of the banked water in the future, these water credits could potentially be marketed to other utilities, agencies, private developers, etc. and provide a source of revenue to the City. Ultimately, the City's ability and desire to obtain water credits for their effluent is dependent on a variety of factors including internal/external demands, ability to bank/store effluent, and other social, economic and sustainability-related factors.

In an effort to more fully understand the potential feasibility of obtaining water credits for the City's effluent, the team undertook a preliminary evaluation regarding the development of water credits and the potential marketing of these credits. The purpose of this Technical Memorandum No. 1 (TM 1) is to document the results of the initial phase of this water credit analysis.

1.1 Basis for Evaluation

The City does not currently have a direct need to reuse its effluent. The City has also made contact with its water provider, the Arizona Water Company, to determine their interest in/need for reclaimed water. At the present time, the Arizona Water Company did not indicate an interest in the City's effluent.

Sedona's WWRP is located in the Oak Creek drainage basin, which is designated by Federal and State regulations as a "dedicated unique water" or an "Outstanding Arizona Water" by the Arizona Department of Environmental Quality (ADEQ). EPA and ADEQ's Antidegradation Implementation Procedures prohibit degradation of any water quality parameter in Oak Creek. Further, ADEQ has established the Total Maximum Daily Load (TMDL) in the Oak Creek Basin, which is summarized as "no new or increased loading to Oak Creek or its tributaries will be allowed". ADEQ's TMDL for Oak Creek does not include any loading from the City of Sedona. Therefore, a guiding principal for this study has been to define effluent disposal strategies that prevent effluent discharges, whether from surface or subsurface discharges, from reaching Oak Creek or its tributaries.

Two primary strategies have been identified to manage the effluent for possible marketing opportunities including:

- Aquifer storage and recovery (ASR) wells (Vadose zone injection and surface spreading basin technologies have proved unfeasible).
- Direct discharge to the Verde River.

Both strategies would likely require upgrades to the existing WWRP to produce Class A+ quality effluent. Recommendations for upgrading the Sedona WWRP to produce Class A+ quality effluent are presented in TM 2. The quality of effluent discharged via aquifer storage and recovery injection (ASR wells) will be required to meet Aquifer Water Quality Standards or drinking water standards. In addition, direct injection to the aquifer generally requires a high quality water to minimize potential aquifer plugging and reduce the likelihood of diminished recharge rates. Direct discharge to the Verde River would likely require Class A+ quality to obtain a discharge permit.

2.0 RESEARCH AND INTERVIEWS

The team conducted several meetings, interviews, and discussions to assist in determining potential opportunities for Sedona to develop water credits including:

- Meetings and discussions with Herb Dishlip, Herb Dishlip Consulting (former Deputy Director of the Arizona Department of Water Resources [ADWR]).
- Larry Geare, Real Estate Broker, specializing in water sales and transfers.
- ADWR file review, City of Cottonwood, Designation of Adequate Water Supply (DAWS).

- United States Bureau of Reclamation (USBR) meeting, Central Yavapai Highlands Water Resources Management Study, meeting with Leslie Meyers, USBR study coordinator.

Additional meetings with ADEQ and ADWR have been postponed until further hydrogeological data from an ongoing geophysical testing program has been collected and analyzed.

The subsequent sections summarize the information obtained as part of the water credit analysis.

2.1 Comments from Herb Dishlip, Herb Dishlip Consulting

On July 23, 2009, Herb Dishlip accompanied the Carollo team and Gary Small to a meeting with City staff and WEDLU at the Sedona WWRP. During the course of the discussion concerning the opportunities to enhance the benefits the City of Sedona could receive from its effluent, Herb described a number of factors for the City to consider. (Note: The remainder of this section was provided directly by Herb Dishlip.)

- Under Arizona law, effluent is a unique category of water. ARS §45-101.4 defines effluent as "water that has been collected in a sanitary sewer for subsequent treatment in a facility that is regulated pursuant to Title 49, Chapter 2. Such water remains effluent until it acquires the characteristics of groundwater or surface water." The only direct state regulation of effluent is by the Department of Environmental Quality and is related to water quality aspects for protection of human health and the environment. The Arizona Department of Water Resources (ADWR) has no direct regulatory authority over effluent and the use of effluent does not require a state permit or appropriation (other than water quality limitations.) However, effluent can be abandoned if it is discharged into a surface water stream or allowed to percolate back into a groundwater aquifer.
- The value of effluent within Arizona has increased greatly over the past 25 years, since it now represents a potential water supply for communities that are in need of supplementary water resources. The primary driver for the increased demand has been the result of regulatory measures, which have put severe limitations on the volume of groundwater that may be withdrawn within the Active Management Areas (AMAs). Examples of nearby cities that have made significant investments in effluent reuse include Prescott, Prescott Valley, and Chino Valley. Other drivers include the need to overcome physical water shortages, such as in the Town of Payson, and the desire to conserve potable water supplies by using effluent to satisfy non-potable demands for agricultural or golf course irrigation. Reflecting the increased value of the effluent, many communities have moved away from calling the water "wastewater" and now describe the water as "reclaimed water."

- Effluent has also been a key resource in assisting in satisfying the water resources needs of various Indian water rights settlements. The Cities of Mesa and Chandler will use their effluent supplies to create a water exchange for the Gila River Indian Community's Central Arizona Project supplies. The City of Tucson is furnishing effluent to the Tohono O'odham Indian Reservation as a portion of the water supplies needed for the San Xavier and Shuck Toak communities.
- Arizona's underground storage and recovery statutes have greatly enhanced the opportunities to improve the beneficial use of effluent. Underground storage and recovery are activities that are subject to regulation by ADWR. Underground storage uses groundwater recharge techniques, such as spreading basins or injection wells to artificially place water into a groundwater aquifer. While the water may physically intermingle with native groundwater, under the Arizona laws, the water does not become groundwater from a legal standpoint. In the case of Sedona effluent, any water deposited into an aquifer having been subject to an underground storage permit would still be considered effluent and not transition to groundwater as referenced in the ARS §45-101.4 definition cited above. Effluent water stored in this manner may later be recovered utilizing wells that have been specially permitted as "recovery wells." If the effluent is stored underground only a short time, it may be eligible to be treated as "annual storage and recovery." If the effluent is intended to be stored for a longer period of time, the stored water would be eligible to earn "long term storage credits" (LTSC). The earning of long-term storage credits is somewhat analogous to depositing money in a savings account in a bank. However, in this case, the currency saved are in units of "acre feet of LTSC" rather than money. The bank is administered through the regulatory oversight of ADWR. LTSC are owned by the entity that stored them, but they are generally marketable and can be sold to other entities. LTSC may be lost if the water is no longer stored in the basin where the permit was issued. In the case of Sedona effluent, LTSC could be lost if the water was found to have left the Verde River Groundwater Basin because it somehow found its way to a surface water stream such as Oak Creek.
- Subject to state and federal water quality regulations, effluent may be discharged to a surface water stream. Generally, water flowing in a stream is considered to be surface water subject to the Arizona surface water laws. There are two exceptions to the general rule.
  - The first exception is found in ARS §45-173, which allows a natural channel to be used to carry the water of another if such use can be made without diminishing the quantity of water, which naturally flows therein. The quantity of water delivered through a natural channel would be subject to evaporation and transpiration losses. An agreement between Sedona and downstream water right holders would be necessary before Sedona could use the ARS §45-173 approach without the risk of legal challenge.

  - The second exception is found in ARS §45-802.01.12 where effluent discharged to a stream may be considered to retain its legal character if the activity is subject to a "managed underground storage facility". In this case, Sedona would apply for and receive a permit from ADWR to store the effluent in this manner.

- The marketability of Sedona's effluent will be based on a number of critical factors. Arizona's history of market transactions has tended to be very localized and market prices in one area do not necessarily apply well to other areas. Factors which may affect market price include:
  - Quality of the Water - A+ effluent is more useable than B+ effluent and would attract a higher price.
  - Reliability - Will the water be available without being subject to shortage? Are LTSC subject to being lost because the water left the basin?
  - Location - Will the water require extensive pipelines or other distribution systems to get it to the end user?
  - Length of Sale - A sale in perpetuity will gain the greatest price, while a short term lease or a lease subject to recall would gain the lowest price.
  - Demand - Demand and number of competing buyers.
  - Environmental Laws and Concerns- Would the water in any way create an impact on wildlife (especially endangered species?)

2.2 Comments from Larry Geare

Carollo Engineers met with Larry Geare to gain a better understanding of water marketing opportunities in the Verde Valley, and to gain insight into potential legislative action that might affect water supply development in the Verde Valley in the future. According to Mr. Geare, new water laws may be proposed by ADWR, and some members of the House and Senate, in the upcoming sessions in 2010. Two schools of thought have emerged as a result of these discussions. First, the Director of ADWR has recently indicated that Prescott and Prescott Valley should develop a mitigation plan before pumping is initiated in the upper Big Chino area. Mr. Geare also noted that some members of the House have discussed placing an Irrigation Non-expansion Area (INA) overlay on the Big Chino area to prevent new wells from being drilled. In his opinion, there will likely be proposals in the next session to place an INA overlay over the entire Verde Valley. This proposal may have the support of several stakeholders, and if supported by ADWR, could pass. If an INA is not enacted, existing surface water irrigators could potentially sell their current surface rights to municipal development, and then attempt to drill new wells to continue operation, provided the groundwater was not legally considered subflow. An INA overlay would preclude this type of activity.

Per the discussion with Mr. Geare, the counter argument to enacting an INA surrounds the true applicability of an INA to the Verde Valley. INAs are enacted for the purpose of limiting future groundwater development for irrigated agriculture, which is not likely to see significant growth in the lower Verde Valley in the future. INAs do not limit use of groundwater by future subdivision development or other municipal and industrial (M&I) uses. An INA would also not prevent an irrigator that is currently using 50 percent groundwater and 50 percent surface water from selling their surface water rights and using 100 percent groundwater.

Also according to Mr. Geare, discussions regarding an Active Management Area (AMA) expansion or creation of a new AMA have been ongoing, but seemed unlikely to materialize. However, recently there were discussions at ADWR regarding the expansion or creation of a new AMA in the Big Chino area. All of this discussion indicates that there is heightened awareness of competing water interests in the Verde Valley, placing strain on potentially limited resources to meet all of the future demands.

Recognizing this fact places a greater importance on Sedona's development of a long-term water marketing strategy. In Mr. Geare's opinion, there are very significant near- and long-term market opportunities for Sedona's effluent.

2.3 Summary of Cottonwood File Review

The application file for the City of Cottonwood's Designation of Adequate Water Supply (DAWS) determination by ADWR contained a revised Hydrology Study associated with the 100-year demand and supply aspects for the City. Historically, the economy of the area has relied on small-scale mining, light industry, and ranching. Recent growth in the area has been attributed to retirement and tourism activity. Land uses are changing as farmland and ranches are being subdivided and developed, directly affecting the water supply of the area. The number of wells is increasing proportionally with the rapid increase in urbanization, which will affect the volume of water available in the regional aquifer.

The City of Cottonwood is involved both individually and with regional water groups in aggressively pursuing new water resources, water rights, and protection of existing supplies. Cottonwood's existing population is approximately 21,000, with a 2050 projected population of approximately 77,630 according to the USBR's Central Yavapai Highlands Water Resources Management Study (CYHWRMS). The hydrology study noted that regional groundwater is currently declining at a rate of 1.75 feet/year, based on well records from 1994 to 2004.

The existing City water demands are approximately 3,200 acre-feet per year (AF/yr). Projected additional future water demand in the "service area" is estimated at 2,800 AF/yr, resulting in a total future demand of 6,000 AF/yr. Based on this study, the maximum projected 100-year depth-to-groundwater (existing static level plus regional decline plus calculated Cottonwood decline) was estimated to be 921.5 feet below ground surface.

While this does not exceed ADWR's physical availability standard of 1,200 feet below ground surface, it is still a significant decline. This analysis does not take into account other regional groundwater declines due to increased development.

The results of this study confirm the importance of the Communities in the Verde Valley developing a long-term approach to water management. In addition, it further emphasizes the importance for Sedona to consider a long-term water marketing strategy and reaffirms the potential near- and long-term market opportunities for Sedona's effluent.

2.4 Summary of USBR Meeting

Carollo met with the USBR to gain an understanding of the goals and objectives of the CYHWRMS, and to learn of the progress to date. The study team is nearing completion of the water use and available supply assessment task, which is projected by October 2009. Copies of tabulated existing and future water use and supply data were provided. Information listed for Cottonwood showed a total 2006 demand of 6,277 AF/yr, and a projected 2050 demand of 10,870 AF/yr. This data conflicts with the demand data presented in Cottonwood's DAWS application (See Section 2.3 above) which shows an existing water demand of 3,200 AF/yr and a 100-year demand of 6,000 AF/yr. The discrepancy could arise from assumptions associated with different water service areas.

Using the USBR figures, and assuming no further water supply development (as assumed in the study), the USBR study predicts a water supply deficit for Cottonwood of approximately 4,600 AF/yr. Similarly for Sedona, the study shows existing demand at 4,112 AF/yr and projects a 2050 demand of 6,915 AF/yr, resulting in a shortfall of approximately 2,800 AF/yr, assuming no further water supply development. Many of the communities in the CYHWRMS study area exhibit similar water supply deficits without further resource development.

The next phase for the USBR study is to assess the water supply availability to meet these projected demands and supply shortfalls. This effort is projected to take approximately one year to complete. Following completion of the study, Sedona will have a better understanding of its future water resources position relative to other regional demands and available resources. One of the most significant unknowns appears to be the uncertainty regarding which State Lands will develop and the resulting demands. Given these uncertainties, it may be prudent for Sedona to retain at least a portion of its water credits for its own protection of future supply needs. It should be noted that the study team indicated that USBR was very supportive of Sedona's efforts to develop wetland/wildlife habitat with its effluent, and to seek recharge and storage for future recovery to meet demands within the Verde Valley.

2.5 Summary of ADWR Meeting

Carollo, Hydrosystems Inc., and the City of Sedona met with staff from the Arizona Department of Water Resources (ADWR) to present preliminary results from the completed hydrogeologic studies and to discuss future steps in acquiring an Underground Storage Facility (USF) permit.

Because Sedona is outside of an Active Management Area (AMA), a USF permit is not required. However, a USF would be beneficial because it would provide a legal accounting mechanism for Sedona to inject effluent into the aquifer and bank water credits for potential future use and/or sale.

As part of the meeting with ADWR, the project team presented results from a series of Controlled Source Audiofrequency MagnetoTellurics (CSAMT) surveys recently performed. The tests were completed to confirm the locations of subsurface geologic formations, as well as to determine if effluent injection was feasible on the WWRP site. The project team is planning to perform additional CSAMT surveys to further confirm the subsurface geology as well as identify the optimal location for a test borehole for a potential injection well. A proposed 1,800-ft exploratory well is planned, and a pilot injection well test will be performed to help determine whether significant groundwater mounding will occur, and how much effluent injection can be achieved at the site.

In addition to discussion of injection, the team also reviewed considerations associated with obtaining recharge credits as part of a constructed wetlands. In order to obtain recharge credits, recharge must be the primary use of the facility, with other components (i.e., riparian habitat, community uses, etc.) secondary. If the constructed wetlands' primary use is for a community benefit or other non-recharge use, recharge water credits cannot be obtained. For example, Tucson Water's Sweetwater Wetlands experiences seepage, however, the primary use is that of a wetlands for community benefit. Therefore, the seepage experienced at the Sweetwater Wetlands is not considered recharge for a permitted perspective. Alternatively, while the Gilbert constructed wetlands has a riparian habitat, fishing lake and other community assets incorporated into the design, its primary use is recharge. Consequently, the facility is permitted for, and receives recharge credits. The results of the CSAMT testing confirmed that the area surrounding the Sedona WWRP does not experience significant seepage and that effluent discharged to the ground surface (i.e., in a wetlands) would likely not reach the underlying aquifer. Consequently, Sedona should not expect to achieve recharge credits for effluent discharged to a potential wetlands. Rather, seepage achieved at the wetlands would be considered disposal/discharge.

Finally, ADWR indicated that a USF permit must be obtained and utilized from the initiation of the project in order to begin banking water credits. ADWR will not allow a community to retroactively claim credit for previously unpermitted water recharged to the aquifer.

ADWR requested that they be kept apprised of the project status and are committed to working with the City, as necessary, to assist in developing a USF permit for applicable recharge of their WWRP effluent.

3.0 WATER MARKETING OPPORTUNITIES

Based on the research conducted as part of this study, effluent from the Sedona WWRP can be discharged to the Verde River or recharged to the aquifer for future recovery and marketing, as long as the WWRP discharge does not reach Oak Creek or its tributaries. The potential value of the effluent depends on a variety of factors including whether it is inside or outside an AMA, the reliability of the source, market conditions, demands for effluent, and costs to deliver or recover the effluent. Several potential marketing opportunities have been identified including:

- The Upper Verde River (depletion mitigation to lower basin water users).
- Lower Verde River augmentation of future development depletions.
- Salt River Project for exchange marketing into the Phoenix metro area (AMA).
- Recharge and recovery to support new regional developments pumping groundwater.
- City of Sedona, storing and reserving some, or all of its own supply for future uses.

Each potential alternative is described in additional detail in the following sections.

3.1 Upper Verde River Depletion Mitigation

There has been significant discussion concerning potential depletions caused by the Big Chino groundwater pumping to the Upper as well as the Lower Verde River. To the extent that quantification of these potential depletions comes to fruition, Sedona's effluent may be useful in mitigating adverse effects to the lower Verde River. However, the effluent source would not provide mitigation to the Upper Verde River caused by Big Chino pumping. The effluent could be delivered directly to the Verde River in a pipeline, or stored in the aquifer and subsequently recovered and delivered to the Verde River.

3.2 Lower Verde River Depletion Mitigation

Sedona's effluent could be used to augment future depletions to the Lower Verde River to the extent that these depletions were adversely affecting existing users. The effluent could be purchased by future developers who may be seeking to secure a long-term water supply. The effluent could be delivered directly to the Verde River in a pipeline, or stored in the aquifer and subsequently recovered and delivered to the Verde River.

3.3 Salt River Project

Future development in the Verde River Valley will continue to place increased burdens on limited water resources. The Salt River Project may view this as adversely affecting their claim to Verde River water. If they were to prevail, Sedona's effluent could be marketed and used to offset impacts to SRP by upstream development.

A second approach could include negotiating with SRP to market the effluent to a third party in the Phoenix Metro area or Phoenix AMA. This type of exchange approach would require several agreements and rigorous monitoring to become a legitimate opportunity. The effluent would need to be transported in the Verde River to SRP's delivery facilities, and would require a water wheeling agreement with SRP, which would be subject to seepage losses and evaporation (ultimately reducing total volume of water available for credit). Delivery to the Verde River would require construction of a transmission pipeline from the Sedona WWRP to the river. By developing such an exchange to the Phoenix Metro area, Sedona could likely expect the highest marketing return due to the extreme competition for water resources in the Phoenix AMA.

3.4 Recharge and Recovery

Ultimately, aquifer storage and recovery provides Sedona with the greatest flexibility for developing credits for future marketing. Sedona could develop a recharge and recovery project that would store effluent in the aquifer, building up storage credits for future marketing. The key to developing this concept is to prove that the hydrogeological conditions will support an underground storage facility (USF), that the groundwater will remain in storage in the Verde Basin, and that the stored water will not surface in Oak Creek or any of its tributaries. This strategy will require permitting from ADEQ in the form of an Aquifer Protection Program (APP) Permit. In addition, Sedona will need to obtain a USF permit from ADWR to provide the third party accounting and validation for the stored water. The ongoing hydrogeologic work and the APP/USF permits will ultimately determine the ability to store effluent and the actual capacity. However, as stated previously in this TM, if aquifer storage and recovery proves feasible, Sedona may want to consider reserving a portion of the stored water credits for its own use, in the event that future regional water management places restrictions on the City's future water use.

4.0 FEASIBILITY OF WATER CREDIT DEVELOPMENT THROUGH AQUIFER RECHARGE AND STORAGE

Sedona is continuing to pursue a strategy of effluent management that is based on aquifer storage and future recovery for marketing purposes. Several challenges have been identified that need to be overcome before being able to determine the feasibility of such a project. These challenges include:

- Defining the subsurface hydrogeology to establish an underground storage facility, determine that the water remains in storage, and that it does not discharge into Oak Creek or its tributaries.
- Determining the sustainable injection rates, and how many ASR wells will be required.
- Establishing that the Class A+ water quality is suitable for aquifer storage, confirming that the effluent will meet aquifer water quality standards, and obtaining an APP for the project.
- Determining if it is feasible to construct such a project on the WWRP site, or identify alternative locations.
- Determining the cost effectiveness of the project compared to other effluent management strategies.
- Obtaining a USF permit from ADWR for third party accounting and validation.

5.0 CONCLUSION

The work completed as part of this project was intended to provide a preliminary evaluation of the potential opportunities to market effluent generated by the Sedona WWRP. Each of the alternatives outlined above would require significant additional evaluation and effort to determine their ultimate feasibility. However, the work completed to date clearly indicates the importance of Sedona developing a long-term approach to water management, and the potential benefits of including a water marketing strategy in that approach. In addition, the evaluation validates the potential value of Sedona's effluent and confirms that there are possible near- and long-term marketing opportunities for the effluent.