Water Supply Analysis for
Arizona Green Power, LLC's Solar-Wind Downdraft Tower

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INTRODUCTION

Arizona Green Power, LLC is considering construction of a Solar-Wind Downdraft Tower in the City of San Luis. The Solar-Wind Downdraft Tower will generate electrical power and this power generation will require the use of groundwater pumped from the aquifer under the City of San Luis. It is estimated that up to approximately 12,500 acre-feet of groundwater will need to be pumped each year to supply the project. This report will analyze the possible impact of the Solar-Wind Downdraft Tower on the City of San Luis' groundwater supply and the associated groundwater aquifer.

The City of San Luis currently has a Designation of Assured Water Supply issued by the Arizona Department of Water Resources on February 15, 2011 (DWR 40-700761.0000.) This Designation of Assured Water Supply documents that the City of San Luis has demonstrated that 8,908 acre-feet per year (af/yr) of groundwater will be physically and legally available for at least 100-years. The physical and legal availability of this groundwater was documented in a Hydrology Study titled "Availability of Water for Adequate Water Supply Designation – City of San Luis, Arizona." This Hydrology Study was prepared by N.W. Plummer, Earl Burnett, and Don Young, three former U.S. Bureau of Reclamation employees with extensive knowledge of water supply issues in Yuma County and along the Colorado River, and by James Davey, a Yuma County based civil engineering consultant, with this team (except for Mr. Burnett) preparing and reviewing this current report.

To analyze the effect of the Solar-Wind Downdraft Tower on the City of San Luis with regards to water supply, the aspects of the aquifer under the City of San Luis and the City's water supply that must be analyzed are:

1. The physical availability of water in the groundwater aquifer underlying the City of San Luis;
2. The effect of the additional water use by the Tower Project on the aquifer;

PHYSICAL AVAILABILITY OF WATER

The overall physical availability of the water in the groundwater in the aquifer underlying the City of San Luis was analyzed in detail in the Hydrology Report. To quote from the report:

"For the entire hydrologic zone affecting the City of San Luis west of the Algodones Fault about 96 million acre-feet of groundwater is estimated to be stored to a depth of 1200 feet, and about 48 million acre-feet of groundwater is estimated to be currently stored to a depth of 600 feet in the United States and Mexico." (Executive Summary, Section C.)

The 48 million acre-feet of groundwater available in the aquifer at a depth of less than 600 feet represent that water in the most widely used coarse gravel zone of the aquifer, where most wells are located today, and the total of 96 million acre-feet represent the combined availability if deeper wells are constructed.

As a quick calculation of the effect of the Tower Project and City of San Luis groundwater pumping on the underlying aquifer, the aquifer can be treated as a static body of water assuming that storage is a fixed number and that the aquifer is not subject to recharge (though in fact the aquifer is recharged by the Colorado and Gila Rivers and from irrigated farm land.) Using this static assumption, with total of 96 million acre-feet available in the aquifer and using 12,500 acre-feet per year over the next 100 years for the Tower Project (assuming a very long life for the project), plus the City's 8,908 af/yr designated assured water supply, the total water pumped over the next 100 years will be about 2,140,800 acre-feet, or only 2.25% of the total available water. And again, these percentages do not consider recharge of the aquifer.

The complexity of the underlying aquifer was documented in detail in the Hydrology Study. The aquifer is subject to recharge by flows of the Colorado and Gila Rivers, from percolation of the irrigation water applied to the lands of the Yuma Mesa Irrigation and Drainage District, the Yuma County Water Users Association and Unit B Irrigation District, and by recharge from the City of San Luis' East Mesa Wastewater Treatment Plant and domestic irrigation water used in the City of San Luis. The recharges are offset by pumping from the Yuma Mesa Wellfield, the 242 Wellfield, the City of San Luis Wellfield, private wells and the Sonoran Mesa Wellfield (also known as the Mesa Arenosa Wellfield) in Mexico.

Groundwater pumping within 5 miles of the Mexican border in the vicinity of San Luis is subject to agreement between the United States and Mexico per Minute 242 to the US-Mexico Water Treaty of 1944. This agreement limits groundwater pumping in the United States and in Mexico to 160,000 acre-feet per year each in the 5-mile zona. The Hydrology Study looked at actual groundwater pumping up to the year 2009 and estimated annual groundwater pumping under the treaty up to the year 2110 for the purposes of modeling future groundwater elevations. The values of actual and estimated groundwater pumping used in the model for pumping in the 5-mile zone were: :

Actual and Estimated Annual Groundwater Pumping in the 5-Mile Zone, 2009 to 2110
(in Acre-Feet per Year)

United States	2009 Actual	2030 Est.	2110 Est.
242 Wellfield	45,712	77,767	125,000
Private Wells	10,139	8,420	25,500
City of San Luis Wells	3,574	8,908	8,908
Totals	59,425	95,095	159,408

Mexico	2009 Actual	2030 Est.	2110 Est.
Sonoran Mesa Wellfield	157,859	160,000	160,000

The significance of this table is that:

(1) Mexico is the largest user of groundwater in the San Luis area, pumping their Sonoran Wellfield at near its maximum allowed capacity.
(2) The City of San Luis wells are by far the smallest user of groundwater, both in the near term and long term;
(3) The US pumping capacity will only reach near its capacity of 160,000 acre-feet per year with significant increases in pumping of the 242 Wellfield wells and of private wells. These are conservative assumptions and may not fully occur.

With the conservative pumping rates from the above table, the Hydrology Study predicted groundwater levels in the San Luis area would decline by the following amounts as measured at the pumping center of the City of San Luis (Table 15):

Well Field	Groundwater Drawdown 2010 to 2030	Groundwater Drawdown 2010 to 2110
Sonoran Mesa Wells	14 Feet	30 feet
242 Well Field	13 Feet	33 Feet
Private Wells	1 Foot	7 Feet
City of San Luis Wells	3 Feet	5 Feet
Total Drawdown	34 Feet	81 Feet

(Note – includes 3 to 6 feet of drawdown caused by the Yuma Mesa Wellfield to the North)

Again, it can be seen that the City of San Luis and the Private Wells only contribute to groundwater level declines in a very minor way, causing a combined 12 feet of drawdown out of the total predicted drawdown of 81 feet over 100 years.

Below are discussed changes since the Hydrology Study was prepared in 2010 and the effects of these changes on the 2010 report and how the inclusion of the Tower Project in the City of San Luis water use would affect the future groundwater levels.

EFFECTS OF ADDITIONAL WATER USE ON THE GROUNDWATER AQUIFER

Since the Hydrology Study was prepared in 2010, several changes in groundwater pumping and water use have occurred in San Luis area. In addition, the effects of the Tower Project being constructed need to be assessed.

From the tables above, 4 well fields affect the groundwater aquifer under the City of San Luis – the 242 Wellfield, private wells, City of San Luis wells, and wells in Mexico's Sonoran Wellfield.

It can be generally expected that almost full pumping of the Sonoran Wellfield at 160,000 af/yr will continue in the future. From 2010 to 2019, however, per records from the U.S. International Boundary and Water Commission, the Sonoran Wellfield only averaged less than 134,000 af/yr. Over these 10 years, this reduced pumping volume has resulted in over 260,000 acre-feet of groundwater not being withdrawn from the aquifer.

There has also been noticeably less groundwater pumped from the 242 Wellfield than anticipated since 2010. Instead of annual pumping volumes of to 77,767 af/yr as projected, annual pumping volumes have averaged only 30,056 af/yr (USIBWC Data). Over the last 11 years, this reduced pumping volume has resulted in about 524,000 acre-feet of groundwater not being withdrawn from the aquifer. While future flows could certainly increase to values modeled, the current trend indicates the model was conservative and could well be over-predicting groundwater declines due to the 242 Wellfield. (Future 242 Wellfield flows increasing to up to 125,000 af/yr after 2030 are based on possible declines of return flows from the Yuma Valley to 15,000 af/yr, with the balance of the maximum 140,000 acre-feet deliveries coming from the 242 Wellfield. To date, no such significant declines in Yuma Valley return flows have been observed.)

It is noted that between lesser pumping of the Sonoran Wellfield and 242 Wellfield alone, some 790,000 acre-feet less water has been pumped vs. the anticipated pumping between 2010 and 2020. This alone is the equivalent of almost 67 years of Tower Project water use.

Significant changes in the pumping of private wells in the 5-mile zone have also occurred since 2010. At the time of the Hydrology Study, private wells in the San Luis area consisted of wells irrigating farms along the Colorado River, wells in the Hillander C Irrigation District used for irrigation, and wells at the Arizona State Prison and a few small private wells. Since that time, the Hillander C irrigation wells have been taken out of use.

Hillander C Irrigation District is a smaller private irrigation district now located within the current boundaries of the City of San Luis. Bounded by Cesar Chavez Blvd. (County 23rd Street), Avenue F-1/2, Avenue C and County 25th Street, the lands of Hillander C are being rapidly urbanized. These lands also include the land on which the Tower Project will be located.

With the Hillander C wells being taken out of use, groundwater use by private wells has decreased by about 4,500 af/yr (Ref: Table 6 – 2009 sum of wells in Township 11 South, Range 24 West.) Private irrigation well pumping without Hillander C was 5,639 af/yr in 2009 (rounded to 5700 af-yr) and this should continue to be fairly constant over the coming years (it consists of pumping for irrigation purposes along the Colorado River, of which land is limited for any increases, plus the more minor Arizona state prison pumping.) This decrease in private well groundwater usage, which again has already occurred, will cover a substantial part of the additional water usage of the Solar-Wind Downdraft Tower Project's project annual water usage.

Overall, the combined modeled City of San Luis well pumping plus the private well pumping was estimated in the Hydrology Report's groundwater model to total 35,000 af/yr in years 2030 to 2110 (Section 8, page 28 – paragraph 4.) Per the model this was to be 9,500 acre-feet of City of San Luis pumping and 25,500 acre-feet of private well pumping, but in essence, any combination of City of San Luis and private well pumping that totaled 35,000 af/yr would produce the approximately the same overall results in groundwater level declines.

With future private well groundwater pumping estimated at 5,700 af/yr, the City of San Luis wells pumping their full assured water supply capacity of about 8,900 af/yr (over twice the current pumping rate of 4195 af/yr), and the proposed 12,500 af/yr to be used by the Tower Project, a total of about 27,100 acre-feet of groundwater would be pumped from the aquifer each year. This is a sustainable level, less than projected 35,000 acre-feet per the Hydrology Study for years 2030 to 2110. Using the full 35,000 acre-feet of total City and private well pumping, an additional 7,900 acre-feet would still be available for City use and other projects.

It also needs to be noted that the City of San Luis has Yuma Project water right entitlements to Colorado River for lands in the City which have urbanized and have converted their water rights to the City. To date, the City has 1,565 acre-feet of such water rights and this total will increase with any urban development in the Yuma Valley. These water right may only be used for water use on Yuma Project lands in the Yuma Valley and will require construction of water treatment infrastructure to use the Colorado River water. But they are also sufficient to cover most all future developments within the City of San Luis in the Yuma Valley.

SUMMARY AND CONCLUSIONS

- The groundwater aquifer under the City of San Luis contains a very significant quantity of water, estimated at between 48 and 96 million acre-feet of groundwater, plus possible future recharge flows to the aquifer. Of this amount, the Solar-Wind Downdraft Tower Project proposes to use about 12,500 acre-feet per year, a small fraction of the total water available.

- The City of San Luis has a Designation of Assured Water Supply from the Arizona Department of Water Resources for 8,908 acre-feet per year. The City currently uses about 4,195 acre-feet per year.

- A Hydrology Study with groundwater model was prepared for the Arizona Department of Water Resources as a part of the City's 2010 Assured Water Supply application. Since 2010, 30% less groundwater water has been pumped from the San Luis aquifer than was modeled. Groundwater levels have also declined less than modeled, declining since 2010 to now about 11 feet under the City of San Luis vs. a predicted 18-foot decline.

- The Hydrology Study estimated groundwater pumping in the United States and Mexico to the year 2110. The table below shows the predicted breakdown of this groundwater pumping.

Predicted Groundwater Uses in the San Luis Area as Modeled

United States Groundwater Pumping	Modeled Water Use (to the Year 2110)
242 Wellfield	125,000 Acre-Feet/Year
City of San Luis and Private Wells	35,000 Acre-Feet/Year
Totals	160,000 Acre-Feet/Year
Mexico Groundwater Pumping	
Mesa Arenosa Wellfield	160,000 Acre-Feet/Year

The 35,000 acre-feet per year available for use by the City of San Luis, the Tower Project and by private wells can be broken down as:

Totals of Future City of San Luis, Private Wells and Tower Project Groundwater Pumping

Total Estimated Future Water Use - City/Private	35,000 Acre-Feet/Year
Less Allocated Uses	
City of San Luis Assured Water Supply Pumping	8,900 Acre-Feet/Year
Farms Outside of Levee, Arizona State Prison	5,700 Acre-Feet/Year
Solar-Wind Downdraft Tower	12,500 Acre-Feet/Year
Subtotal	27,100 Acre-Feet/Year
Balance Remaining for Further City of San Luis Uses	7,900 Acre-Feet/Year
Plus Converted Water Rights for Developments in the Yuma Valley	
Plus Any Unused 242 Wellfield Allocations	

- The above table shows that as previously modeled there is adequate groundwater available for the City of San Luis' assured water supply, for the Solar-Wind Downdraft Tower, for other private well users not projected to be served by the City, plus an additional 7,900 acre-feet per year for other uses. And this summary does not include Yuma Project lands in the Yuma Valley for which the City of San Luis has converted Colorado River water rights.

- Total decline in groundwater levels was estimated at 81 feet in the year 2110 in the San Luis area per the Hydrology Study groundwater model. Including the Tower Project into the calculations as a prorated percentage of the overall decline, the decline in groundwater levels attributed to the Tower Project would be about 3 to 4 feet of the 81 feet total.

- As documented in the Hydrology Study, the Arizona Department of Water Resources has determined that groundwater near the City of San Luis is not Colorado River Water (ADWR Letter of 4/26/1999.) Colorado River water is available, however, through water rights of Yuma Project lands in the Yuma Valley converted to the City of San Luis, with these water rights only usable in the Yuma Valley but being sufficient to cover most all future development in the Yuma Valley. Additional Colorado River water could potentially also be acquired from Yuma Mesa Irrigation and Drainage District's allotment of municipal and industrial water. Overall, in addition to the ability of the groundwater aquifer under the City of San Luis to supply more than adequate groundwater for the Solar-Wind Downdraft Tower Project, these additional sources of water for future uses will help to ensure that the City of San Luis has adequate water resources to meet future water demands.