ARIZONA DEPARTMENT OF WATER RESOURCES
BEFORE THE DIRECTOR

IN THE MATTER OF THE PETITION TO DESIGNATE THE SAN SIMON VALLEY SUB-BASIN OF THE SAFFORD GROUNDWATER BASIN AS A SUBSEQUENT IRRIGATION NON-EXPANSION AREA	**MOTION FOR REHEARING OR REVIEW**

Pursuant to A.R.S. §§ 45-114(C) and 45-436(B), Farmers Investment Co. ("FICO") hereby submits this motion for rehearing or review of the Arizona Department of Water Resources' ("ADWR") decision not to designate the San Simon Valley Sub-basin of the Safford Groundwater basin ("Sub-Basin") as a subsequent Irrigation Non-Expansion Area ("INA") as authorized by A.R.S. § 45-432(A).

Under the Groundwater Code, the Director may designate a subsequent INA if the Director determines that there is insufficient groundwater to provide a reasonably safe supply for irrigation of the cultivated lands in the area at the current rates of withdrawal and it is not necessary to establish an Active Management Area. *See* A.R.S. § 45-432(A). The Director solicited comments from the public, and on July 17, 2015, FICO submitted comments to the Director and attached a report prepared by Leonard Rice Engineers, Inc., entitled "Evaluation of the San Simon Sub-Basin as an Irrigation Non-expansion Area," dated July 14, 2015 (collectively, the "FICO Comments"). The FICO Comments, which are incorporated herein, presented information demonstrating that the costs associated with lifting groundwater from ever-increasing depths would exhaust the economically viable irrigation supply within the Sub-Basin within the next 50-60 years, and requested the Director to designate the Sub-Basin as in INA in order to protect the Sub-Basin's agricultural economy.[1]

[1] This estimate has subsequently been revised to 30-40 years. *See* Section I(B), *infra*.

After reviewing the public comments and holding a public hearing pursuant to A.R.S. § 45-435, ADWR issued the "Findings, Decision and Order of ADWR's Director," on August 12, 2015 ("Director's Decision"). The Director raised "questions" regarding several components of FICO's economic analysis and stated, without either conducting his own economic analysis or providing data that disputes that provided by FICO, that "the Department has not been presented with sufficient evidence to support the designation of the San Simon Valley Sub-basin as a subsequent INA on this ground." Director's Decision ¶¶ 39-40. Rather than analyzing the economic impact of future groundwater withdrawals on the farming industry in the Sub-Basin, the Director relied exclusively on the physical availability of groundwater in the Sub-Bain in determining that there will be sufficient groundwater available for irrigation of the cultivated lands in the area after 100 years of pumping at the current rates of groundwater withdrawal. *See* Director's Decision ¶41. Based on the Director's findings, the Director held that "the San Simon Valley Sub-basin of the Safford Groundwater Basin SHALL NOT be designated as an INA." Director's Decision, at 14.

As set forth in this motion, the Director's "questions" regarding FICO's economic viability analysis are unfounded, and the Director made no attempt to conduct his own analysis in that regard despite the fact that the purpose of INA statute and the Groundwater Code is to protect the economic effectiveness of agriculture. *See* Section I, *infra*. The fact that water might be physically available in the aquifer is irrelevant if the costs of obtaining that water for agriculture are prohibitively high. *See id.* Moreover, the Director only accounted for a fraction of the irrigation requirements of the lands currently cultivated in the area. *See* Section II, *infra*. The Director's failure to consider the economic burden of withdrawing groundwater from ever increasing depths or to account for all of the irrigation requirements of the lands currently cultivated as part of his analysis under A.R.S. § 45-432(A) is arbitrary, capricious, and constitutes an abuse of discretion.

Additionally, the Director's "physical" availability determination was based upon unreliable groundwater withdrawal and water level decline rates and an insufficiently calibrated and unreliable groundwater flow model that shows almost no correlation with the observed groundwater conditions in the Sub-Basin. *See* Sections III, *infra*. As noted herein, the actual groundwater decline in the Sub-Basin is greater than estimated by ADWR, and actual drawdowns will be much more than those predicted by the Director. *See id.* Accordingly, FICO's determination that irrigated agriculture will become economically infeasible within approximately 30-40 years is, if anything, **conservative**.

For the reasons set forth herein, the Director should grant FICO's motion for rehearing or review in order to properly evaluate the criteria set forth in A.R.S. § 45-432(A) and consider the economic feasibility of withdrawing water for agriculture in the Sub-Basin as part of that analysis.

I. Rising Pumping Costs will Cause Irrigated Agriculture to Become Uneconomic at Current Withdrawal Rates Long Before Depletion of the Lower Aquifer.

The Director largely ignored FICO's economic feasibility analysis presented in the FICO Comments, and instead based his decision primarily on ADWR's findings that: (1) the average depth to water in the major agricultural areas of the Sub-Basin would be approximately 350 feet, and would not exceed 700 feet below land surface; (2) the saturated thickness in the lower system would not be less than 400 feet after 100 years of groundwater pumping at current withdrawal rates; and (3) the average rate of water level declines throughout the entire Sub-Basin are relatively low. *See* Director's Decision ¶ 41. The Director also noted that "the Department is aware that pumping for agricultural purposes is occurring or has occurred at depths to water greater than 400 feet below land surface in other parts of the state." *Id.* ¶ 39(2).

ADWR's failure to conduct any economic feasibility analysis of its own and instead rely completely on the physical availability of water was arbitrary and inconsistent with the purposes set forth in the Groundwater Code. Additionally, the concerns expressed by the Director with FICO's economic analysis are unsubstantiated. Finally, the Director's determination that irrigation wells exist within the state that pump groundwater from depths greater than 400 feet actually supports the creation of an INA in the Sub-Basin.

A. The Director's Determination is Arbitrary in that it Completely Ignores Negative Economic Impacts to Agriculture, the Protection of which is a Main Purpose of the INA Statute and the Groundwater Code.

While ADWR claims that its depth to water and saturated thickness projections demonstrate that a "significant supply of groundwater will be accessible for irrigation purposes in the sub-basin for at least 100 years" (Director's Decision ¶ 37), ADWR makes no effort whatsoever to demonstrate that such theoretically "accessible" water will provide an economically viable supply for irrigation of the cultivated lands in the Sub-Basin. Rather, ADWR has merely shown that groundwater would physically remain in the aquifer after 100 years of pumping, which, as demonstrated herein, is not the sole (or even most appropriate) determination required by A.R.S. §45-432(A).

A.R.S. § 45-432(A) provides that ADWR may designate an INA in a groundwater basin or sub-basin that lacks sufficient "groundwater to provide a reasonably safe supply for irrigation of the cultivated lands in the area at the current rates of withdrawal." Therefore, the purpose of designating an INA is specifically tied to the sufficiency of groundwater supplies for the irrigation of existing agricultural lands, which indicates that INAs are primarily intended to function as a tool for preserving existing agricultural land uses in areas where groundwater withdrawals threaten to undermine the continued viability of irrigation. *See* A.R.S. §§ 45-402(22), -432(A)(1). For purposes of the Groundwater Code, "irrigate" is defined as "apply[ing] water to two or more acres of land to produce plants or parts of plants for sale or human consumption, or for use as feed for livestock, range livestock or poultry." A.R.S. 45-402(18). Because INAs are specifically concerned with the sufficiency of groundwater supplies for irrigating cultivated lands, and considering that irrigation is statutorily defined as an economic, productive activity, deciding whether to designate an INA is not merely a question of simply calculating whether an aquifer contains enough water to continue supplying water to farmers regardless of the economic circumstances. Rather, to determine whether a basin contains sufficient groundwater to provide a reasonably safe irrigation supply, the Director must evaluate whether the available groundwater supply is reasonably safe as an input in the context of the economics of irrigated agricultural production.

Although no courts have interpreted the criteria for designating an INA under existing A.R.S. § 45-432(A), interpretations of the purpose underlying the designation of "critical groundwater areas" under the preexisting 1948 Groundwater Code (the language of which is nearly identical to the language of A.R.S. § 45-432(A)) provide guidance here. In *Southwest Engineering Co. v. Ernst*, the Arizona Supreme Court upheld restrictions on pumping groundwater in designated "critical groundwater areas," which were defined by statute as basins or sub-basins lacking "sufficient ground water to provide a reasonably safe supply for irrigation of the cultivated lands in the basin at the then current rates of withdrawal." 79 Ariz. 403, 291 P.2d 764 (1955). The Court found that the management of groundwater in critical groundwater areas addressed a "preponderant public concern in the preservation of the lands presently in cultivation as against lands potentially reclaimable," and determined that the legislature's purpose in adopting measures to regulate groundwater withdrawals in designated critical areas was to protect groundwater resources from excessive pumping that would otherwise result in "complete exhaustion of the state's groundwater so that in the end the lands dependent thereon will revert to their desert state **or in the lowering of water tables so that the increased cost of pumping will reduce these lands to a marginal or submarginal condition**." *Id.* at 409, 291 P.2d at 768 (emphasis added).

Moreover, the Groundwater Code's "Declaration of Policy" contained in A.R.S. § 45-401 supports the assertion that economic considerations are a predominant concern in the decision to regulate groundwater withdrawals through INAs or AMAs. For example, A.R.S. § 45-401(A) states the legislature's findings that excessive groundwater withdrawals are "threatening to destroy the economy of certain areas of this state" and that the best interest of the general economy and welfare of the state favored enacting the Groundwater Code "to prescribe which uses of groundwater are most beneficial and economically effective." Additionally, A.R.S. § 45-401(B) declares that managing and regulating groundwater withdrawals is in the "interest of protecting and stabilizing the general economy and welfare of this state and its citizens."

The economic concerns expressed by the Arizona Supreme Court in *Southwest Engineering* and the Arizona Legislature in the Groundwater Code are particularly significant in rural parts of Arizona with primarily agricultural economies like the San Simon Valley.[2] Permitting groundwater levels to decline to the point that farmers can no longer afford to pump water for irrigation will actually "destroy the economy" of the area and is entirely inconsistent with the express policies set forth in the Groundwater Code. Accordingly, the Director erred by arbitrarily ignoring the economics of pumping groundwater from increasing depths for irrigating crops and basing his decision not to designate an INA for the Sub-Basin solely on the physical volume of water expected to remain deep in the aquifer after 100 years of pumping.

B. Irrigated Agriculture will Become Economically Infeasible for Most Farms in the Sub-Basin in Approximately 30-40 Years.

The analysis contained in Leonard Rice Engineers, Inc.'s September 2015 report entitled "Response Report Regarding the ADWR Director's San Simon Sub-Basin INA Decision" (attached hereto as **Exhibit 1**), demonstrates that current irrigation demands and groundwater withdrawals will lower water tables in the area such that the increased

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[2] As Kathleen Ferris, former ADWR Director and contributing author of the Groundwater Code, recently stated, "The [Groundwater Code] was written to protect existing ag users, written totally from an ag point of view." Tony Davis, *In Bowie, Faucets Weren't Supposed to Trickle to a Stop, Arizona Daily Star*, Sept. 5, 2015, available at http://tucson.com/news/local/in-bowie-faucets-weren-t-supposed-to-trickle-to-a/article_9e87bdc3-6513-5efb-a04e-79392e5d6490.html.

costs of pumping groundwater will cause irrigated agriculture in the area become economically infeasible for most farms in approximately 30-40 years, rather than the 50-60 years originally estimated in the FICO Comments. *See* Exhibit 1 at 22. This revised conclusion is based upon: (1) a revised estimated groundwater decline of 2.0 feet per year (as opposed to the estimated decline contained in the ADWR model) (*see* Section III, *infra*.); (2) the increased costs of water based on groundwater declines; and (3) the additional capital costs associated with groundwater declines, including the installation of higher horsepower pumps and replacing and lower wells. *See* Exhibit 1 at 22.

The Director determined that the economic analysis conducted in the FICO Comments did not provide sufficient evidence to support designating a subsequent INA in the Sub-Basin, and questioned FICO's use of long-term farm income and expense percentages and FICO's stated profit margin for orchards. *See* Director's Decision ¶¶ 39-40.[3] As noted by agricultural economist David P. Anderson,[4] however, it is "standard in the industry to use a long term average cost and revenue" in conducting analyses of the economic viability of multiple decade investments like pecan orchards. *See* Affidavit of David P. Anderson (attached hereto as **Exhibit 2**) ¶ 4. Moreover, as calculated by Dr. Anderson, considering orchard development costs and mature crop production costs and returns over a 30-year period, the annual average long term return over costs for pecan orchards is 12.8 percent, which is squarely within the 5%-15% profit margin assumed in the FICO Comments. *Id.* ¶ 11.

The Director's criticisms of FICO's economic analysis are misplaced, and the Director should grant FICO's motion and reevaluate the decision to not designate the Sub-Basin as an INA due to the economic stresses to agriculture associated with lifting water from ever increasing depths.

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[3] While questioning portions of FICO's analysis, the Director notably neither provided conflicting data nor conducted his own independent economic analysis.

[4] Dr. Anderson is an agricultural economist and professor at Texas A&M AgriLife Extension Service, who was retained by FICO to review the economic analysis contained in the reports authored by Leonard Rice Engineers, Inc., that accompany both the FICO Comments and this motion.

C. The Vast Majority of Wells Pumping Groundwater From Depths to Water of Greater Than 400 Feet are Located in INAs and AMAs.

The Director's assertion (without any supporting information) that pumping groundwater for agricultural purposes is known to occur at depths to water greater than 400 feet below land surface actually supports the creation of an INA in the Sub-Basin. First, irrigation wells that pump from that depth are extremely rare. *See* Exhibit 1 at 4-6. ADWR's GWSI well data reveals that only 4% of the irrigation wells in the state currently have non-pumping depths to water greater than 400 feet below land surface. *See id.* at 6. The overwhelming majority of these wells (88%) are located within an AMA or INA where ADWR has already decided that groundwater withdrawal rates require regulation to avoid unrestrained depletion of the resource. *See id.* at 4. Additionally, almost all of the agricultural wells with depths to water greater than 400 feet below land surface that are not located within an AMA or INA are located just adjacent to an INA or are located in the Sub-Basin. *See id.* In total, **98%** of the irrigation wells withdrawing water at depths below 400 feet are either located within or adjacent to INAs or AMAs, or are located within the Sub-Basin itself. *See id.*

The fact that nearly all of the irrigation wells with depths to water greater than 400 feet below land surface are located either within an AMA or INA indicates that the Arizona Legislature and ADWR have historically found groundwater levels approaching 400 feet below surface concerning enough to limit further withdrawals and interpreted the AMA and INA provisions of the Groundwater Code to necessitate such regulation well before groundwater levels actually fall 400 feet. This fact provides further support for the designation of the Sub-Basin as an INA.

II. **<u>ADWR did not Consider the Full Irrigation Requirements of the Currently Cultivated Lands in the Sub-Basin</u>.**

ADWR maintains that it only considered current rates of groundwater withdrawal in determining whether the Sub-Basin contains sufficient groundwater to provide a reasonably safe supply for irrigation of the cultivated lands in the area, as required by A.R.S. § 45-432(A). *See* Director's Decision ¶¶ 27, 29, 31, 39(1), 41. To estimate current groundwater withdrawals in the Sub-Basin, ADWR principally relied upon USGS data, including crop surveys of the irrigated acreage in the area, the consumptive water use of the crops surveyed, and the efficiency of the irrigation methods used in the Sub-Basin. *See id.* ¶ 27. ADWR concludes in its findings that approximately 45,000 acre-feet of groundwater was withdrawn in 2014 to irrigate approximately 20,000 acres of crops, more than 60% of which consisted of permanent orchard crops. *See id.* ¶ 20; *see also* Hydrology and Water Use Data of the San Simon Valley Sub-Basin, Presented by Frank Corkhill, at 16 ("ADWR Presentation").

As discussed below, the consumptive use and withdrawal estimates relied upon by ADWR are inaccurate. *See* Section III(A), *infra*. Moreover, the Director only accounted for a fraction of the irrigation requirements of the lands currently cultivated in the area. The 2014 USGS crop survey data relied upon by ADWR shows that nearly 6,700 acres in the San Simon Sub-Basin consisted of new pecan crops. *See* United States Geological Survey, Basin Acreage and Withdrawals for 2014, Crop Table ("USGS Crop Table").[5] The consumptive water use of these newly planted orchards is lower than the consumptive use of the orchards currently producing crops, and is separately accounted for in ADWR's current groundwater withdrawal estimates. *Id.*

The Director's analysis is in error because although juvenile orchards require much less water than other crops, including mature orchards, the USGS Crop Table relied upon by ADWR and the Affidavit of David P. Anderson demonstrate the amount of water required to sustain mature orchards and produce an actual crop is significantly higher. *See* USGS Crop Table; Exhibit 2 ¶¶ 9, 12. Furthermore, orchards are considered permanent

[5] The 2014 USGS data, including crop surveys, consumptive water use estimates, irrigation efficiencies, and groundwater withdrawal estimates relied upon by the Director were obtained from ADWR by a public records request dated September 8, 2015. Leonard Rice Engineers, Inc., contacted the USGS directly and procured the same information for years 2007-2013, which allowed it to conduct a more thorough and accurate analysis.

crops and differ from most other crops in that they typically do not yield a marketable product for several years while they mature but then may continually produce for decades without replanting. Therefore, the increase in water use is predictable and necessary if existing tree nut farmers in the Sub-Basin are to grow products for sale, human consumption, or use as feed as required by the statutory definition of "irrigate." *See* Exhibit 1, at 3; Exhibit 2 ¶¶ 9, 12; *see also* A.R.S. § 45-402(18).

The Director asserts that he may not consider expected increases in the water requirements of currently planted juvenile orchard acres because giving consideration to such increases would require disregarding the statutory language that requires the Director to evaluate the sufficiency of the groundwater supply "at the current rates of withdrawal." *See* Director's Decision ¶ 31. However, nearly one-third of the currently cultivated acres in the Sub-Basin are guaranteed to require a predictably larger amount of water as they become mature, producing orchards, and nearly two-thirds of the currently cultivated acres are likely to remain planted with mature orchards so long as there is water available for irrigation. Applying the "current rates of withdrawal" language in the "snapshot" manner set forth in the Director's Decision prohibits a determination of whether sufficient groundwater exists in the Sub-Basin to provide a reasonably safe supply for the irrigation of **currently** cultivated lands as required by the statute. By basing his calculation of withdrawal rates partly on the temporary, stunted irrigation demands of juvenile orchards, the Director is merely evaluating the longevity of the groundwater supply in the Sub-Basin at rates of withdrawal that are too low to provide an irrigation supply sufficient to produce tree nut crops on the **currently** cultivated lands in the area. *See* Exhibit 1 at 3; Exhibit 2 ¶ 12 ("[T]o produce a sufficient yield adequate water must be used for the mature crop."). Because this is an absurd result, the legislature could not have intended for A.R.S. § 45-432(A) to operate as interpreted by the Director. *See, e.g.*, *Walgreen Ariz. Drug Co. v. Ariz. Dep't of Revenue*, 209 Ariz. 71, 73, 97 P.3d 896, 898 (App. 2004) (noting that statutes must be interpreted "to give them a fair and sensible meaning and to avoid absurd results").

III. <u>Numerous Flaws Exist in the Director's Decision Regarding "Physical Availability" that Demonstrate FICO's Economic Analysis is Actually Conservative</u>.

As noted in Sections I and II, *supra*., the Director's failure to consider the economic burden of withdrawing groundwater from ever increasing depths or to account for all of the irrigation requirements of the lands currently cultivated in considering whether to designate the Sub-Basin as an INA under A.R.S. § 45-432(A) is arbitrary, capricious, and constitutes an abuse of discretion. Additionally, as set forth in this Section, the findings that the Director did rely upon in determining that sufficient "physical" supplies will exist in the foreseeable future are flawed. These flaws exacerbate FICO's concerns that agriculture in the Sub-Basin will become economically infeasible in the next 30-40 years.

A. ADWR Significantly Underestimated the Current Rates of Groundwater Withdrawal.

The United States Geological Survey ("USGS") groundwater withdrawal estimates relied upon by ADWR are unreliable because the USGS: (1) did not use a proper crop coefficient for pistachio and pecan orchards in its consumptive use analysis; (2) misrepresented the distribution of acreage between mature pecan trees and young pecan trees; (3) used only regional precipitation data; and (4) used unrealistic irrigation efficiency estimates when converting irrigation water requirements into pumping volume. *See* Exhibit 1, at 18. Actual groundwater withdrawal estimates are 1.7 times greater (78,000 acre-feet per year ("AFY") as opposed to 44,000 AFY) than the estimates relied upon by the Director in his decision. *See* Exhibit 1, at 17-22. ADWR's calculation therefore substantially alters one of the essential findings required by A.R.S. § 45-432(A), *i.e.*, the amount of groundwater actually pumped in the Sub-Basin.

B. ADWR Underestimated Current Water Level Decline Rates.

The Director based his decision in part on the finding that the average decline rate of all wells in the Sub-Basin that exhibited declining water levels between 2007 and 2015 was 1.7 feet per year. *See* Director's Decision ¶¶ 26, 41. However, ADWR's calculated groundwater decline underestimates the actual decline rates, particularly in the major agricultural pumping centers.

First, ADWR based its calculation upon only 32 well measurements gathered from wells spread throughout the approximately 1,930 square miles in the Sub-Basin, which is too little data to constitute an accurate representation of water level declines in the entire Sub-Basin. *See* Exhibit 1, at 6-7. Moreover, the inclusion of data from wells in both the upper and lower aquifers in ADWR's decline rate calculations results in figures that do not truly reflect the average rate of decline for the wells in the lower aquifer, from which the majority of the agricultural pumping in the Sub-Basin occurs. *See id.* The average water level decline rate calculated from the seven hydrographs for wells in the lower aquifer presented by ADWR at the May 16, 2015 public hearing is 2.9 feet per year, which is 1.7 times greater than the average rate of decline ultimately relied upon by the Director. *See id.* Calculating average decline rates using ADWR's 2007-2015 water level sweep data rather than data from the 32 wells included in ADWR's decline rate calculations results in a Sub-Basin-wide average decline rate of 2.0 feet per year, which would result in Sub-Basin-wide water level declines of 200 feet over the next 100 years. *See id.*

Second, irrigated agriculture in the Sub-Basin is concentrated on about 20,000 acres of land around Bowie, Olga, Southeast of San Simon, and North East of Portal and not distributed throughout all of the Sub-Basin's approximately 1,930 square miles. *See* Hydrology and Water Use Data of the San Simon Valley Sub-Basin, Presented by Frank Corkhill, at 13-17 ("ADWR Presentation"). However, A.R.S. § 45-432(A) requires ADWR to evaluate whether there is a reasonably safe supply of groundwater for irrigation of the cultivated lands in the area. Thus, the water level decline rates observed in the agricultural pumping centers are most relevant for purposes of determining whether to designate an INA. Notably, the average water level decline rates for wells around Bowie and San Simon, calculated from ADWR's 2007-2015 water level sweep data, are actually 2.2 feet per year and 2.8 feet per year, respectively, which again is much more of a decline than the 1.7 feet per year relied upon by the Director. *See* Exhibit 1, at 7, Table 1.

C. ADWR's Groundwater Model does not Predict Observed Conditions in the Sub-Basin.

ADWR's groundwater flow model does not accurately predict the observed historic and present groundwater conditions in the Sub-Basin. *See* Exhibit 1, at 7-17. For instance, ADWR's model only predicts an average water decline rate for the Sub-Basin of 0.7 feet per year, which is less than 50% of ADWR's 1.7 feet per year calculation, and only 35% of the more accurate figure calculated from ADWR's 2007-2015 water level sweep data. *See id.* at 7; Section II, *infra*. Moreover, the model-simulated drawdown over the period from 1990-2015 underestimates historical drawdown and shows little correlation to the observed drawdown in any of the major pumping centers. *See id.* at 7-13.

Additionally, the model's ability to predict future groundwater conditions in the Sub-Basin is further hampered by its failure to consider factors such as well partial aquifer penetration, seasonal pumping, cell-to-well drawdown, and well inefficiency, all of which are necessary to accurately simulate groundwater pumping in the Sub-Basin and predict future pumping water levels and lifting costs. *See id.* at 15-17. These concerns lead to the conclusion that the model underestimates drawdown in the Sub-Basin **by 50 feet or more in addition** to the increased drawdown that the model would predict if it was properly calibrated. *See id.* at 22. The issues associated with ADWR's model serve to exacerbate the economic concerns outlined herein and in the FICO Comments and demonstrate that FICO's estimate is conservative.

IV. **Conclusion**

The concerns set forth by the Supreme Court in *Southwest Engineering* and the Groundwater Code (which are shared and presented by FICO) support the designation of a subsequent INA in the San Simon Valley Sub-Basin. Similar to the situation described by the court in *Southwest Engineering*, unrestrained groundwater withdrawals in the San Simon Valley are threatening to lower water tables such that the costs of pumping will force growers in the Sub-Basin to abandon existing farming operations in only a few decades, which will destroy the area's mainly agricultural economy. Because the majority of the cultivated acres in the area are used for growing tree nuts and the productive life of some of the existing orchards will likely outlast the economically available irrigation supply given the water demands of the existing farming operations, the Sub-Basin does not have sufficient groundwater to provide a reasonably safe supply for the irrigation of cultivated lands in the area at current rates of withdrawal. Accordingly, FICO requests that the Director grant its motion for rehearing or review of his decision not to designate a subsequent INA for the Sub-Basin in order to properly evaluate the economic impact of decreasing groundwater levels on agriculture.

DATED this 25th day of September, 2015.

SALMON, LEWIS & WELDON, PLC

By: ______________________________

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EXHIBIT 1

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Response Report Regarding the ADWR Director's San Simon Sub-basin INA Decision

Prepared For

Farmers Investment Co.

September 2015

Project No.: 1477FIC01

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ENGINEERS, INC.

Integrated Water Resources Engineering
Innovative Solutions for Water and Land

Response Report Regarding the ADWR Director's San Simon Sub-basin INA Decision

Prepared for:

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September 22, 2015

1477FIC01

The technical material in this report was prepared by or under the supervision and direction of the undersigned, whose seal as a Professional Engineer is affixed below.

Jon R. Ford, P.E. and C.P.G., Senior Project Manager

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1 INTRODUCTION

The purposes of this report are to clarify possible misinterpretations of our July report, to point out errors in the ADWR analysis that cause that analysis to be unreliable, and to explain why the Director's decision to deny creation of a San Simon Sub-basin INA is in error. Our important opinions are as follows:

1. With regard to an INA designation, assessing whether or not there is a reasonably safe supply of groundwater requires both a hydrologic assessment and an economic assessment by the ADWR Director.
2. The INA decision criterion of 400 feet of remaining saturated thickness after a 100 year computer model simulation is without basis and is arbitrary.
3. Not considering the future full irrigation demand of the currently irrigated acres is an artificial condition.
4. ADWR's estimated basin wide current 1.7 feet per year decline rate, which the Director relied upon, is in error. The actual current basin wide decline rate is approximately 2.0 feet per year and it is even greater in the Bowie and San Simon pumping centers.
5. The ADWR groundwater flow model (model), which the Director relied upon, is unreliable because it underestimates the current and future decline rate in the sub-basin.
6. The assumptions on which our July economic analysis was based are reasonable and correct.
7. Recognizing that the model is unreliable and assuming the current water elevation decline rate and correcting for the USGS's unreliably low estimate of current irrigation pumping, we now are of the opinion that irrigated agriculture for the currently irrigated lands will become economically infeasible in the San Simon Sub-basin in as little as 30 to 40 years instead of 50 to 60 years as presented in our July report.
8. Our economic analysis does not consider the significant capital expenditures necessary to periodically install higher horsepower pumps in existing wells nor does it include the capital expenditure necessary to construct new wells with a large diameter that would be necessary to accommodate the larger diameter electrical power cables. Therefore, our economic analysis is conservative.
9. The Director pointed out that there are places in Arizona where irrigation groundwater pumping is occurring where the non-pumping depth to water is deeper than 400 feet. This is true; however, it is rare in that currently only approximately four percent of all irrigation wells have non-pumping water levels deeper than 400 feet. This fact supports that a non-pumping depth to water of 400 feet is approximately the irrigation groundwater pumping economic limit.
10. The USGS estimate of current irrigation pumping is too low by 34,000 ac-ft/yr, therefore, the estimated agricultural pumping developed by the USGS is unreliable. The reasons for the underestimation by USGS include: use of the wrong crop coefficients for pecan and pistachio orchards, misrepresentation of mature versus new pecan acreage, use of regional climate data instead of site specific climate data, and the use of incorrect irrigation efficiencies. The consequence of this unrealistic estimate of pumping is that the

model underestimates the future depth to water because it includes too little current irrigation pumping.

2 STATUTE REFERENCE TO A REASONABLY SAFE SUPPLY REQUIRES AN ECONOMIC EVALUATION

The statute allows an INA to be created if there is insufficient groundwater to provide a reasonably safe supply. ADWR incorrectly interprets this to mean that it need only consider the rate of depletion to the water stored in the aquifer and not consider economic depletion of the aquifer. Since the statute is aimed at irrigated agriculture which is a for profit business enterprise that necessarily relies upon the presence of a "reasonably safe" groundwater supply to exist, it is necessary that the ADWR Director also evaluate the economics of the groundwater supply when deciding whether or to not to create an INA. In his decision, the Director acknowledges that economic feasibility is relevant to his decision but ADWR failed to evaluate it.

3 THE CRITERION OF 100 HUNDRED YEAR COMPUTER SIMULATION THAT SHOWS AT LEAST 400 FEET OF REMAINING SATURATED THICKNESS IS ARBITRARY AND WITHOUT BASIS

The Director concluded that a significant supply of groundwater will be accessible for irrigation purposes in the sub-basin for at least 100 years. This conclusion was based on the ADWR groundwater flow model prediction that 100 years into the future, the saturated thickness of the lower aquifer will not be less than 400 feet in any major area of current groundwater pumping. This conclusion is without basis because:

1. The depth to the bottom of the lower aquifer is poorly known and has been inferred from geophysical data and very limited drilling data,
2. As discussed below, the model is unreliable,
3. The selection of a 100 year time period for the model simulation is arbitrary because it is not related to any hydrologic or economic criterion, and
4. There is not any relationship between the prediction of remaining aquifer saturated thickness at 100 years and the statutory criteria of being a reasonably safe groundwater supply.

The INA decision criterion of 400 feet of remaining saturated thickness after 100 years of pumping could very probably be made for most or all of the existing AMA's and INA's. Thus, this criterion besides being without basis is arbitrary.

4 DIRECTOR'S CRITICISM OF OUR JULY ECONOMIC ANALYSIS IS IN ERROR

The Director dismissed our economic analysis for the following two reasons:

1. We used the full orchard irrigation demand rather than the current demand.

2. We failed to demonstrate that the irrigation demand would eventually render irrigated agriculture infeasible in the sub-basin because our assumption about relative farm expenses was invalid and because there was a lack of clarity about whether or not we considered orchard profitability.

Failing to consider the full future irrigation demand and instead basing the INA decision on an artificial situation is short sighted because it will lead to uncontrolled irrigation growth and then economic failure in the sub-basin. We believe that it is probable that the legislature did not consider that the irrigation demand of orchards is vastly different from most crops. Most crops effectively have a constant year-to-year irrigation demand because they are planted and harvested each year, with the only variation being climatic. Orchards on the other hand, require an increasing irrigation supply from the time trees are planted until they reach maturity. This occurs over a period of years, and many of the orchards in the San Simon sub-basin are not yet mature.

ADWR realizes that irrigated agriculture will eventually be rendered economically infeasible. Its web site states for example, "**In the Pinal AMA, where the economy is primarily agricultural, the management goal is to preserve that economy for as long as feasible, while considering the need to preserve groundwater for future non-irrigation uses.**" In many ways, the San Simon Sub-basin is a juvenile Pinal basin.

It appears that the Director misinterpreted expense assumptions in our July report. What we said was that although year-to-year farm expenses and revenue vary; over the long term, each expense and each revenue remain a nearly constant percentage of the average annual total expenses and average annual total revenue. This is true in any business. Every business person has no choice but to rely upon this assumption, otherwise there is too much risk associated with the business venture. Irrigated agriculture in many places in Arizona including the San Simon sub-basin has an expense that violates this assumption. That is the ever increasing cost of energy to lift groundwater to the land surface as the depth to water ever increases. Unfortunately, in this situation there is not a revenue increase to offset the increase in energy expense. This problem is exacerbated when more land becomes irrigated. The consequence is that eventually the energy expense consumes all profit and the farm fails. Farms with lower profit margin fail first and those with a higher profit margin last somewhat longer. So, there is no question about if irrigated agriculture in the San Simon sub-basin will become infeasible. It is only a question of when it will occur. We believe that our July economic analysis as modified by section 15 of this report is a reasonable prediction of when.

With regard to whether or not our analysis included orchard profit margin, we believe that it did. We do not have information on orchard profitability but we know that general business profits range from zero to about 15 percent. Generally, we believe farm profitability is lower than general business with many farms operating at a loss. So, we believe that the range we used is reasonable. David Anderson PhD. has been retained by FICO to review our economic analysis and assumptions and he concludes that they are correct.

5 ARIZONA IRRIGATION WELLS WITH A NON-PUMPING DEPTH TO WATER GREATER THAN 400 FEET ARE RARE

In support of his conclusion that our economic analysis is inapposite, the Director pointed out in his decision that pumping for agricultural purposes is occurring or has occurred at depths to water greater than 400 feet in other parts of the state. Since the Director did not cite or explain this observation, we have investigated this issue. We determined that it is very rare for the non-pumping depth to water to be greater than 400 feet in irrigation wells. In fact, **only 6 percent** (549) of the approximately 8600 agricultural irrigation wells included in the ADWR GWSI database have ever had non-pumping depth to water measurements greater than 400 feet. Almost all of these wells (88%) are located in either an AMA or INA where groundwater pumping is controlled by ADWR to avoid depleting the groundwater resource further. Most of these wells are located in the Phoenix AMA, the Pinal AMA, or the Harquahala INA as shown on Figure 1. In addition to the wells in either an AMA or INA in the central part of the state, there another 54 wells with a depth to water greater than 400 feet in the McMullen Valley adjacent to the Harquahala INA. This accounts for 98 percent of the wells with a depth to water greater than 400 feet. Most of the remaining wells are located in the San Simon Sub-basin.

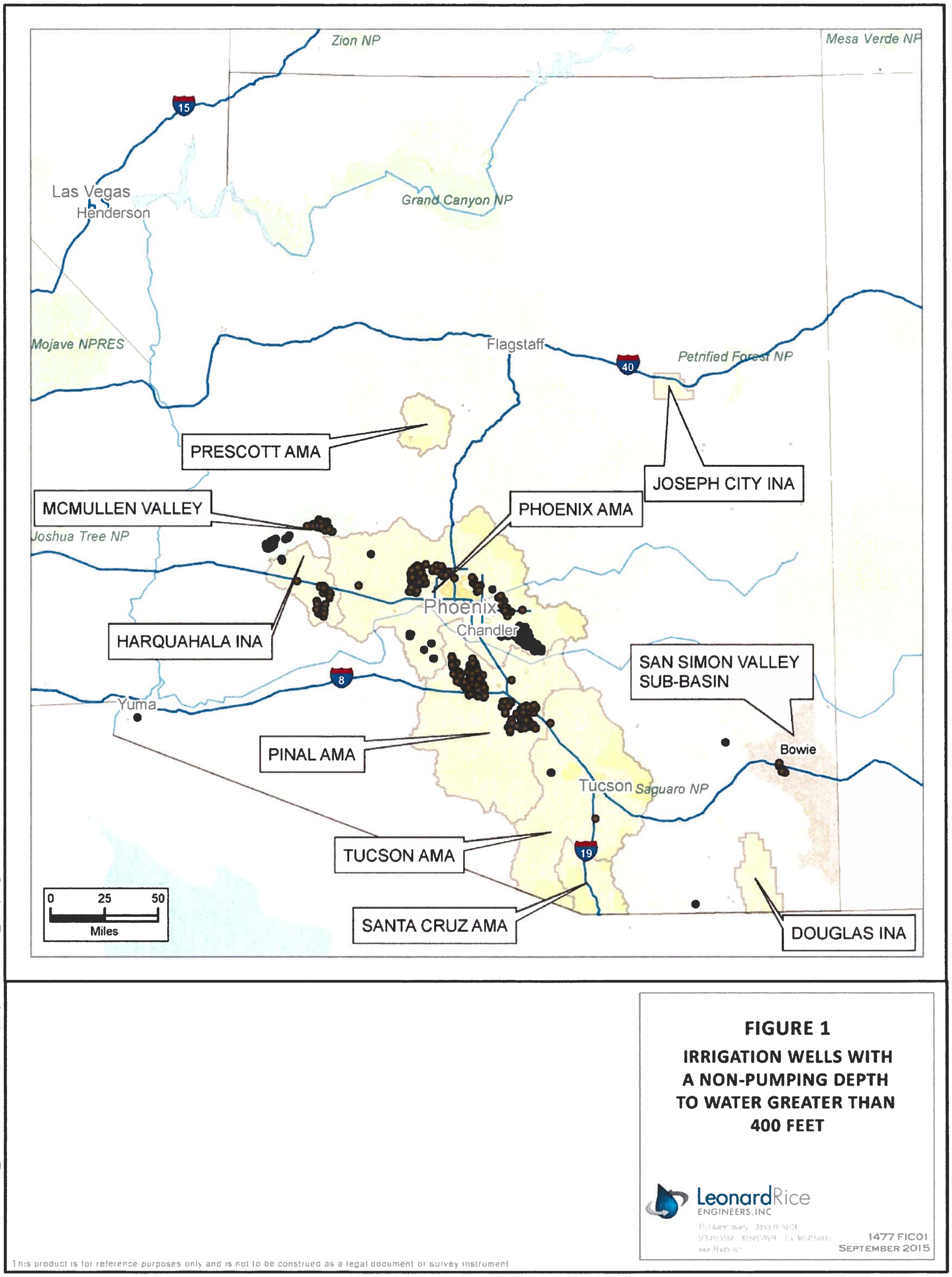


FIGURE 1
IRRIGATION WELLS WITH A NON-PUMPING DEPTH TO WATER GREATER THAN 400 FEET

Furthermore, many of the wells that had a depth to water greater than 400 feet at one point in their history that are located in either an AMA or an INA now have rising water levels and no longer have a depth to water greater than 400 feet. The most recently available data shows that there are approximately 355 wells in the state with a non-pumping depth to water greater than 400 feet. **That is only 4 percent of the irrigation wells in the ADWR GWSI database.**

Our analysis of irrigation wells with depth to water greater than 400 feet shows that the depth to water in the San Simon sub-basin and the projection of its continued decline is anomalous in Arizona. Consequently, the INA Applicants' concern that the current depth to water and its continued downward trend will negatively impact the economic viability of irrigated agriculture in the San Simon sub-basin in the not too distant future is valid.

6 DECLINING IRRIGATED ACREAGE AND IRRIGATION GROUNDWATER PUMPING IN ACTIVE MANAGEMENT AREAS ARE INDICATIVE OF AN ECONOMIC THRESHOLD

The ADWR Arizona Water Atlas (web version) shows that between 1985 and 2006-2010 the irrigated acreage in the AMA's declined by approximately 30 percent and that irrigation groundwater pumping declined by approximately 50 percent. Most of the acreage decline is post 1990 and within the Phoenix AMA (51%). Most of the pumping decline is in the Phoenix (62%) and Pinal (45%) AMAs. Both acreage and pumping declines are the result of farmers making economic decisions. As discussed above, the central Arizona AMAs are in an overdraft condition where there are areas that the depth to groundwater is greater than 400 feet. Consequently, the expense of lifting groundwater in those areas negatively impacts farm economics. It does not matter whether the decisions were made because the rate of return on investment was higher for another land use than irrigated agriculture or because the rate of return on Irrigated agriculture was negative. The decline in both irrigated acres and groundwater pumping is indicative that there is an economic threshold to pumping groundwater for agricultural irrigation and that economic threshold should have been considered in the Director's decision.

7 ADWR UNDERESTIMATED THE CURRENT WATER LEVEL DECLINE RATE IN THE LOWER AQUIFER

The Director relied upon ADWR's 1.7 feet per year calculated groundwater decline rate for the period 2007 to 2015 which projects to an additional 170 foot increase in the average depth to water over the next 100 years. The 100 year time period is used in this section only for the purpose of providing a comparison to the ADWR groundwater decline rate. This calculation is unreliable for three reasons. First, it is based only upon 32 measurements of depth to water from the GWSI index wells in the sub-basin that are spread across an area of approximately 1930 square miles. This is about one data point every 60 square miles. This is too little data to accurately represent the rate of water level change in the basin. Furthermore, the data includes wells in both the upper and lower aquifers.

Second, Frank Corkhill's presentation on May 16, 2015 includes seven hydrographs for the lower aquifer in the basin. The average decline rate for these seven wells is 2.9 feet per year which is 1.7 times greater than the decline rate that the Director relied upon. A 2.9 feet per year decline rate projects to an additional 290 feet average depth to water in 100 years. It would be greater in the areas being irrigated.

Finally, we analyzed the ADWR 2007 and 2015 water level "sweep" data and found that the average decline rate over the entire basin for the lower aquifer is 2.0 feet per year which projects to an additional 200 feet average depth to water in 100 years. The current decline rate in each of the pumping centers is shown in Table 1.

Table 1: ADWR "Sweep" Data San Simon Sub-basin Lower Aquifer Decline Rate

Pumping Center	2007-2015 Average Annual Decline Rate (feet/year)
Entire Basin	2.0
Bowie	2.2
San Simon	2.8
San Simon South	0.5
Rodeo	0.7

Therefore, the 1.7 feet per year decline rate clearly does not represent the decline rate in the sub-basin and that the actual average decline rate in the sub-basin is approximately 1.2 times greater. The actual decline rate in the Bowie and San Simon pumping centers is approximately 1.5 times greater. This analysis shows that the ADWR decline rate is unreliable.

8 THE ADWR MODEL IS UNRELIABLE BECAUSE IT UNDERESTIMATES PRESENT AND FUTURE DEPTH TO GROUNDWATER

The Director relied upon the June 2015 ADWR Groundwater Flow Model of the San Simon Valley Sub-Basin (model) predictions of future conditions in the lower aquifer. However, the model under predicts the observed decline rate relative to that actually observed between 2007 and 2015. The model only predicts an average basin wide decline rate of 0.7 ft/yr which is less than half of the 1.7 feet per year that ADWR calculated from the water level data, and only 35 percent of the value that we calculated from the ADWR sweep data. See Table 2. This means that the model does not accurately match historically observed water elevation changes; therefore, the model cannot reliably predict the future depth to water.

Table 2: ADWR Model Simulated San Simon Sub-basin Lower Aquifer Decline Rate

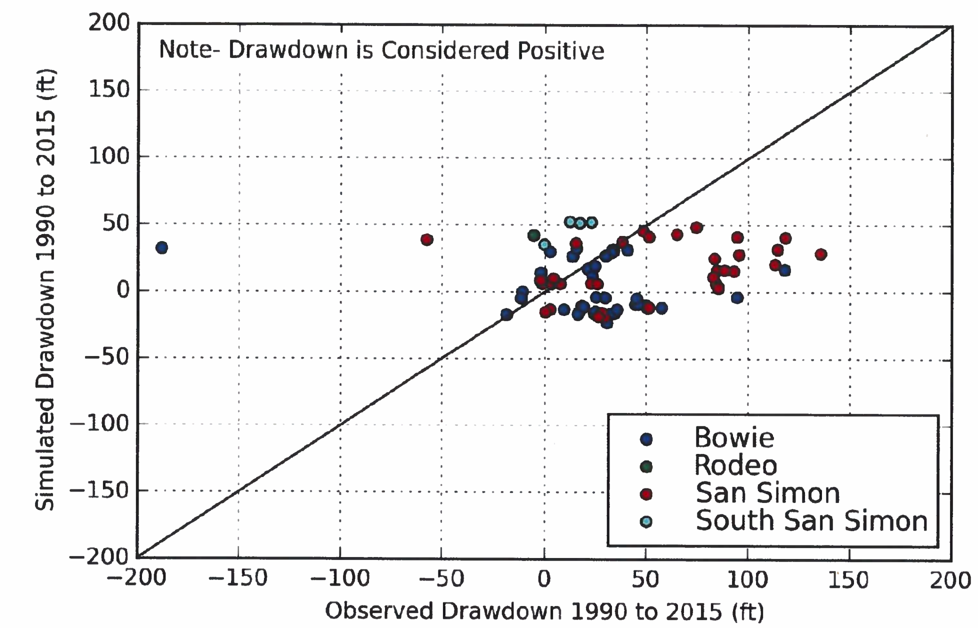
Pumping Center	2007-2015 Average Annual Decline Rate (feet/year)
Entire Basin	0.7
Bowie	0.2
San Simon	1.2
San Simon South	2.0
Rodeo	1.8

9 THE LACK OF MODEL MATCH TO OBSERVATIONS BETWEEN 1990 AND 2015 SHOWS THAT THE MODEL IS INACCURATE AND NOT RELIABLE

We also evaluated whether or not the model accurately replicates drawdown during the historical 1990 through 2015 time period on a well-by-well basis. This time period was chosen because it represents a period of relatively constant pumping, and it included a period of water level recovery following the sharp decline pumping in rates during 1981-1983.

For this analysis, we selected wells that had at least one observation prior to 1990 and had at least one observation in 2015 and we calculated the observed 1990 water level for every well using linear interpolation between the first observation prior to 1990 and the first observation after 1990. We then compared the model-simulated drawdown from 1990 to 2015 to the observed drawdown from 1990 to 2015. The results of this comparison are shown on Figure 2.

As shown on Figure 2, the model does not accurately replicate actual drawdown over the 1990 to 2015 time period. In fact, there is almost no correlation between the simulated and observed drawdowns. As shown in Figure 2, the actual drawdowns are often more than 50 feet greater than the model prediction, particularly in the San Simon area, where the simulated values reflect a rise in the water elevation.



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AUTHOR: JPB
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Figure 2

Scatter Plot Showing Observed Drawdown and Simulated Drawdown from 1990 to 2015

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10 COMPARISON OF WELL HYDROGRAPHS AND MODEL PREDICTIONS IN THE FOUR PUMPING CENTERS

For each of the San Simon Sub-basin irrigation pumping centers, we have compiled a series of representative well hydrographs that demonstrate that the model does not properly replicate the historical data. They are shown on Figures 3 and 4. We have also summarized how the model simulation compares to the actual water level observations for each of the four pumping centers.

There are 26 wells in the Bowie pumping center with more than 10 water level measurements. Eighteen of these wells show either recovery or reduced drawdown after 1980. In 12 of these wells, the model significantly overestimates recovery. There are four wells that show significant drawdown (falling water levels over time) but the model shows rising water levels. This indicates the either the aquifer hydrologic properties or pumping estimates are not properly modeled in this area. Figure 3 shows two example hydrographs from the Bowie pumping center.

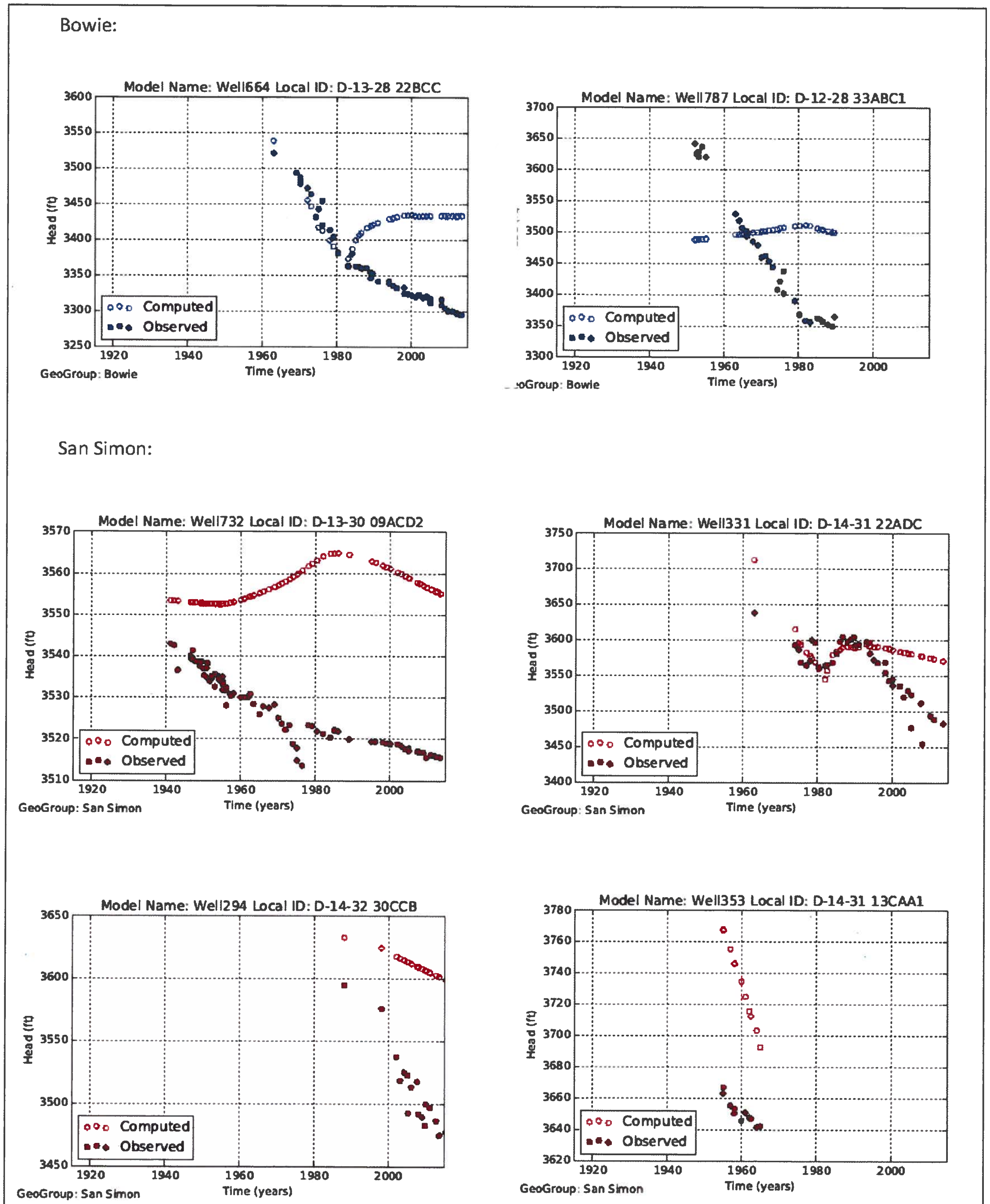

Figure 3

Representative well Hydrographs with ADWR Model Predictions Bowie and San Simon Pumping Irrigation Areas

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There are 25 wells in the San Simon pumping center with more than 10 water level measurements. This area shows the most variability between actual water levels and modeled water levels. Six of the wells have declining or steady water levels; however, the model predicts rising water levels in these wells. There are three wells that have some actual water level rise after 1980; however, the model overestimates the rise. There is a fourth well that does not have data before 1980. Regardless, the model under predicts drawdown in this well. The model also underestimates drawdown in one other well, but it overestimates drawdown in eight other wells. There are three wells where the model matches the observed drawdown reasonably well, but the actual water elevations are in error by 40 to 75 feet. Figure 3 includes four representative hydrographs for the San Simon pumping center.

There are nine wells in the South San Simon pumping center that have more than ten observations. Six of these wells show limited recovery between 1975 and 1985 and then continual decline after 1985. The model does not predict this recovery at any well. Furthermore, the model overestimates drawdown in eight of the nine wells. Figure 4 includes two representative hydrographs for the South San Simon pumping center.

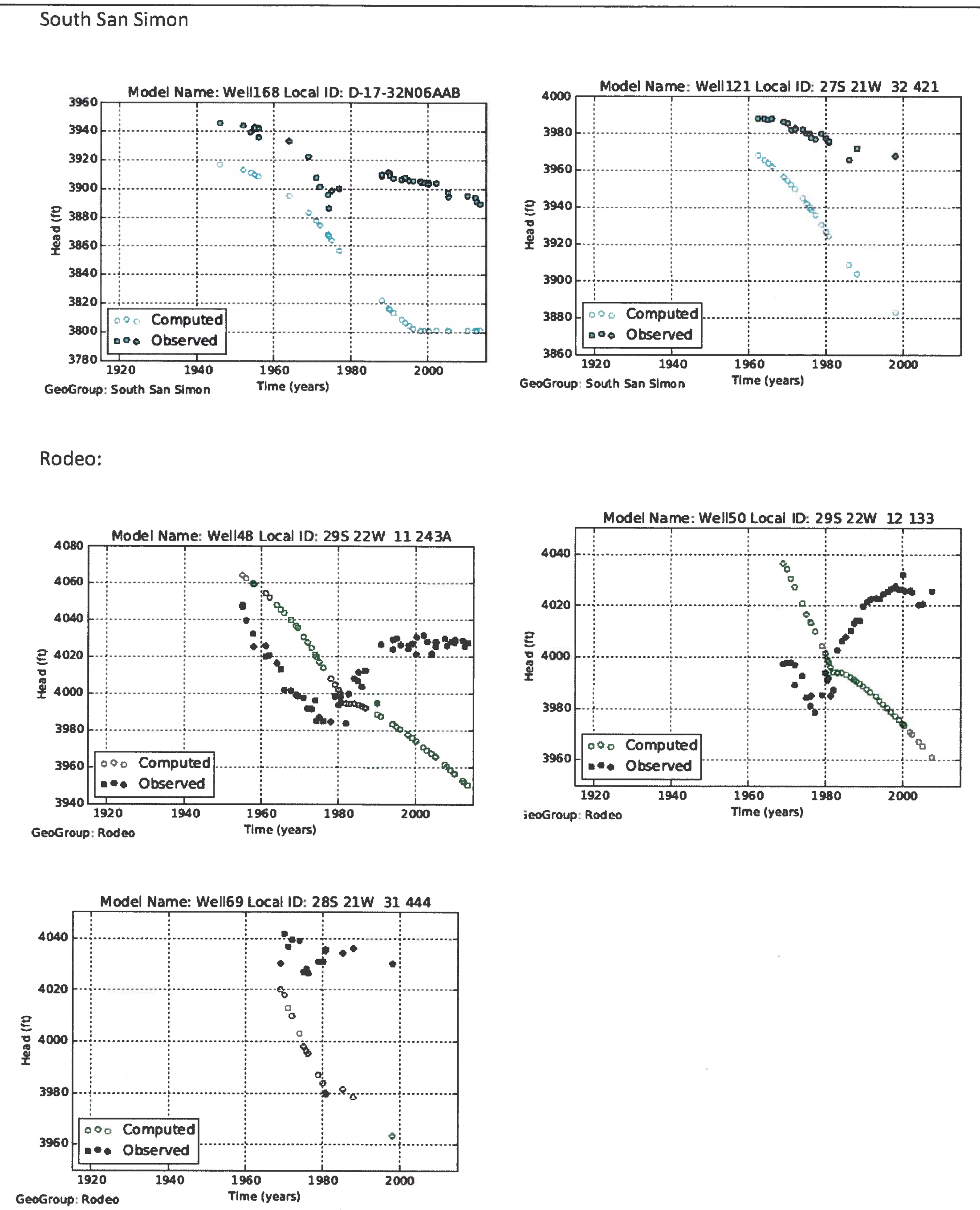

Figure 4

Representative well Hydrographs with ADWR Model Predictions South San Simon and Rodeo Pumping Irrigation Areas

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There are seven wells in the Rodeo pumping center with more than 10 observations. Four of them show some recovery starting prior to 1980 and continuing to the present. One well does not recover; rather, it shows a decrease in the rate of drawdown over the same time period. The model predicts a decrease in the rate of drawdown in these four wells, but not until approximately 1980. The model does not predict the recovery observed in the four wells nor does it predict any change in the rate of drawdown in the well that shows a decrease in the rate of drawdown, but not recovery. For the sixth well, the model matches the observed water level data. For the seventh well, the observations are so very scattered that it is not possible to compare the observations and the model simulation. In summary, the model significantly overestimates total drawdown from beginning to end in five of the seven wells. Figure 4 shows three representative hydrographs for the Rodeo pumping center.

11 BECAUSE THE MODEL HAS POOR MODEL CALIBRATION STATISTICS IT IS UNRELIABLE

Because the model under estimates historical drawdown, we evaluated the model calibration. Our first step was to filter the ADWR Final Water Level Data for the San Simon Valley Sub-Basin Excel spreadsheet by doing the following:

1. Observations with no water level elevation data were discarded.
2. Model layers were assigned by examining the well depth reported final GWSI water level dataset provided by ADWR. For wells that did not have a well depth reported, we assigned a layer based on the Visual MODFLOW files provided by ADWR or, if the water level was below the bottom of model Layer 1, we placed the well in model Layer 2.

For the purposes of the calibration analysis, each of the wells was assigned to the nearest of the four irrigation pumping centers (Bowie, San Simon, San Simon South, and Rodeo) as shown on Figure 5.

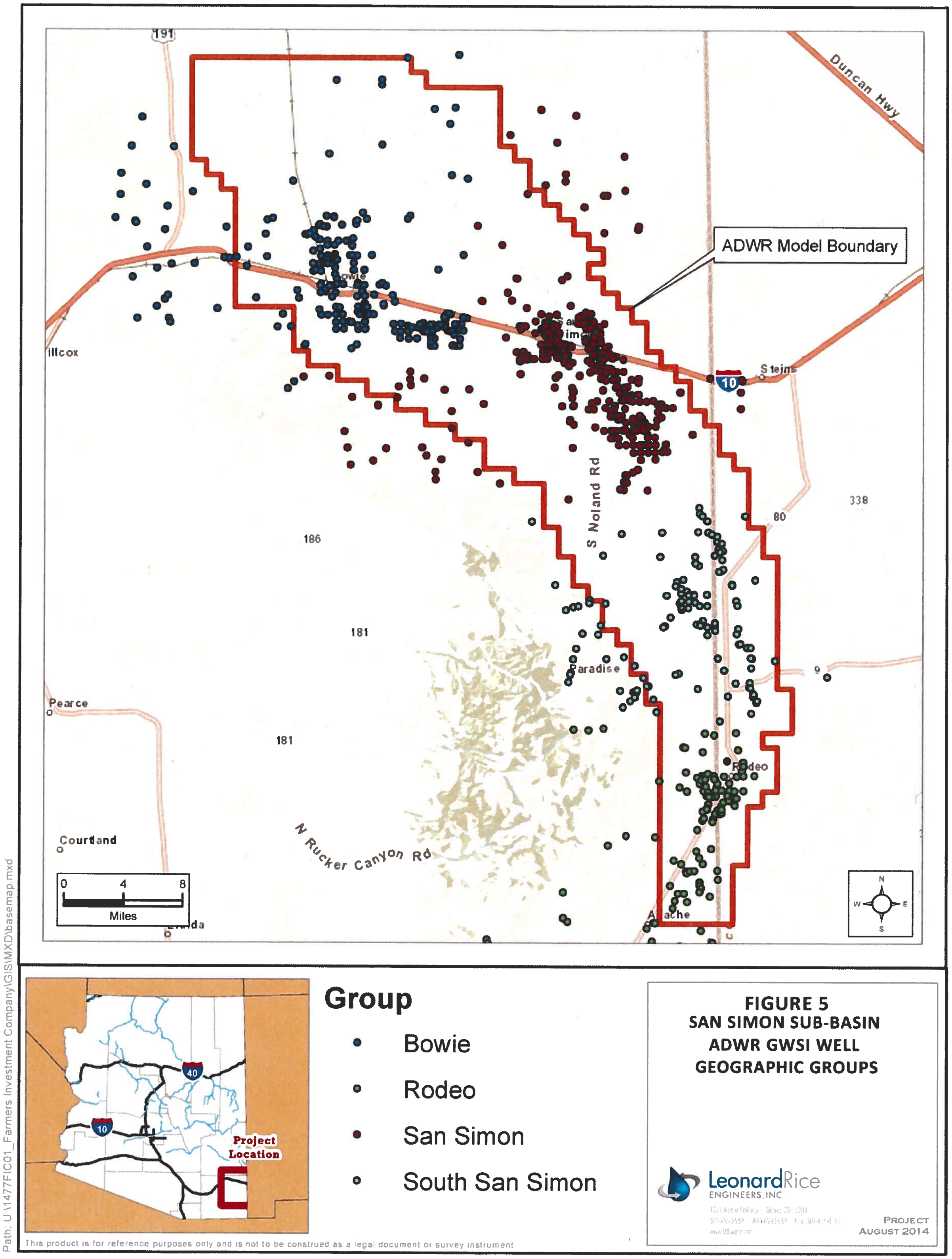

FIGURE 5
SAN SIMON SUB-BASIN
ADWR GWSI WELL
GEOGRAPHIC GROUPS

We then used the data selected above to evaluate the calibration of the model in terms of typical calibration statistics that are commonly used to evaluate groundwater flow models. Table 3 presents the Mean Residual, Root Mean Squared Error (RMSE), Normalized RMSE, and the correlation coefficient between the simulated and observed values. The RMSE is approximately twice as large as it should be. The normalized RMSE for this model (5.8%) is larger than what is acceptable for the relatively flat two aquifer system present in the San Simon Valley Sub-Basin. Additionally, the correlation coefficient of 0.76 is relatively low for this type of setting. These statistics confirm that the model is insufficiently calibrated and that it predictions are unreliable.

Table 3: ADWR Model Calibration for Final Observation Dataset

Calibration Statistic	Value and Units
Mean Residual	7.1 ft
Root Mean Square Error (RMSE)	80.7 ft
Normalized RMSE	5.8%
Correlation Coefficient between Observed and Simulated Values (r^2)	0.76

12 COMPARISON OF ALL OBSERVED WATER ELEVATION DATA AND MODEL PREDICTIONS SHOWS THAT THE MODEL IS UNRELIABLE

The lack of sufficient model calibration is shown on Figure 5 which is a scatterplot that compares all observed and model simulated Layer 2 groundwater elevation values in the sub-basin. As explained above, each data point was assigned to the nearest of the four irrigation pumping centers in the sub-basin. Figure 6 includes the ideal 1:1 correlation line between the observed and simulated groundwater elevation points. Also presented on Figure 6, are lines representing ±100 ft from the ideal 1:1 correlation line.

As shown on Figure 6, the water elevations in the Rodeo and South San Simon areas are generally below the ideal 1:1 correlation line and that numerous points for these areas are in excess of 200 feet below the ideal line indicating that the actually observed head is generally higher than the simulated head. This figure also shows that numerous points plot more than 100 feet above and below the ideal line for the Bowie pumping area. The wide scatter of the data away from the ideal correlation line further demonstrates that the model is insufficiently calibrated; therefore, its predictions are unreliable.

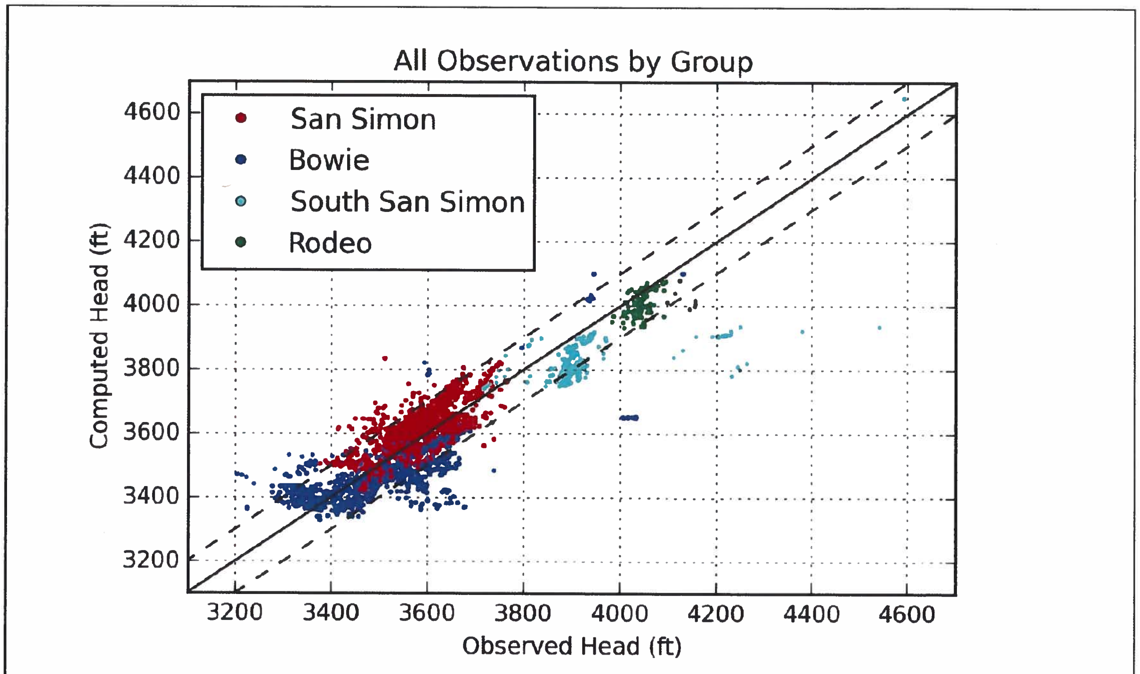

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Figure 6

Scatter Plot Showing all Observed and Simulated Water Levels at Each Monitored Well

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13 THE MODEL DOES NOT PROPERLY PREDICT THE FUTURE WATER LEVEL IN WELLS

The model does not account for other factors that are necessary to predict both future pumping water levels and groundwater lifting costs. These factors are:

- Well partial aquifer penetration
- Seasonal pumping
- Cell-to-well drawdown
- Well inefficiency

Since none of the wells are completed to the bottom of the aquifer, this partial aquifer penetration impacts the ability of the model to simulate the water elevations of the lower aquifer. The bottom of model Layer 2 (lower aquifer) corresponds to the estimated depth-to-bedrock in the basin, or -3,000 ft (3,000 ft below sea level), whichever is shallower. Most of the irrigation wells (>95%) have depths shallower than 1,000 ft below the land surface, which means that they are screened across only a portion of the total thickness of model Layer 2. So, the wells are penetrating only a small fraction of the total aquifer thickness. The partial aquifer penetration effect is so severe that it may be necessary to split Layer 2 into at least two additional layers to more properly simulate this effect. In the current model, wells in Layer 2 are able to access the entire transmissivity and storage in Layer 2, which is unrealistic and likely explains why the model under-estimates past and future drawdown rate.

It is common for irrigation wells to pump on an intermittent and/or seasonal basis. During seasonal irrigation pumping or periods of high pumping within an irrigation season the water level in a pumping well is deeper than the average annual water level simulated by the model. This means that actual seasonal lifting costs would be greater than those based upon the model predicted average annual water level. Assuming that well specific capacity is linear; a well pumping 9 months out of the year could experience a drawdown during pumping that is 1.33 times greater than simulated by the model.

The MODFLOW computer code that ADWR used to create the model simulates the average water level in each model cell. It does not simulate the water level in each well in the cell. There are several methods available to estimate the deeper pumping water levels in the actual well; however, ADWR did not make this correction.

During pumping, the water level in the well is deeper than the water level in the aquifer adjacent to the well due to resistance across the well screen and disturbed zone around the well and other effects. The resistance results in a 20-30 percent deeper pumping level in the well. ADWR did not make the well inefficiency correction.

The cumulative effect of not considering seasonal/intermittent pumping, aquifer partial penetration, cell-to-well drawdown correction, and well inefficiency is that pumping wells located within the main pumping centers would likely have 50 or more feet of drawdown in addition to that predicted by a properly calibrated model. Because the model is both not properly calibrated and does not properly simulate the above discussed factors, it predicts unrealistically shallow future pumping water levels in wells and it is therefore, unreliable.

14 THE USGS ESTIMATE OF CURRENT PUMPING IN THE SAN SIMON SUB-BASIN IS UNRELIABLE

The USGS provided to us its crop acreage data, estimate of crop distribution, estimate of crop irrigation water requirement, and corresponding pumping requirement for the San Simon Sub-basin for the period 2007-2104. The USGS only supplied detailed information on its calculation of the irrigation water requirement and calculation of irrigation well pumping for 2014. We reviewed all of this data and conclude that the USGS pumping 2007-2014 estimates are unreliable for the following reasons:

1. the USGS consumptive use analysis for the San Simon Sub-Basin used the wrong crop coefficient for pistachio and pecan orchards,
2. the USGS misrepresented the distribution of acreage between mature pecan and young pecan,
3. the USGS irrigation crop requirements are in error because regional precipitation data were used, and
4. the USGS estimated pumping is in error because incorrect irrigation efficiencies were used.

To evaluate the USGS estimates of irrigated acres and corresponding pumping, we completed a historical consumptive use analysis of agricultural irrigation in the San Simon Sub-Basin for the period 2007-2014. Table 4 and Figure 7 compare the USGS estimates to our irrigated area and pumping estimates. Table 4 shows that the two estimates of irrigated acres are nearly the same between 2007 and 2014. Table 4 and Figure 7 also show that between 2007 and 2010 the two estimates of irrigation groundwater pumping are similar. However, the difference in the two estimates of irrigation groundwater pumping has been increasing annually, so that in 2014, our current estimate (78,000 ac-ft/yr) is more than 1.7 times greater than the USGS current estimate (44,000 ac-ft/yr). This means that the model is even less reliable than explained above because it includes too little groundwater pumping from the lower aquifer and therefore it predicts a future depth to groundwater that is too high.

Table 4: Comparison of USGS and LRE Estimates of Irrigation Groundwater Pumping in the San Simon Sub-basin

Year	USGS Irrigated Acres	USGS Consumptive Use (1000 X AF)	USGS AG Pumping (1000 X AF)	LRE Irrigated Acres	LRE Consumptive Use (1000 X AF)	LRE Ag Pumping (1000 X AF)
2007	12,426	37	51	12,425	37	54
2008	12,424	39	49	12,424	37	52
2009	13,075	37	46	13,094	36	47
2010	13,075	39	49	13,095	41	54
2011	14,705	41	50	14,705	53	74
2012	14,704	42	48	14,704	55	74
2013	17,686	42	51	17,686	57	77
2014	20500*	37**	44	18,207	58	78

* From the USGS data, it appears that this value contains acreage that is not being currently irrigated. The summation of currently irrigated lands was found to be 18,207 acres.

** CU estimated from the USGS_SSI_crops_10_2014_corrected table.

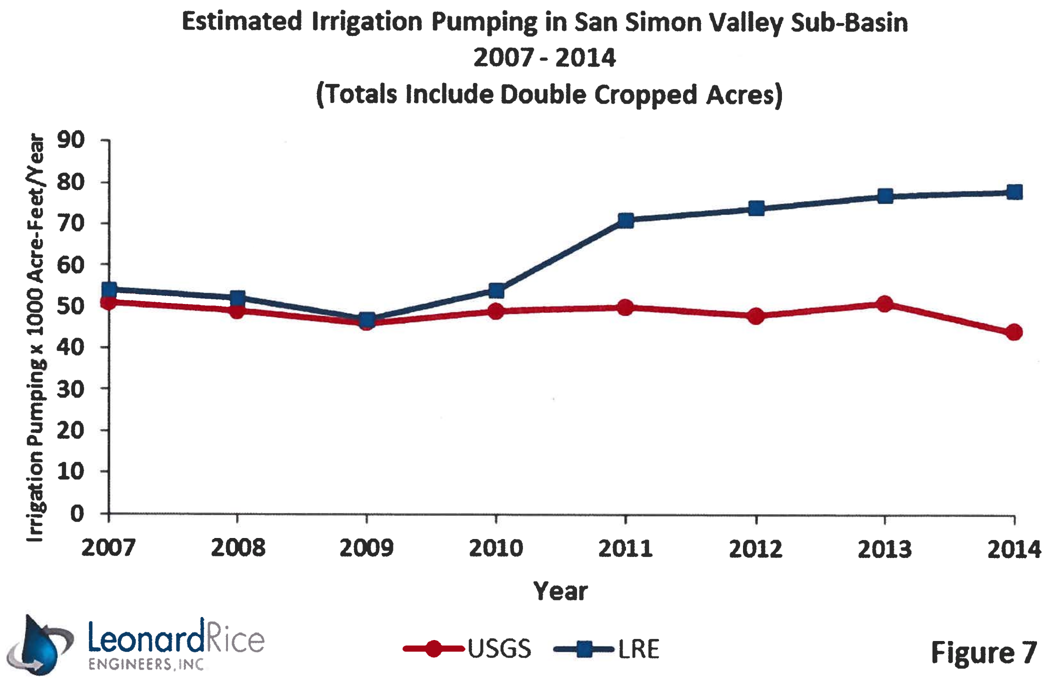

Figure 7

The USGS consumptive use analysis utilized the TR-21 crop growth stage coefficient for orchard crops for all pecan and pistachio orchards. Research conducted by New Mexico State University, University of Georgia, and University of California found that pecans are very inefficient users of water and they require large amounts of water to support optimal growth. Whereas the TR-21 crop growth stage coefficient for orchard crops suggest that orchards need approximately 45 inches of water per year, the research found that pecans have a water requirement (potential evapotranspiration – PET) of approximately 60 inches per year. The research for pistachios supports a similar PET as pecans. For the purpose of our analysis, a 60 inch per year crop growth stage coefficient was developed and applied to all pecan and pistachio orchards.

From our review of the USGS consumptive use analysis, we conclude that the methodology for calculating pumping requirements for pecan and pistachio orchards varies significantly between 2007 and 2014. The USGS calculations of pumping in 2007 and 2008 assumed that of the 3,317 acres of orchard irrigated (pecans and pistachios were not broken out); 1,062 acres were drip irrigated with a 100% efficient system. In 2009, the USGS calculations of pumping for drip irrigation of orchards assumed an efficiency of 90%. Starting in 2011, for drip irrigated orchards; the USGS assumed that only 60% of the pumping requirement is withdrawn. This pattern of withdrawing only 60% of the pumping requirement for all drip irrigated orchards continued through 2014. We do not agree with the USGS approach of reducing the pumping withdrawal for all orchards drip irrigated. In 2013 the USGS identified 7,131 acres of pecan orchard and 2,546 acres of "young" pecans, and if assumed that the young pecans irrigation water requirement was half of that of a full orchard. Then in 2014, the USGS identified 7,468 acres of young pecans and only 2,757 acres of mature pecans. While we agree with the USGS approach that new pecan orchards, less than eight years old, consume approximately half of the irrigation water requirement of a mature orchard, we do not agree with the decrease in mature pecan orchard from 7,131 acres in 2013 to 2,757 acres in 2014.

Based on the discrepancies within the USGS acreage, LRE developed Table 5 which compares the USGS acreage for pecan and pistachio orchards and our interpretation of irrigated acreage and irrigation method. In 2007, the USGS identified 3,316 acres of orchards; there was no distinguishing between pecans and pistachios. Pecans and pistachios are not separated until 2011. Review of aerial photographs shows that pistachios have been established for more than 10 years. Based on literature review, our opinion is that pecan and pistachio established for 8 years or more require a full irrigation water requirement. For mature pistachio orchards we filled the years of 2007 through 2010 with the same total acreage identified by USGS in 2011 and then subtracted out that acreage from the original orchard numbers (column labeled Mature Pecan). This resulted in lower estimates for mature pecan orchards then utilized by USGS. Our opinion is that the total number of mature orchard identified by USGS in 2007 (3,316 acres) continued through 2014, and that any difference between total orchard acreage and mature orchard acreage was young pecans.

Our review of the USGS consumptive use analysis shows that the regional PRISM data was utilized to estimate 2014 annual precipitation. In our opinion, the PRISM data is not site specific. In contrast, our analysis relied on climate data obtained from the Arizona Meteorological Network (AZMET) and the Western Regional Climate Center (WRCC) for site specific data for the Town of San Simon. The WRCC data has missing days within the period of our analysis; therefore, we used AZMET for 2012 through 2014. From these data we conclude that the 2014 total annual precipitation was 9.76 inches. The USGS regional PRISM data assumed a 2014 annual precipitation of 13.64 inches. Therefore, the USGS over estimation of precipitation resulted in erroneously low estimates of both crop irrigation water requirement and irrigation pumping.

Table 5: Comparison of USGS and LRE Acreage. Crops and Irrigation Systems of the San Simon Sub-basin

USGS

	Mature Pecan				Young Pecan				Total	Mature Pistachio				Total	Total	Total
Year	Drip	Sprinkler	Flood	Total	Drip	Sprinkler	Flood	Total	Pecan	Drip	Sprinkler	Flood	Total	Mature	Young	Orchard
2007		1007	2309	3316					3316					3316		3316
2008		1007	2309	3316					3316					3316		3316
2009	1234	2129	829	4192					4192					4192		4192
2010	1234	2129	829	4192					4192					4192		4192
2011	3387	1963	788	6138					6138	1062	89		1151	7289		7289
2012	3387	1963	788	6138					6138	1062	89		1151	7289		7289
2013	4347	1998	786	7131	762	1784		2546	9677	1120	89		1209	8340	2546	10886
2014	145	1877	735	2757	5781	1675	11	7468	10225	1062	89		1151	3907	7468	11375

LRE

	Mature Pecan				Young Pecan				Total	Mature Pistachio				Total	Total	Total
Year	Drip	Sprinkler	Flood	Total	Drip	Sprinkler	Flood	Total	Pecan	Drip	Sprinkler	Flood	Total	Mature	Young	Orchard
2007		918	1247	2165					2165		89	1062	1151	3316		3316
2008		918	1247	2165					2165		89	1062	1151	3316		3316
2009	172	1164	829	2165		876		876	3041	1062	89		1151	3316	876	4192
2010	172	1164	829	2165		876		876	3041	1062	89		1151	3316	876	4192
2011	213	1164	788	2165	3174	799		3973	6138	1062	89		1151	3316	3973	7289
2012	213	1164	788	2165	3174	799		3973	6138	1062	89		1151	3316	3973	7289
2013	215	1106	786	2107	4894	2676		7570	9677	1120	89		1209	3316	7570	10886
2014	383	1048	735	2166	5543	2504	11	8059	10225	1062	89		1151	3316	8059	11375

To convert annual irrigation water requirement to estimated annual irrigation pumping volume, the USGS assumed the following irrigation efficiencies in 2014: 90% for drip irrigation, 80% for sprinkler irrigation, and 75% for flood irrigation. Prior to 2014, the USGS assumed 70% irrigation efficiency for flood irrigation. In our opinion, these irrigation efficiencies are too high because they do not consider the management element or system factors of the complete irrigation practice. The Farm Irrigation Rating Index (FIRI), also known as the FIRI method, provides a relative rating system to consistently relate the effectiveness of irrigation practices from one farm to another. The FIRI method was developed by the USDA, Natural Resources Conservation Service (NRCS) to estimate differences between the gross volume of farm delivery and the net consumed by the crops.

The FIRI method starts with the potential efficiency for an optimally performing unit, then makes adjustments to the overall irrigation efficiency based on management and system factors. The FIRI method management factors that influence the overall irrigation efficiency include implementation of water management plans specific to on-site conditions, measurement of water delivery to each field for each irrigation set or run, soil moisture monitoring and scheduling, experienced operators, excellent maintenance, demand based water delivery, and conservation tillage to improve soil conditions. The FIRI method system factors that influence the overall irrigation efficiency include water distribution control, climate, sprinkler design, wind, and emitter clogging.

In 2014, the USGS irrigation efficiency for flood irrigation was increased from 70% to 75%. Factors that can increase efficiency of flood and furrow irrigation include the presence of finer textured soils, on-farm improvements including construction of concrete lined irrigation ditches and high flow irrigation turnouts, and the use of precision laser leveling and press wheel (Yuma County Agriculture Water Coalition, 2015). We are not aware of major improvements or changes to the fields flood irrigated that would result in an increase from 70% to 75% irrigation efficiency. It is our opinion that optimal performance for flood irrigation in the San Simon Sub-Basin is no more than 70%.

The irrigation efficiencies used by the USGS are representative of optimally performing irrigation systems. It is our opinion that the actual irrigation efficiencies for the San Simon Sub-Basin are less because of the impact of management and system factors. Assuming mid to upper range ratings for water management and system factors for irrigation throughout the San Simon Sub-basin, we estimate the following irrigation efficiencies using the FIRI method: flood irrigation efficiency drops from 70% to 51.5%, sprinkler irrigation efficiency drops from 80% to approximately 54%, and drip irrigation efficiency drops from 90% to 59%. We understand that, many of the orchards are well managed; however, other farms may not be. Therefore, for our pumping estimate, we have assumed an average drip irrigation system efficiency of 74.25%, sprinkler irrigation system efficiency of 67.1%, and flood irrigation system efficiency of 55% for the San Simon Sub-basin.

15 UPDATED ECONOMIC ANALYSIS SHOWS THAT IRRIGATED AGRICULTURE IN THE SAN SIMON SUB-BASIN WILL BECOME UNECONOMIC IN APPROXIMATELY FORTY YEARS.

Our July economic analysis was based upon a forecast of future depth to water derived from the model. As we have shown, the model underestimates depth to water so it is not reliable; therefore, we have updated our analysis using a decline rate of 2.0 feet per year. Coupling the decline and correcting the unreliably low estimate of a current irrigation pumping, we conclude that the irrigated agriculture in the San Simon Sub-basin will become uneconomic in as little as 30 to 40 years rather than the 50 to 60 years presented in our July report.

Our economic analysis only considers the increasing cost of water; however, there are other significant costs associated with declining water levels. Those include the need to periodically install higher horsepower pumps, replace the wells with larger diameter casings to accommodate the larger diameter electrical cables required for the higher horsepower pumps. The cost to install a pump is in the range of $50,000 to $150,000 and it may be necessary every 5-10 years. The cost to replace a well could be $400,000 to $750,000. These periodic expenses will negatively affect profitability. So, if these costs were considered, the economic life of irrigated agriculture may well be less than 40 years. Therefore, our update economic analysis is a conservative.

EXHIBIT 2

AFFIDAVIT OF DAVID P. ANDERSON

RECEIVED
SEP 25 2015
LEGAL
DEPT OF WATER RESOURCES

STATE OF TEXAS)
) ss
County of Brazos)

David P. Anderson, being first duly sworn, upon his oath deposes and says:

1. I am a Professor and Extension Economist at Texas A&M AgriLife Extension Service. Over my career I have been involved in analyzing the economics of production agriculture, technology adoption, impact of agricultural policies on farmers and ranchers, and the economics of livestock production. I have been at Texas A&M since 1996. I have authored or co-authored more 600 articles in outlets from academic refereed journals to popular press articles. A copy of my current curriculum vitae is attached hereto as Attachment 1.

2. This affidavit contains my opinions regarding the economic components of the two reports produced by Leonard Rice Engineers, Inc. ("Leonard Rice Reports") in support of the July 17, 2015 comments and the September 25, 2015 Motion for Reconsideration or Review submitted Farmers Investment Co. in this matter.

3. Pecan orchard development requires a number of years of cost outlays with little to no revenues while the trees mature. Orchard development costs are recouped once the trees reach mature, peak crop bearing age.

4. While costs and returns can vary from year to year, costs and returns over a long term, multiple decade investment like a pecan orchard makes it standard in the industry to portray returns as a long term average cost and revenue over those costs. In this case, the pecan investment over multiple decades has been characterized as having a 5 to 15 percent profit, or returns over costs.

5. More complex analyses can be implemented that incorporate variable costs and prices over time, price and cost risk, yield risk, and the development of a probability

distribution of potential financial outcomes. However, summarizing that information into an average return over time is a standard industry practice to summarize the expected rate of return.

6. Farm manager skill and different levels of land productivity and technology employed can result in different rates of returns across farms. The type of crop may also generate different rates of return over costs. The analysis used a range of 5 to 15 percent return over expenses to capture these differences.

7. In 2007, the United Sates Department of Agriculture, Economic Research Service, published a summary of financial performance in agriculture ("USDA ERS"). Across all of agriculture, by size and structure of farms, it was found that "operating profit margin" ranged from 10.8-18.3 percent for large and very large family farms. But, for all farms the average operating profit margin is 3 percent.

8. The rates of return, or profit, used in the Leonard Rice Reports are consistent with the USDA ERS report of operating profit measures across agriculture in the United States.

9. Pecans are a long term project with significant orchard development costs. The University of California Extension Service published pecan orchard development costs ("Freeman"). They report the 5 year cumulative costs of establishment at $8,077 per acre. These development costs have to be recovered after the crop matures when the trees are at peak productivity. It is important to note that differing irrigation technology, yields, and land costs in Arizona may result in higher orchard establishment costs. Accordingly, this $8077 per acre cost does not include such things as full land costs, well establishment and maintenance, or the installation and employment of sprinkler systems (such as those utilized by FICO), all of which would cause this number to increase.

10. Far West Texas pecan cost of production budgets published by the Texas A&M AgriLife Extension Service report annual costs of $1,372.32 per acre. Evidence from California pecan budgets indicates much higher production costs, up to $2,400 per

acre. Different irrigation technology, capital costs, and land costs, such as those referenced in Paragraph 9 above, likely make Arizona production costs higher than West Texas pecan production costs.

11. Using development costs and mature crop production costs and returns over a 30 year orchard production horizon indicated an annual average long term return over costs of 12.8 percent. This estimate is in line with the range of returns over costs used in the Leonard Rice Reports.

12. Pecans are a long term project with significant development costs before harvestable and saleable pecans are harvested. The crop is planted with the expectation of future returns, and to produce a sufficient yield adequate water must be used for the mature crop.

13. The short term economic threshold for continuing operation is where output price is greater than or equal to the variable cost of producing that unit of output (or pound of pecans). When price falls below that variable production cost the rational economic decision is to not produce, or to exit the business. Long term, if all costs are not recovered then the business will not continue. In the case of pecans, if water costs and total costs increase enough then the costs of orchard establishment cannot be recovered, and replacement of old trees past their productive economic threshold life will not be replaced, ending the orchard. There is an economic optimum threshold for production and it is well before the water "runs out." Production will no longer be economically sustainable or viable long before the aquifer runs dry. This is the economic rationale for considering economics in resource management decisions.

14. Based on my experience and my review of relevant information, the long term infeasibility of production is consistent with the economic analysis presented in the Leonard Rice Reports.

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DAVID P. ANDERSON

SUBSCRIBED AND SWORN TO before me by David P. Anderson this 25 day of September, 2015.

Notary Public

My Commission Expires:
Feb 4, 2018

CONNIE J.S. SMOTEK
MY COMMISSION EXPIRES
February 4, 2018

ATTACHMENT 1

CURRICULUM VITAE

Dr. David P. Anderson
Professor and Extension Economist
Livestock and Food Products Marketing

Department of Agricultural Economics
Marketing/Farm Management Project Group

Texas A&M AgriLife Extension Service
Texas A&M University

September 25, 2015

CURRICULUM VITAE

Texas A&M AgriLife Extension Service
Texas A&M University System

PERSONAL INFORMATION

Name: David P. Anderson
Title: Professor and Extension Economist-Livestock and Food Products Marketing
Department: Agricultural Economics
Program Unit: 755
Date: January 30, 2013
Date of Appointment/Last Promotion: September, 2008

EDUCATION

- **Ph.D.** Agricultural Economics, Texas A&M University, College Station, TX, December 1994.
  Major area: Agricultural Economics with specializations in Production Economics and Agricultural Policy.
  Dissertation: "An Econometric Model of the U.S. Sheep and Mohair Industries for Policy Analysis.".
  Major Professor: James W. Richardson

- **M.S.** Agricultural Economics, The University of Arizona, Tucson, AZ, May 1990.
  Major area: Agricultural Economics.
  Thesis: "The Adoption and Diffusion of Strategic Investments: The Case of Land Leveling in Central Arizona."
  Major Professor: Paul N. Wilson

B.S. Agricultural Economics, graduated with distinction, The University of Arizona, Tucson, AZ, May 1987.

EXPERIENCE

Current Position: Professor and Extension Specialist, Livestock and Food Products Marketing

Current Appointment: 100% Extension

Dates: September 1, 2008 - Present

November 2004 to Present - **Livestock and Food Products Marketing Economist (100%),** Texas A&M AgriLife Extension Service.

PAST EXPERIENCE

November 2004 to September 2008 - **Associate Professor and State Specialist Livestock and Food Products Marketing,** Texas AgriLife Extension Service.

September 2002 to October 31, 2004 - **Associate Professor and State Specialist Crop Economics (60%) and Extension Economist for District 9 (Southeast Texas, 40%),** Texas AgriLife Extension Service.

January 1999 to September, 2002 - **Assistant Professor and State Specialist Crop Economics (60%) and Extension Economist for District 9 (Southeast Texas, 40%),** Texas AgriLife Extension Service.

Presentations

International

December 9, 2014	College Station, TX	Presentation on the U.S. Livestock Marketing System and Extension Livestock Programs for visitors from China.
September 14, 2011	College Station, TX	Presentation on the LMIC at the Manitoba Livestock Statistics Users Meeting. (30 minutes, 50 attending, presentation made by webinar technology).
May 7, 2010	Red Deer, Alberta	Presentation on the Future of the Meat Industry at the Alberta Agricultural Economics Association annual meeting. (40 minutes and 50 attending).
December 19-20, 2009	Beijing, China	Presentation on the Evolution of the U.S. Livestock Industry Over the Last 40 Years.
December 19, 2009	Beijing, China	Seminar for the Faculty of the China Agricultural University on Biotechnology and the Economy.
March 5, 2009	El Paso, TX	Presentation on The Development of Animal Identification Systems in the U.S. at a workshop on developing market information institutions in Mexico. (30 minutes and 25 attending).
March 4, 2009	El Paso, TX	Presentation on Data Gathering and Dissemination by US Institutions at a workshop on developing market information institutions in Mexico. (30 minutes and 25 attending).
February 6, 2009	Chihuahua, MX	Presentation on Analysis Y Difusion de la Informacion de los Mercados del Ganado at the Foro Internacional Trazabilidad, Inocuidad E Informacion de Mercados Y Estadistica en Bovinos Carne.
August 26-29, 2008	Mexico City, MX	Presentations on U.S. Livestock and Dairy Markets for SAGARPA and University Economists. (25 attending).

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McCorkle, D.A., M. McFarland, D.D. Hanselka, S.L. Klose, and **D.P. Anderson**. *Economic Impact Brief: Managing Nitrogen Cost and Protecting Water Resources*, MKT-3558AM, Texas AgriLife Extension Service, The Texas A&M University System, College Station, Texas, January 2011.

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