

DRAFT Technical Memorandum

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Project: Edwards Aquifer Habitat Conservation Program

To: Nathan Pence, Program Manager

From: Larry Land, P.E. and Sam Vaughn, P.E.

Subject: Increasing VISPO Enrollments while Reducing ASR Leases for Equivalent Springflow Protection at Comal Springs

Introduction

The approved Edwards Aquifer Habitat Conservation Plan (EAHCP)¹ includes four flow protection measures to ensure at least minimum discharges from Comal and San Marcos Springs for protection of selected endangered and threatened species. These flow protection measures are identified as Voluntary Irrigation Suspension Program Option (VISPO), Regional Water Conservation Program, SAWS ASR Trade-Off, and Emergency Stage V Critical Period Management Reductions. Technical evaluation of these flow protection measures is summarized in a report prepared by HDR Engineering, Inc. (HDR), Todd Groundwater, and Westward Environmental² included as Appendix K in the EAHCP.

As authorized by the EAHCP Implementing Committee, HDR has conducted a modeling study to assess the efficacy of increasing VISPO enrollments and reducing ASR leases, while meeting approved springflow minima. In other words, if VISPO enrollments are increased by a given amount, how much can the ASR leases be reduced and still achieve the same minimum springflow protection criteria established in the EAHCP. This Technical Memorandum documents the approach and findings of the modeling study.

Approach

This modeling study utilized the USGS MODFLOW model that was developed and documented by the U. S. Geological Survey (USGS)³ and modified by HydroGeoLogic⁴ to include a management module. This model calculates water levels, springflows, and water budgets for scenarios, and its results were used to establish the flow protection measures in the EAHCP.

¹ RECON Environmental, Inc., Hicks & Company, Zara Environmental LLC, and BIO-WEST, "Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan," Edwards Aquifer Recovery Implementation Program, November 2012.

² HDR Engineering, Inc., Todd Engineers, and Westward Environmental, Inc., "Evaluation of Water Management Programs and Alternatives for Springflow Protection of Endangered Species at Comal and San Marcos Springs," Edwards Aquifer Recovery Implementation Program, October 2011 (EAHCP Appendix K).

³ Lindgren, R.J., Dutton, A.R., Hovorka, S.D., Worthington, S.R.H., and Painter, S., "Conceptualization and Simulation of the Edwards Aquifer, San Antonio Region, Texas," U.S. Geological Survey Scientific Investigations Report 2004-5277, 2004.

⁴ HydroGeoLogic, Inc., "Reference Manual for the Groundwater Management Package for MODFLOW-2000, Edwards Aquifer Authority, November 2004.

The modeling study steps and assumptions include:

1. Recover the MODFLOW model that was used in the Edwards Aquifer Recovery Implementation Program (EARIP) from project archives and conduct a verification/replication simulation.
2. Update the geographic distribution of VISPO enrollments in the model at the county level in accordance with the October 7, 2014 Final VISPO enrollment of 40,951 acre-feet per year (acft/yr).⁵ Revise the distribution ASR leases to be applied across all irrigation wells instead of all wells. The leases are fixed to 16,667 acft/yr for each tier.
3. Conduct Bottom-Up Program simulation (all four layers) with updated VISPO enrollment distributions at 40,951 acft/yr. The resulting minimum Comal Springs discharge is the Baseline for this modeling study.
4. Use the same ASR injection and recovery schedule and rates as documented in the EARIP.
5. Conduct a series of trial and error model simulations with increased VISPO enrollments (up to a total of 60,000 acft/yr) and ASR lease reductions to be determined. ASR Tier 3 leases (up to 16,667 acft/yr) are reduced first followed, if necessary, by ASR Tier 2 lease reductions (up to 16,667 acft/yr). Continue the trial and error simulations until the minimum monthly springflow at Comal Springs is nearly the same as determined in the Baseline (Step 3) simulation with the October 7, 2014 VISPO enrollment. Simulations include all four layers of the EARIP/EAHCP Bottom-Up Program.
6. Prepare tables and charts to illustrate the effects of increased VISPO enrollments with concomitant ASR lease reductions while meeting the EAHCP minimum springflow objectives. Interpret the results to identify a generally applicable ratio of ASR lease reduction per VISPO enrollment increase.

Modeling Assumptions

VISPO Enrollments

The county distributions of are summarized in Table 1.

Table 1. Volume and Distribution of VISPO Enrollments by County (acft/yr).

County	EARIP (2011)	Enrolled (2014)
Atascosa	1,044	354
Bexar	8,520	2,457
Comal	435	0
Guadalupe	0	0
Hays	0	123
Medina	15,000	11,526
Uvalde	15,000	26,491
TOTAL	40,000	40,951

⁵ The temporal (monthly) distribution of VISPO enrollment and ASR lease pumpage reductions was refined for application across irrigation wells, rather than all wells. This refinement had no consequential effect (< 1 cfs) on simulated minimum Comal Springs discharge.

As shown in Table 1, the VISPO enrollments enrolled are greater and more concentrated in Uvalde County than projected in the EARIP and EAHCP. Figure 1 shows the years during which production under VISPO enrollments is suspended in the model simulation for the baseline scenario.

ASR Leases

In contrast to the VISPO enrollment component of the EAHCP, participation in the ASR lease component has been much less than expected. Despite ongoing drought since approval of the EAHCP, only Tier 1 of the ASR lease component has been triggered. Although Tier 1 has a lease objective of 16,667 acft/yr, only 6,203 acft/yr (37 %) in leases have been successfully obtained as of late 2014 and 1,413 acft/yr (23 %) of these are only one year in duration. As an insufficient volume of ASR leases has been obtained to clearly indicate geographic distribution modification, the distribution used in the EARIP is retained in this modeling study.

Simulations performed in the EARIP that formed the basis for the flow protection measures in the EAHCP included: (1) an initial storage of 80,000 acft in the SAWS ASR well field is assumed to be available, (2) supplemental ASR injections will be made with EAHCP ASR leases, and (3) episodic recovery and offset of SAWS Edwards production will be made during drought. Use of this initial storage available in the SAWS ASR well field made it possible to achieve springflow protection objectives in the drought of record with supplemental injection and storage only under Tier 1 leases (in combination with production forbearance under Tier 2 and 3 leases and episodic recovery of initial and Tier 1 storage). Pursuant to the Implementing Agreement and ASR leases obtained through 2014, only a very limited volume has been stored and is considered available for episodic recovery under the EAHCP. Nevertheless, for the purposes of this modeling study, assumptions from the EARIP regarding ASR storage and episodic injection and recovery are retained herein. Only the ASR lease volumes associated with Tiers 2 and 3 are reduced in proportion to potential increases in VISPO enrollments.

Activation of VISPO Enrollments and ASR Leases

Triggers to activate VISPO enrollments are internal within the groundwater model. More specifically, VISPO pumping reductions in a given year are triggered by a model-calculated J-17 water level below 635 ft-msl on October 1 of the previous year. If VISPO is not triggered, then the irrigation water rights are assumed to be pumped.

Activation of ASR leases, on the other hand, is triggered by moving averages of Edwards Aquifer recharge calculated by the USGS. Tier 1 is activated at all times and Tiers 2 and 3 are activated on the basis of 10-year moving averages below 572,000 acft/yr and 472,000 acft/yr, respectively.

Figure 1 shows a summary of when VISPO enrollments and ASR leases are activated during the model simulation period for baseline conditions. As shown, all of the enrollments and leases are activated from 1951 through 1958. The lowest modeled Comal Springs discharge occurred in August 1956.

Operation of ASR

For this modeling study, assumptions also include keeping the same schedule and rates for injection (pumping and storage of ASR leases) and for recovery (withdrawal from storage and off-set reduction of SAWS pumping) as used in the EARIP. Figure 2 illustrates the schedule and rates of ASR injection and recovery. Figure 3 shows the simulated volumes of water stored in SAWS ASR well field and available for springflow protection for the Baseline scenario.

Modeling Results

Verification of Model Recovery from Archives

Recovery and verification of the Edwards Aquifer model simulations of the Bottom-Up Program from the EARIP were successful. This assessment is based on simulation of essentially identical minimum flows from Comal Springs during the EARIP and in 2015 without updates to the model.

Model Updates

Model updates and minor refinements include: (1) simulating and geographically distributing VISPO enrollments on the basis of October 7, 2014 enrollment; (2) assigning VISPO enrollments and ASR leases only to irrigation wells instead of all wells; (3) adding an irrigation monthly signature to the pumping of VISPO enrollments and ASR leases; and (4) controlling Stage V with J-17 and J-27 instead of just J-17. These model updates and minor refinements caused the simulated minimum Comal springflow with the Bottom-Up Program (i.e. the Baseline for this modeling study) to be about 1 cfs greater than that in EARIP simulations (i.e. 28 cfs instead of 27 cfs).

Increasing VISPO Enrollments and Reducing ASR Leases for Equivalent Minimum Springflow

As described in Step 5 of the Approach, VISPO enrollments were increased in selected increments and ASR leases were iteratively decreased until the 28 cfs minimum Baseline springflow at Comal Springs was replicated. Figure 4 illustrates the modeling results for the test scenarios. As shown, results of these test scenarios are nearly identical at Comal Springs during the most intense part of the drought of record. Table 2 lists and Figure 5 illustrates the combinations of VISPO enrollments and ASR leases that produce a 28 cfs minimum discharge at Comal Springs. Table 3 lists and Figure 6 illustrates the incremental changes in VISPO enrollments and ASR leases by tiers. Results of this modeling study suggest that ASR leases can be reduced by about 950 acft/yr for every 1,000 acft/yr of increase in VISPO enrollments.

Table 2. VISPO Enrollments and ASR Leases with Equal Springflow Protection (acft/yr)

Scenario	VISPO	ASR Tier 1	ASR Tier 2	ASR Tiers 1+2	ASR Tier 3	ASR Tiers 1+2+3
2015 Update	40,951	16,667	16,667	33,333	16,667	50,000
VISPO=45K	45,000	16,667	16,667	33,333	12,481	45,814
VISPO=50K	50,000	16,667	16,667	33,333	8,005	41,338
VISPO=55K	55,000	16,667	16,667	33,333	3,294	36,628
VISPO=60K	60,000	16,667	15,435	32,101	0	32,101

Table 3. Incremental Changes in VISPO Enrollments and ASR Leases for Equivalent Springflow Protection (acft/yr)

Scenario	Increase	Decreases		
	VISPO	ASR Tier 1	ASR Tier 2	ASR Tier 3
VISPO=45K	4,049	0	0	4,186
VISPO=50K	9,049	0	0	8,662
VISPO=55K	14,049	0	0	13,372
VISPO=60K	19,049	0	1,232	16,667

As shown in Table 3 and Figure 6, there is nearly a 1:1 relationship between an increase in VISPO enrollments and a decrease in ASR leases. This is largely explained by the concurrent activation of all the enrollments and leases from 1951 through 1958 (see Figure 1) and similarities in where enrollments and leases are assumed to exist.

Conclusion

The groundwater modeling study shows that ASR leases could be decreased by about 95 percent of an increase in VISPO enrollments while maintaining an equivalent minimum discharge from Comal Springs of 28 cfs. Furthermore, VISPO enrollment increases would effectively reduce risks associated with ASR lease tier triggers based on moving average recharge and mitigate risks associated with loss of assumed initial storage in the SAWS ASR well field.

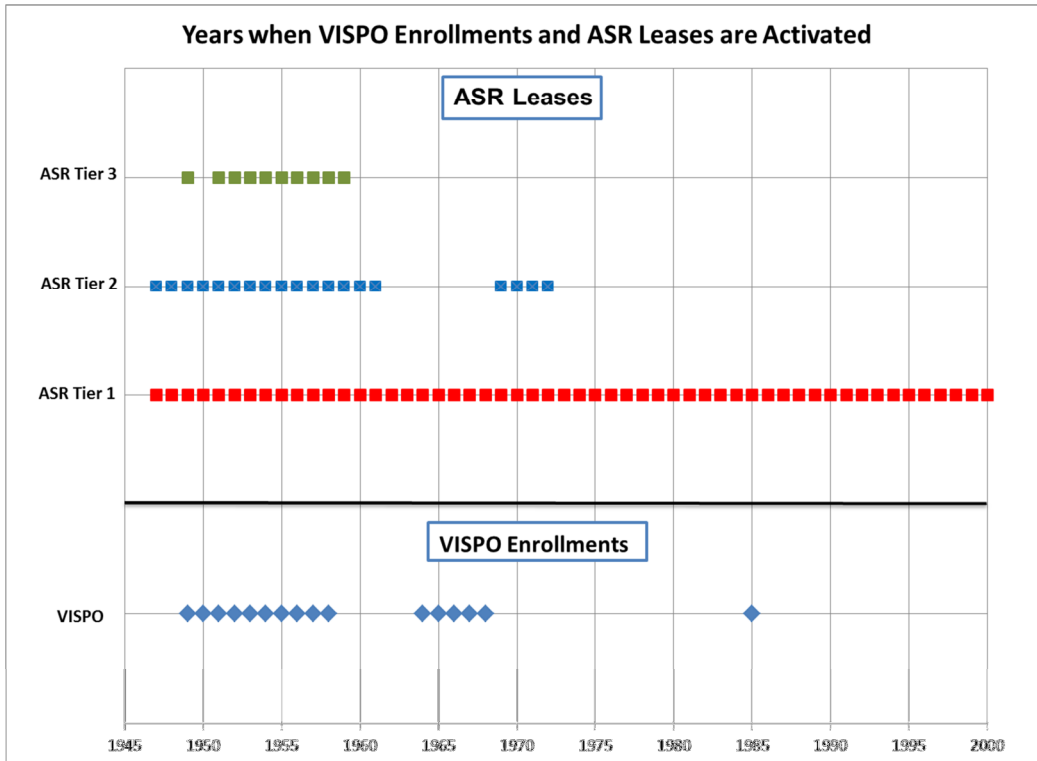


Figure 1. Years When VISPO Enrollments and ASR Leases are Activated for Baseline Scenario

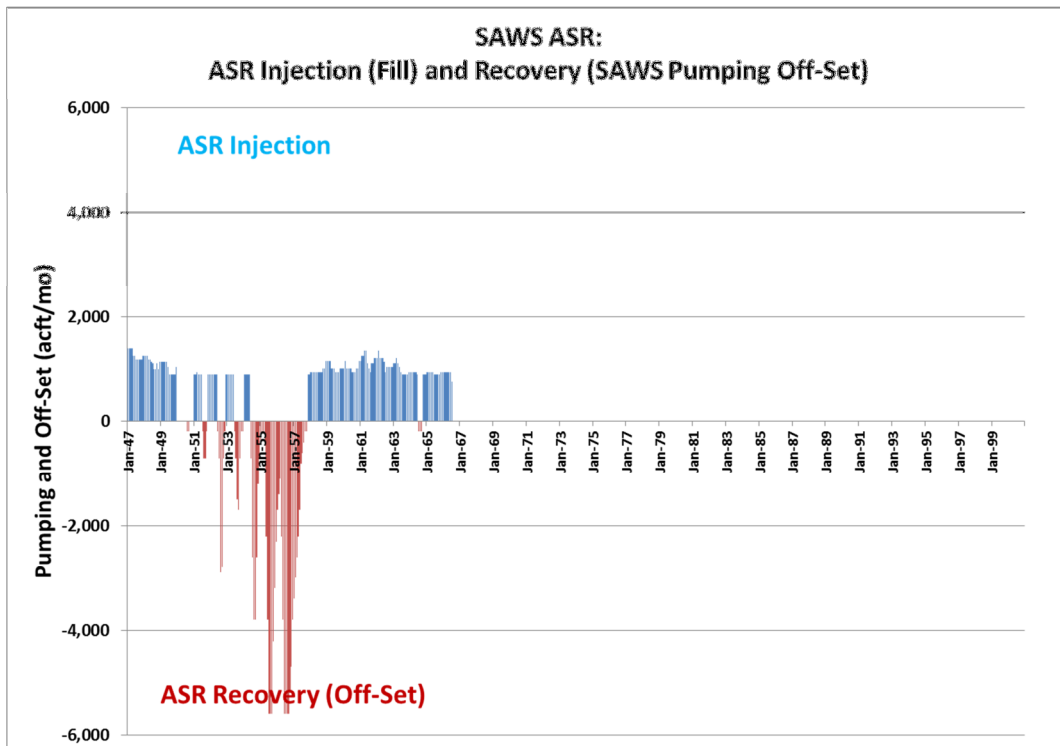


Figure 2. Schedule for ASR Injection and Recovery

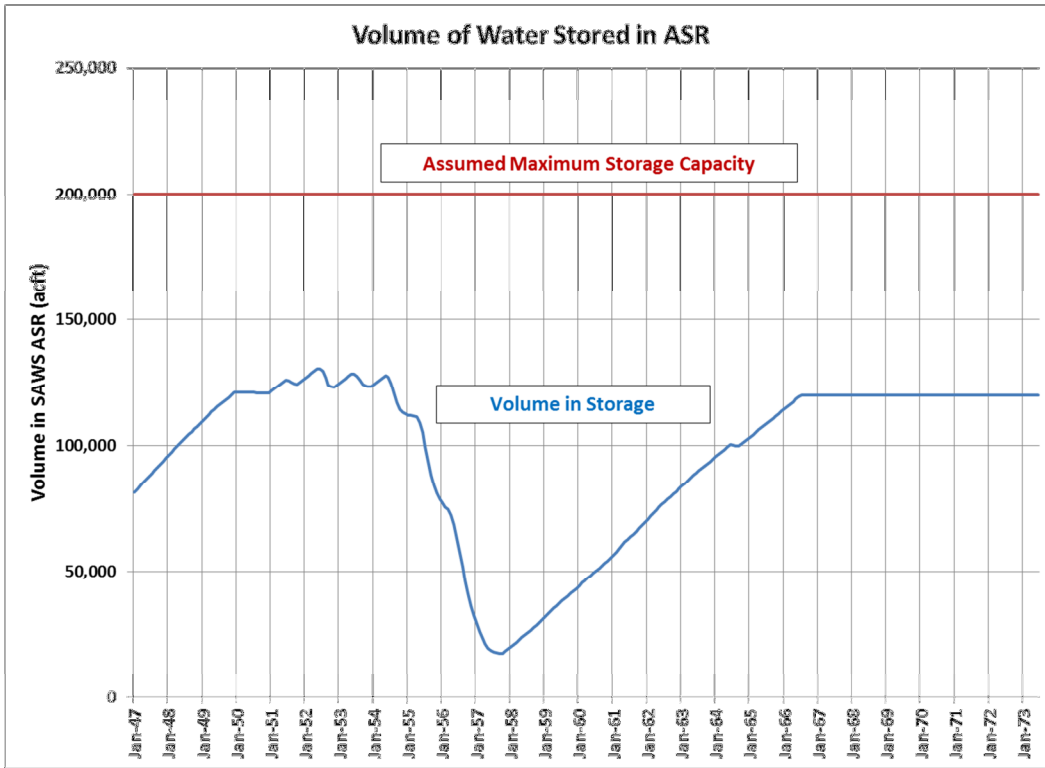


Figure 3. Volume Stored in SAWS ASR Well Field

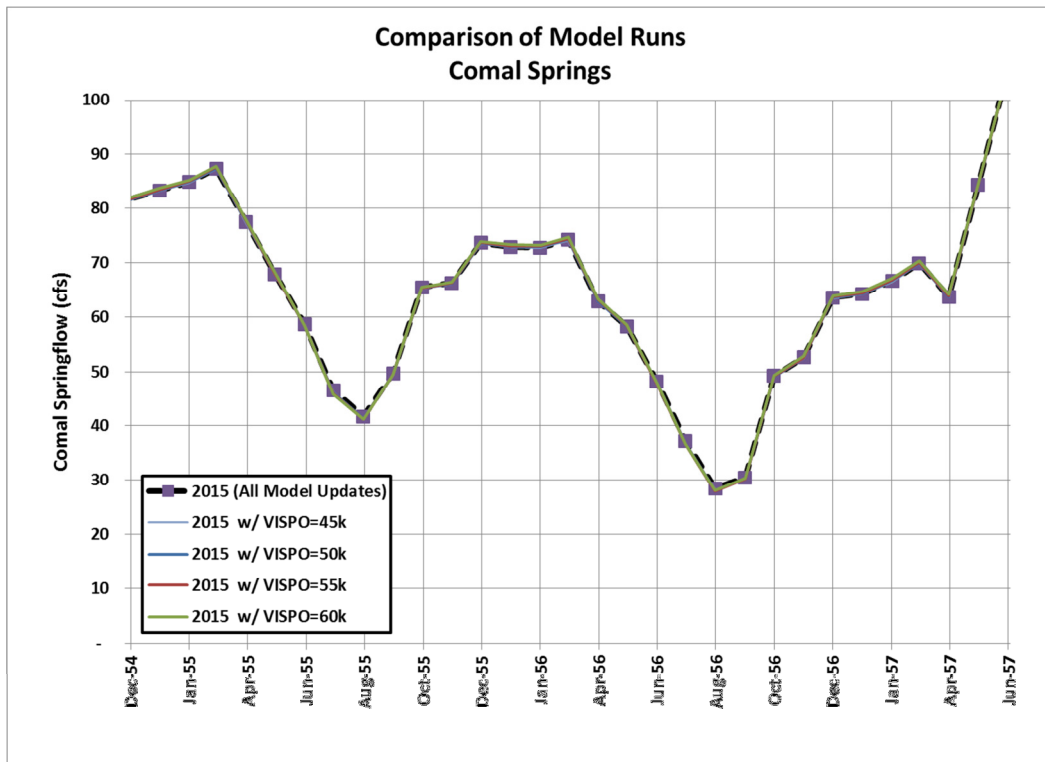


Figure 4. Comparison of Simulation Results at Comal Springs for Increases in VISPO Enrollments and Decreases in ASR Leases

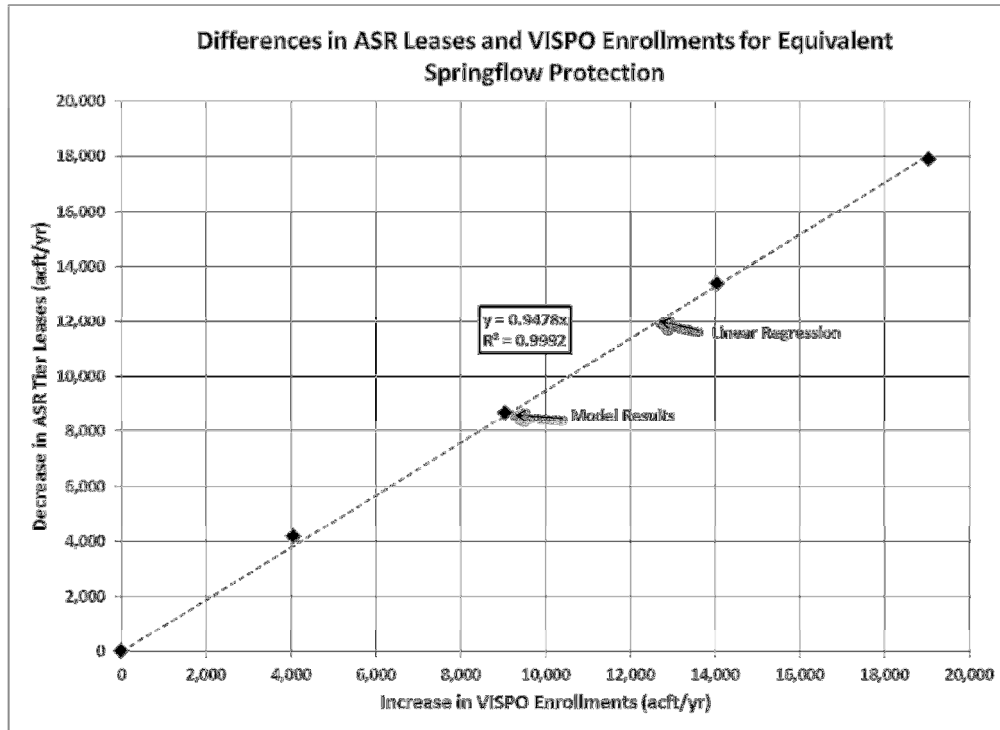


Figure 5. ASR Leases and VISPO Enrollments for Equivalent Minimum Flow from Comal Springs

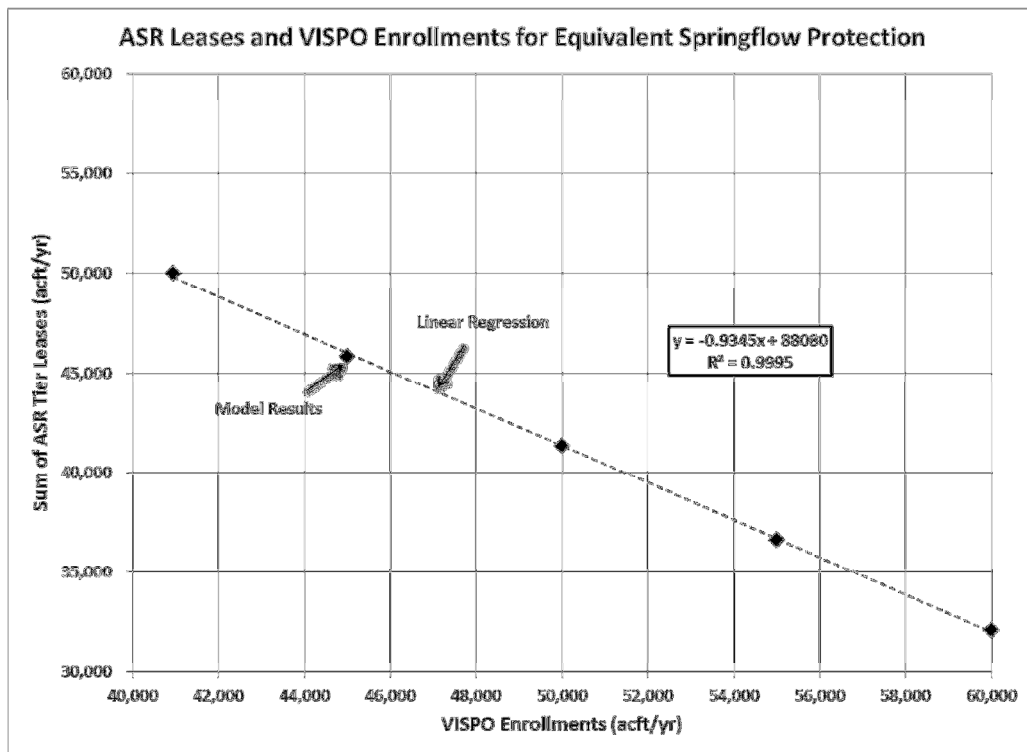


Figure 6. Increases in VISPO Enrollments and Decreases in ASR Leases for Equivalent Minimum Flow from Comal Springs