KT GROUNDWATER

Technical Memorandum

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04/11/2025

To: Dr. Quinn McColly
Managing Director – Water Resources
Conservation Equity Management, LP

From: Michael R. Keester, P.G.

Date: April 11, 2025

Subject: Groundwater flow modeling and simulated effects of pumping from the proposed Redtown Ranch Holdings LLC well field

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To support your permitting efforts with the Neches & Trinity Valleys Groundwater Conservation District ("NTVGCD"), we reviewed modeling files provided to the NTVGCD and conducted additional simulations. Specifically, our work involved verifying the simulated pumping amounts within the pumping files, conducting simulations with the Carrizo Wilcox Groundwater Availability Model ("GAM") developed by Panday and others (2020), and evaluated the simulated effect of the proposed Redtown Ranch Holdings LLC ("Redtown Ranch") pumping. For the simulations, we used two versions of the GAM, namely:

- "Base GAM" where the aquifer properties are as defined by Panday and others (2020)
- "GAM (Sy = 0.07)" where we adjusted the specific yield to be closer to typical values

Within MODFLOW, the modeling code used for the GAM, we can represent storage of water in the aquifer layers several ways. In the GAM, Panday and others (2020) set the model to use a storage coefficient (calculated from a specific storage value) when water levels are above the top of the aquifer (that is, confined aquifer conditions) and specific yield when water levels are below the top of the aquifer (that is, unconfined or water-table aquifer conditions). The storage coefficient is typically between 0.001 and 0.00001 (Freeze and Cherry, 1979) and reflects the drainage from storage due to changes in pressure in the confined aquifer system. The specific yield values for sandy materials, such as the aquifers simulated by the GAM, typically range from 0.1 to 0.3 (Freeze and Cherry, 1979) and represent the amount of water that can drain from the pore space in the aquifer. Based on the typical values, the specific yield is typically at least 100 times more than the storage coefficient.

In the GAM, Panday and others (2020) applied a constant specific yield value of 0.0007 (unitless) in all nodes which is more representative of a confined aquifer system. As a justification for the value, they reported that the GAM is not sensitive to changes in the specific yield. However, in a regional model where most calibration water level data are from aquifers under confined conditions, the insensitivity is due to a lack of data and is not an indication that the selected value is accurate for the unconfined aquifer conditions. The effect of their choice for the specific yield is that when simulated water levels fall below the top of the aquifer (that is, the aquifer becomes unconfined), the model continues to calculate water available from storage as if the system is confined.

To evaluate the simulated effects of the proposed pumping with a specific yield value that is more representative of typical values, we updated the specific yield values in all nodes by increasing it to 0.07. While the updated specific yield value is still less than the minimum literature value, it is 100 times greater than the value assigned by the GAM authors. In addition, it provides a conservative estimate near the lower end of the typical range which we can use to evaluate the difference in simulated effects from proposed pumping.

Approach

We conducted four simulations with the model. Table 1 summarizes the modeling simulations conducted.

Table 1. Summary of model simulations.

Simulation	Description
Base GAM (Sy = 0.0007)	The GMA 11 MAG predictive simulation with no change to the specific yield
GAM (Sy = 0.07)	The Base GAM with the specific yield changed to 0.07
Base GAM (Sy = 0.0007) w/Scenario	The GMA 11 MAG predictive run simulation with no change to the specific yield plus the scenario pumping
GAM (Sy = 0.07) w/Scenario	The Base GAM with the specific yield changed to 0.07 plus the scenario pumping

For the scenario simulations we verified the pumping matched the permit applications. Table 2 summarizes the pumping applied within the model scenarios. Like previous modeling work, pumping from the well field began in model stress period 13 (representing 2025) and ended after stress period 62 for 50 years of pumping. Figure 1 illustrates the location of the simulated wells.

Table 2. Pumping applied in the scenario.

Aquifer	Well	Gallons per Year	Acre-Feet per Year
Carrizo Sand	CZ-1	394,200,000	1,209.8
	CZ-2	341,640,000	1,048.5
	CZ-3	499,320,000	1,532.4
	CZ-4	315,360,000	967.8
	CZ-5	394,200,000	1,209.8
	CZ-6*	394,200,000	1,209.8
	CZ-7*	394,200,000	1,209.8
	CZ-8*	604,850,000	1,856.2
Total Carrizo Sand		*3,337,970,000*	*10,244*
Upper Wilcox	UWLX-1	735,840,000	2,258.2
	UWLX-2	735,840,000	2,258.2
	UWLX-3	525,600,000	1,613.0
	UWLX-4	630,720,000	1,935.6
	UWLX-5	525,600,000	1,613.0
	UWLX-6*	683,280,000	2,096.9
	UWLX-7*	630,720,000	1,935.6
	UWLX-8*	683,280,000	2,096.9
	UWLX-9*	630,720,000	1,935.6
	UWLX-10	683,280,000	2,096.9
	UWLX-11	630,720,000	1,935.6
	UWLX-12	683,280,000	2,096.9
Total Upper Wilcox		*5,150,880,000*	*15,807*
Middle Wilcox	MWLX-1	394,200,000	1,209.8
	MWLX-2	394,200,000	1,209.8
	MWLX-3	350,400,000	1,075.3
	MWLX-4	394,200,000	1,209.8
	MWLX-5	394,200,000	1,209.8
	MWLX-6*	473,330,000	1,452.6
	MWLX-7*	473,330,000	1,452.6
	MWLX-8*	578,520,000	1,775.4
	MWLX-9*	420,740,000	1,291.2
	MWLX-10	394,200,000	1,209.8
	MWLX-11	350,400,000	1,075.3
	MWLX-12	416,100,000	1,277.0
Total Middle Wilcox		*3,500,820,000*	*10,744*
Total Redtown Ranch		***16,150,670,000***	***49,565***

*Outside of the NTVGCD

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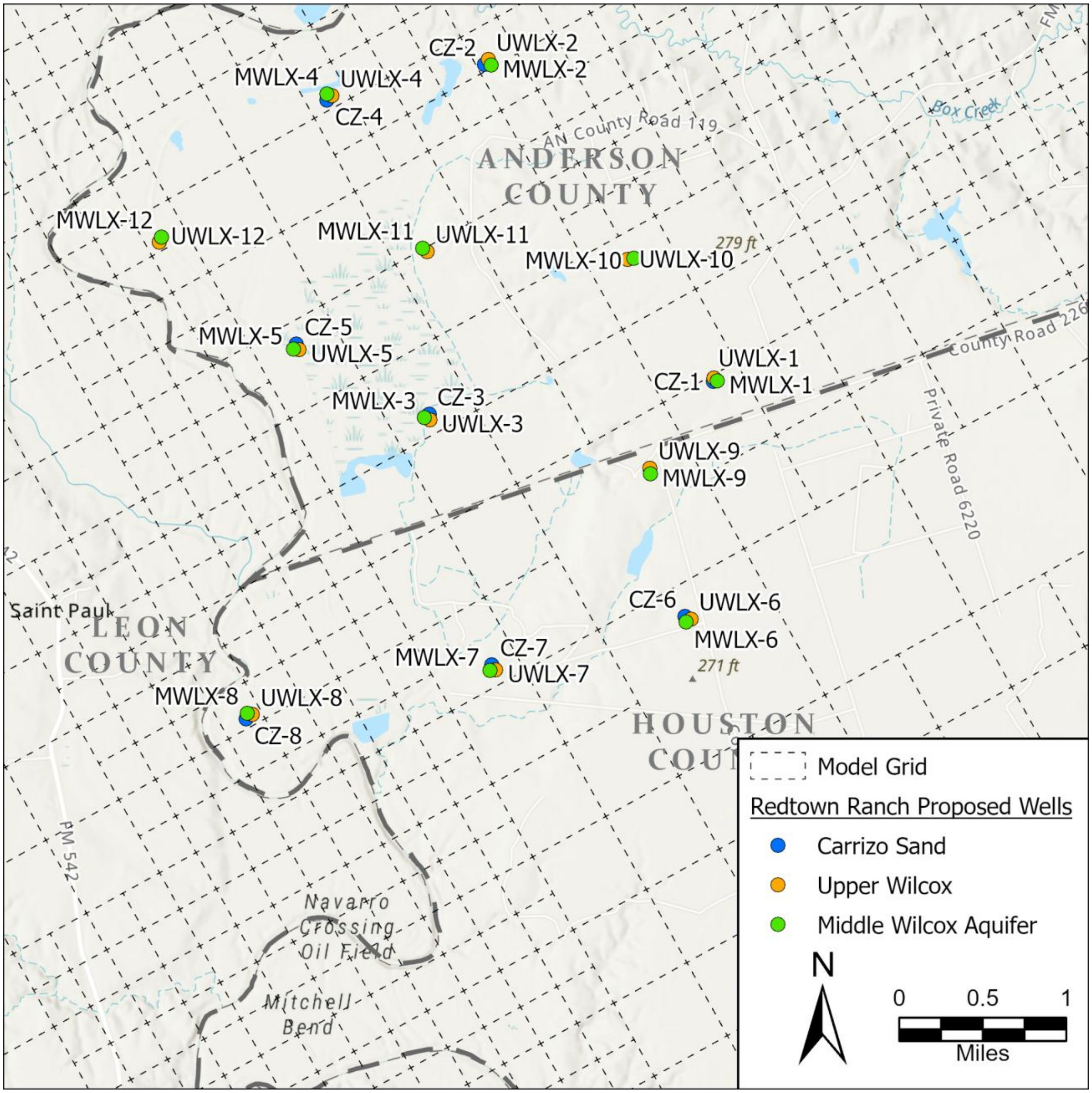


Figure 1. Location of simulated wells.

Results

We began with a review of the local effects of the simulated pumping. The Redtown Ranch well field will produce from the Carrizo Sand, Upper Wilcox, and Middle Wilcox aquifers. As expected, updating the specific yield value results in slower water level decline as more water is available from storage. Figure 2 illustrates the differences between the simulations.

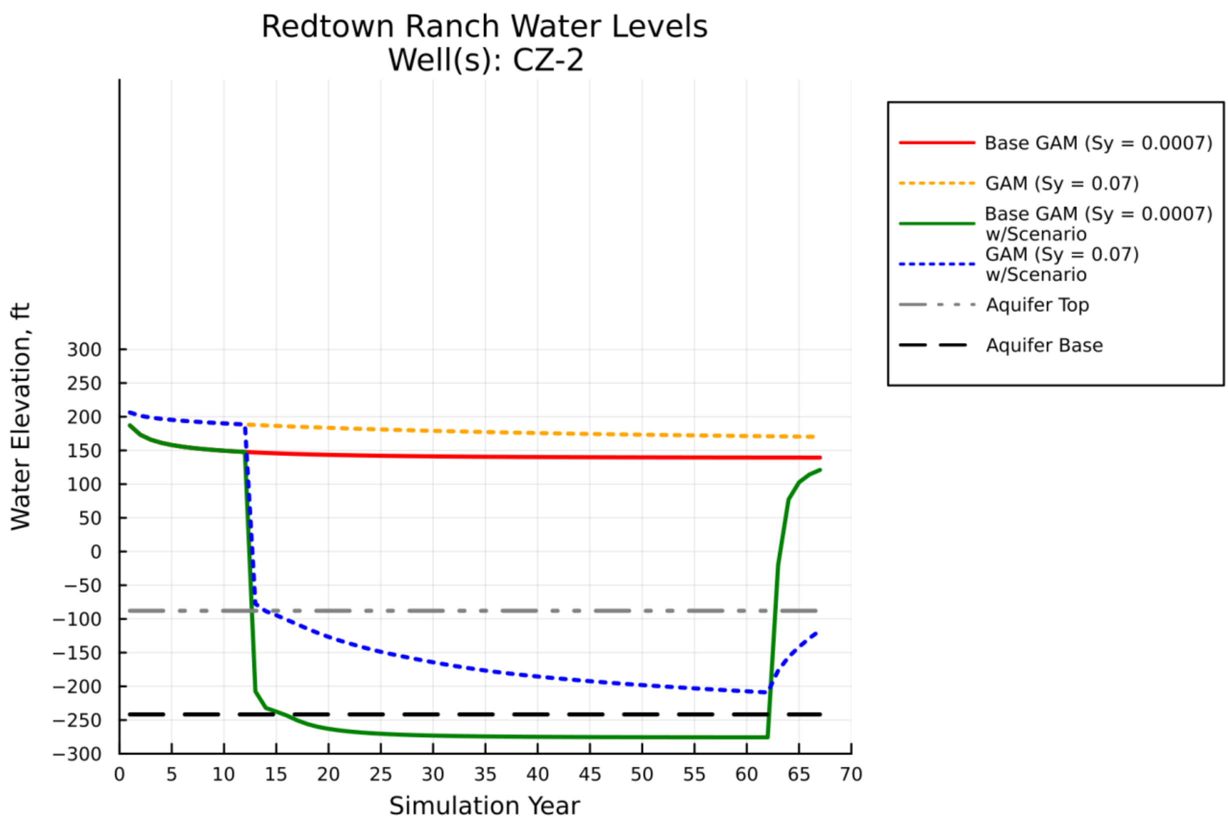


Figure 2. Simulated water level at the model node representing well CZ-2.

As shown in Figure 2, the higher specific yield values (yellow and blue dotted lines) result in a starting water level about 25 feet higher. In the simulation without Redtown Ranch pumping, the water level remains about 25 feet higher at the end of the predictive period. With the Redtown Ranch pumping, the water level declines to the base of the aquifer (and below) almost immediately with the low specific yield (green line). However, the water level declines slower with the higher specific yield (blue line).

Importantly, the GAM automatically reduces pumping when water levels fall below 10 percent of the layer thickness. For the Redtown Ranch simulation with the low specific yield (green line) the pumping briefly reaches the full amount before declining to zero during most of the simulation period. However, as shown on Figure 3 for the well discussed above, the pumping with the higher specific yield meets the target for all of the pumping period.

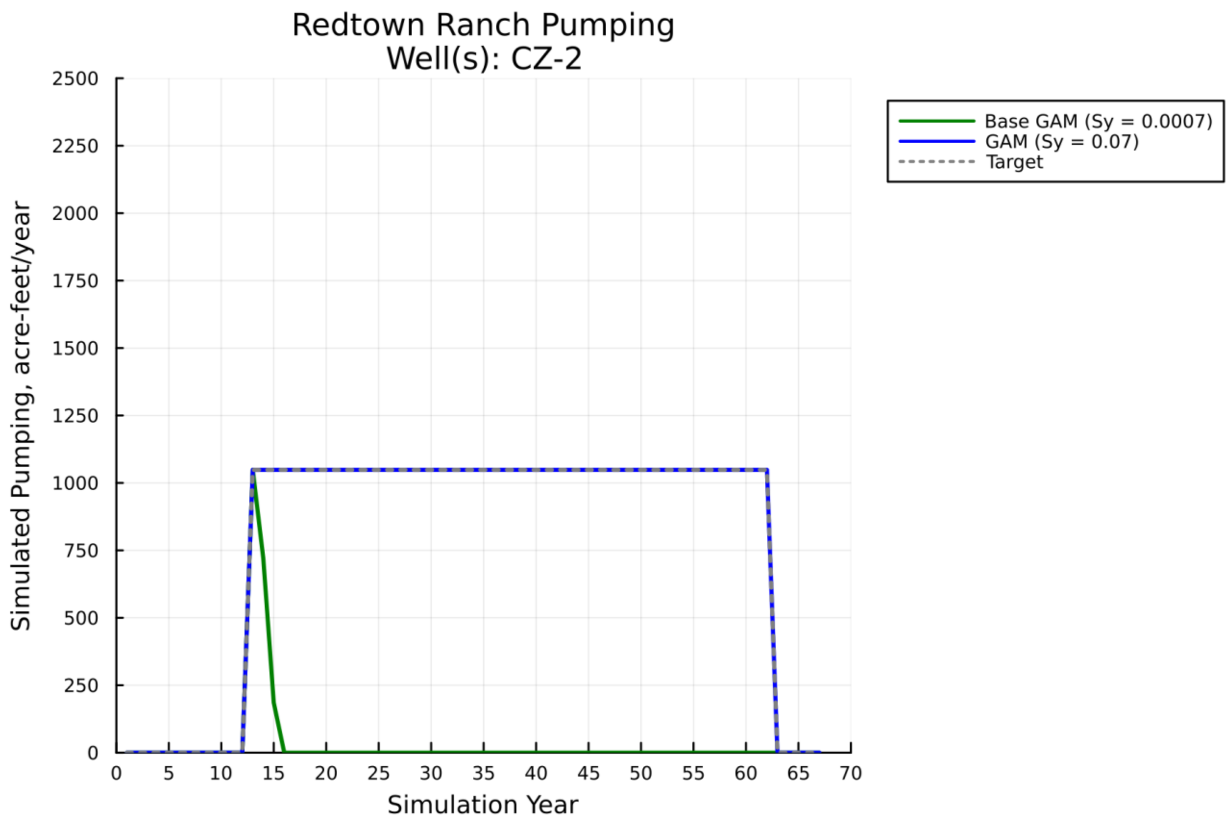


Figure 3. Simulated Redtown Ranch pumping at the model node representing well CZ-2.

As noted above on Figure 2, in the original GAM the simulated water level drops below the bottom of the aquifer. We also observed the simulated water levels in other proposed Carrizo wells dropping below the bottom of the aquifer. For example, at CZ-5 the simulated water level from the original and updated GAM both decline below the aquifer bottom with the proposed Redtown Ranch pumping (Figure 4)

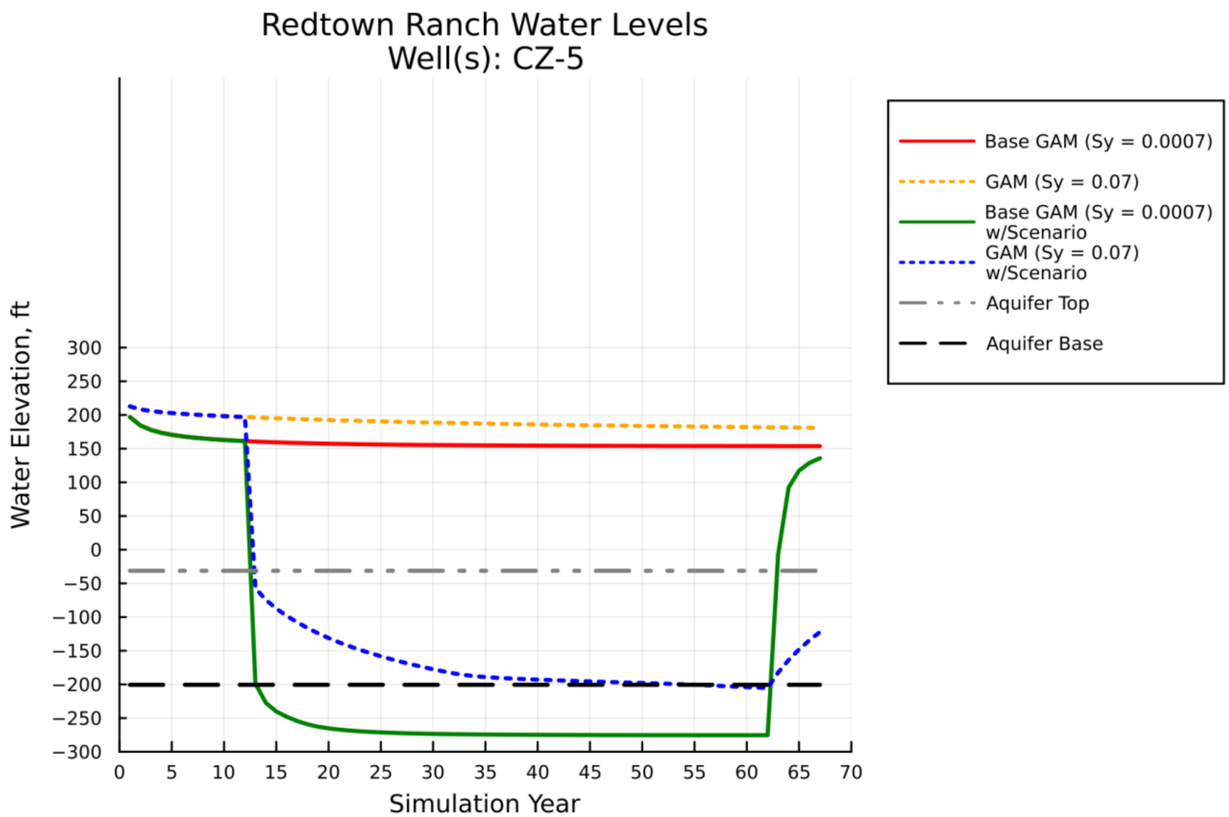


Figure 4. Simulated water level at the model node representing well CZ-5.

While it is physically impossible for an aquifer to have a water level below its base, the model code does allow for a node to have a simulated water level that is below the bottom of the layer. The mathematical reason is to allow the model node to become re-saturated from groundwater flow into the model cell. Upon review of the Upper Wilcox, which is directly below the Carrizo, results we found that the simulated water levels are nearly identical between the Carrizo and Upper Wilcox. Figure 5 illustrates the simulated water level at proposed well UWLX-5 which is collocated with CZ-5.

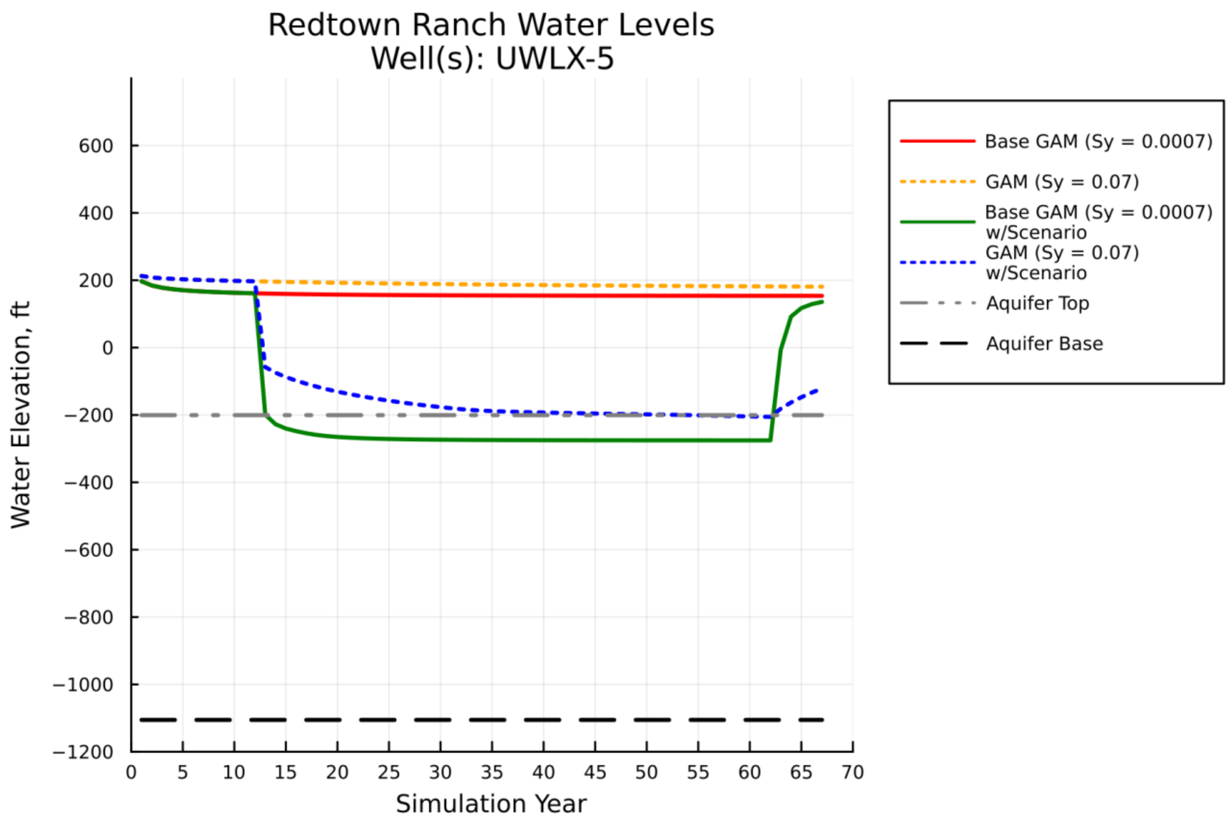


Figure 5. Simulated water level at the model node representing well UWLX-5.

Comparison of Figures 4 and 5 reveals that the simulated water levels in the Carrizo and underlying Upper Wilcox track with each other in the proposed Redtown Ranch Well Field. The reason the simulated water levels in the Carrizo are essentially the same as the Upper Wilcox is because of the vertical hydraulic conductivity Panday and others (2020) assigned to the nodes. As a rule of thumb, the vertical hydraulic conductivity is about 10 percent of the horizontal hydraulic conductivity and may be much lower in a regional model to account for low permeability strata in the model layer.

For the Upper Wilcox in the Redtown Ranch Well Field, Panday and others (2020) set the vertical hydraulic conductivity to 100 percent of the horizontal hydraulic conductivity. By setting the values as equal, the Carrizo and Upper Wilcox are closely connected and act essentially as a single layer. For comparison, the vertical hydraulic conductivity averages 6 percent of the horizontal hydraulic conductivity for the Carrizo in the Redtown Ranch Well Field and 0.005 percent for the Middle

Wilcox. Based on the formulas for calculating vertical hydraulic conductivity Panday and others (2020) reportedly applied, it is not clear why they parameterized the Upper Wilcox to be directly connected to the Carrizo. We believe this vertical hydraulic conductivity parameterization does not reflect the physical hydrogeologic system.

Despite the identified issue with the vertical hydraulic conductivity parameterization, review of the results from each of the proposed Redtown Ranch wells indicates the model with higher specific yield is able to maintain the target pumping rate for more than 20 years prior to decreasing (Figure 6 blue line). Using the published GAM, the Redtown Ranch proposed pumping was never able to reach the target level which is not representative of our understanding of the physical aquifer system. Also, while the model could not maintain the pumping for 50 years in our higher specific yield version, our update to the model specific yield is still less than the range of typical values. Site specific testing and monitoring during production during the first few years will better inform the real-world aquifer characteristics. The ability of the model to maintain pumping for more than 20 years illustrates the aquifer's ability to support the proposed pumping based on our current understanding of the physical hydrogeologic system.

Overall, the results with the closer to typical specific yield show much less drawdown with production rates nearer to the target annual volumes. Attached are hydrographs and simulated pumping for each of the simulated wells. In addition, attached are charts with the total simulated pumping for the Redtown Ranch Well Field.

In addition to the hydrographs, we calculated the average water level decline during the 50-year pumping period within Anderson County due to the proposed pumping (Table 3). We calculated the average drawdown as the simulated water level at the end of stress period 12 minus the simulated water level at the end of stress period 62 divided by the number of nodes in the county without consideration to the area the cell represents. Results with the closer to typical specific yield show about 34 feet, 37 feet, and 112 feet of additional average drawdown for the Carrizo, Upper Wilcox, and Middle Wilcox aquifers, respectively, associated with the proposed Redtown Ranch pumping.

The similarity of additional average drawdown for the Carrizo and Upper Wilcox is likely due to the vertical hydraulic conductivity parameterization. While the aquifer layers are connected and groundwater moves between the layers, we do not expect the connection to be as strong as represented in the model. The connection between the Carrizo and Upper Wilcox is a limitation of the model that could not be corrected like the specific yield because of how a change to the values could more directly affect the calibration. As stated previously, site specific testing and monitoring during production during the first few years will better inform the real-world aquifer characteristics which can then be incorporated into an updated model of the hydrogeologic system.

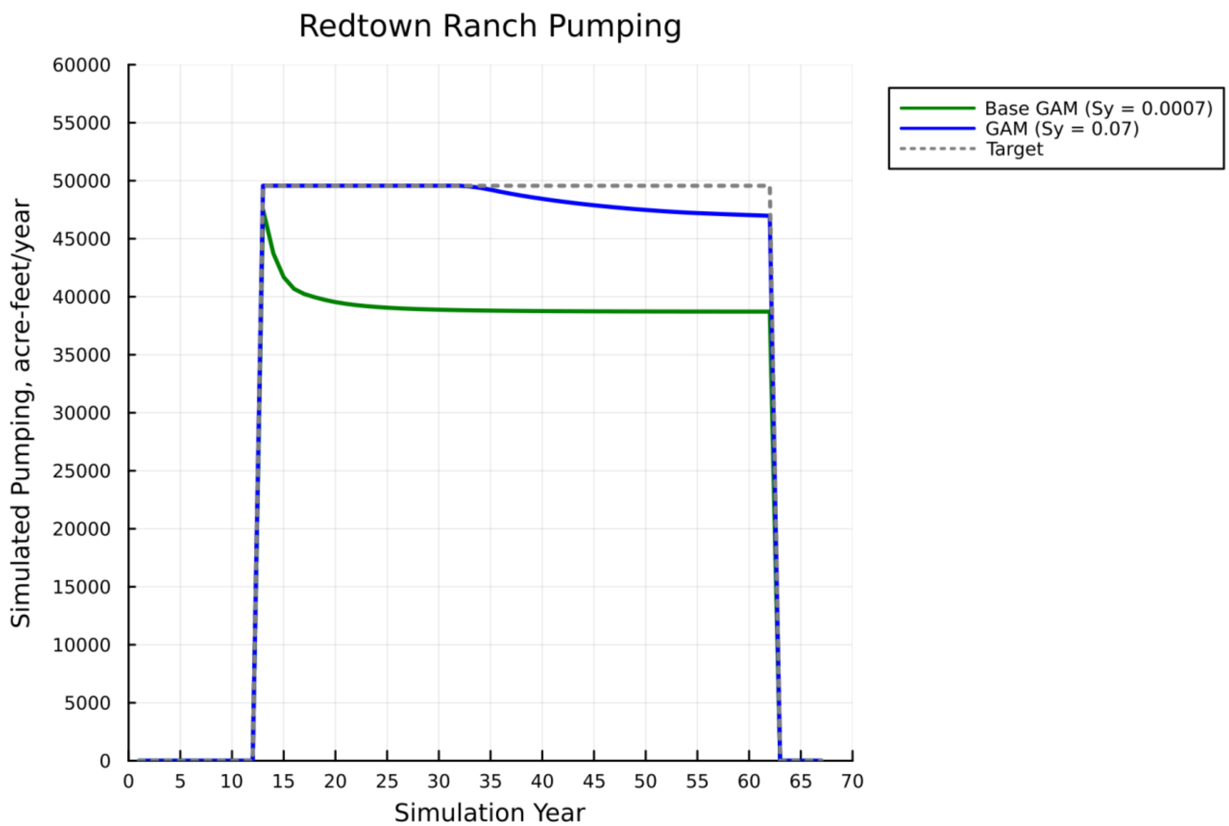


Figure 6. Simulated Redtown Ranch pumping from the Queen City and Middle Wilcox.

Table 3. Summary of calculated average drawdown in Anderson County at the end of the 50-year pumping period.

Aquifer*	Base GAM (Sy = 0.0007)	GAM (Sy = 0.07)	Base GAM (Sy = 0.0007) w/Scenario	GAM (Sy = 0.07) w/Scenario
Alluvium	3	6	10	7
Sparta	3	7	9	7
Weches	5	10	14	11
Queen City	5	8	11	9
Reklaw	13	12	44	24
Carrizo Sand	16	**29**	74	**63**
Upper Wilcox	17	**33**	77	**70**
Middle Wilcox	20	**28**	162	**140**
Lower Wilcox	22	28	164	141

*highlighted aquifers are where the Redtown Ranch wells will produce

Summary and Conclusions

Panday and others (2020) applied a specific yield value in the GAM which is representative of a confined aquifer rather than an unconfined aquifer. The effect of their choice is that if water levels fall below the top of the aquifer the GAM continues to calculate water available from storage as if the system is confined. Since the proposed Redtown Ranch Well Field pumping is expected to draw water levels below the top of the aquifer, using a specific yield value closer to the typical range for the aquifer material is appropriate for evaluating the potential effects of production.

To conduct the evaluation, we updated the specific yield of the GAM to 0.07 or 100 times more than the value used by the model authors. As expected, the simulations result in less drawdown as more water is available from storage. In addition, the GAM can more closely maintain the target pumping amount. By more closely maintaining the target pumping amount, and by being able to maintain the full amount for several years, the simulated effects are more reasonable with regard to our current understanding of the hydrogeologic conditions.

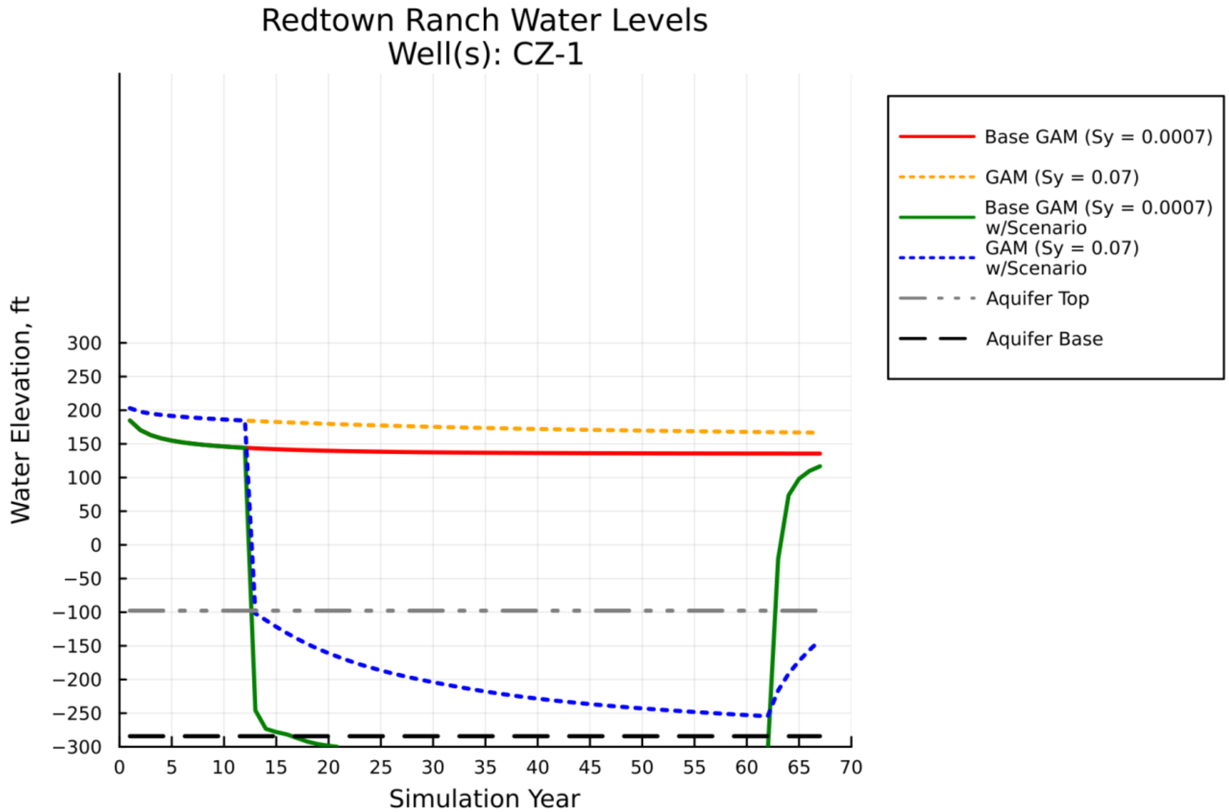
Using the model with the specific yield closer to typical values, the additional average drawdown in Anderson County increases by 34 feet, 37 feet, and 112 feet for the Carrizo, Upper Wilcox, and Middle Wilcox aquifers, respectively, due to the proposed Redtown Ranch pumping. Most of the additional drawdown occurs in and near the proposed well field with the greatest effect being on the proposed pumping wells. While we do expect water level decline in the aquifer, we do not expect the proposed pumping will inhibit the ability of other property owners to use the groundwater resources beneath their land.

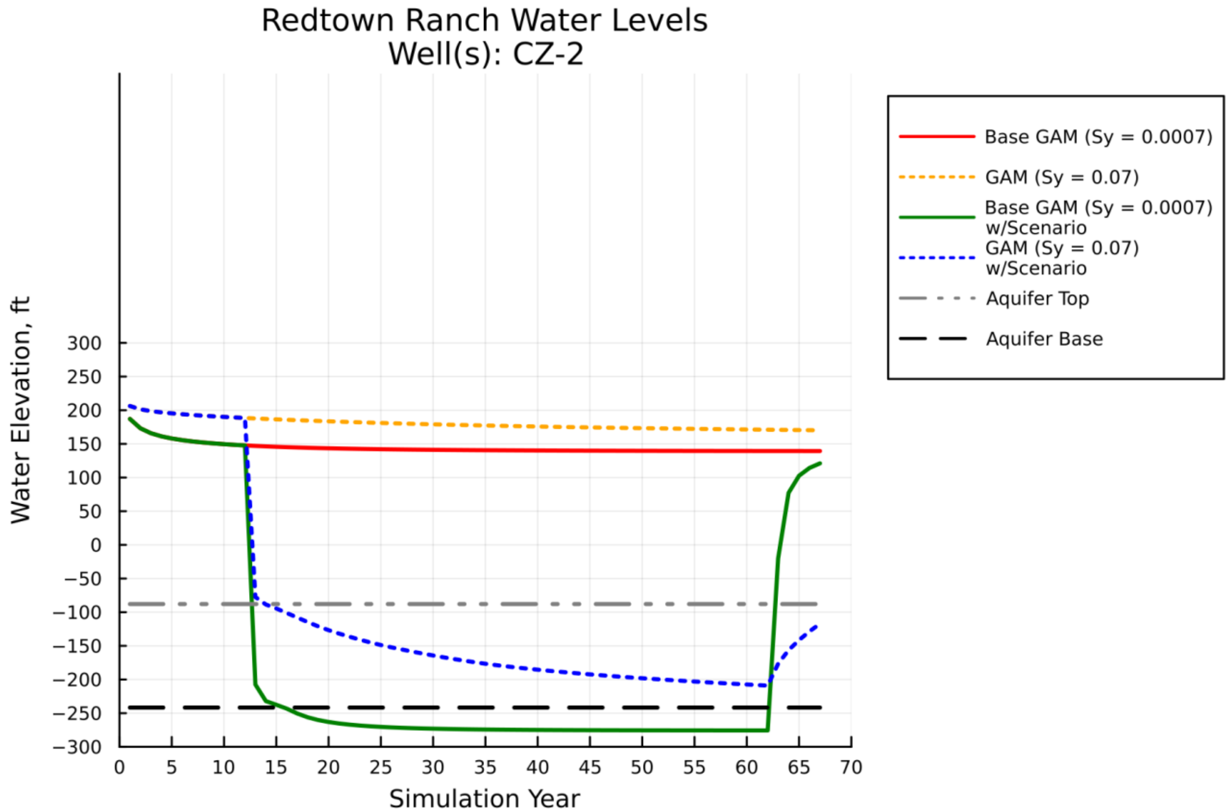
References

Freeze, R.A. and Cherry, J.W., 1979, Groundwater: 604 p.

Panday, S., Rumbaugh, J., Hutchison, W.R., and Schorr, S., 2020, Numerical Model Report: Groundwater Availability Model for the Northern Portion of the Queen City, Sparta, and Carrizo-Wilcox Aquifers: Texas Water Development Board Contract Number # 1648302063, 200 p.

Simulated Hydrographs for Redtown Ranch Proposed Wells


Redtown Ranch Water Levels
Well(s): CZ-1
Water Elevation, ft
Simulation Year
300
250
200
150
100
50
0
−50
−100
−150
−200
−250
−300
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): CZ-2
Water Elevation, ft
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base
300
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−250
−300
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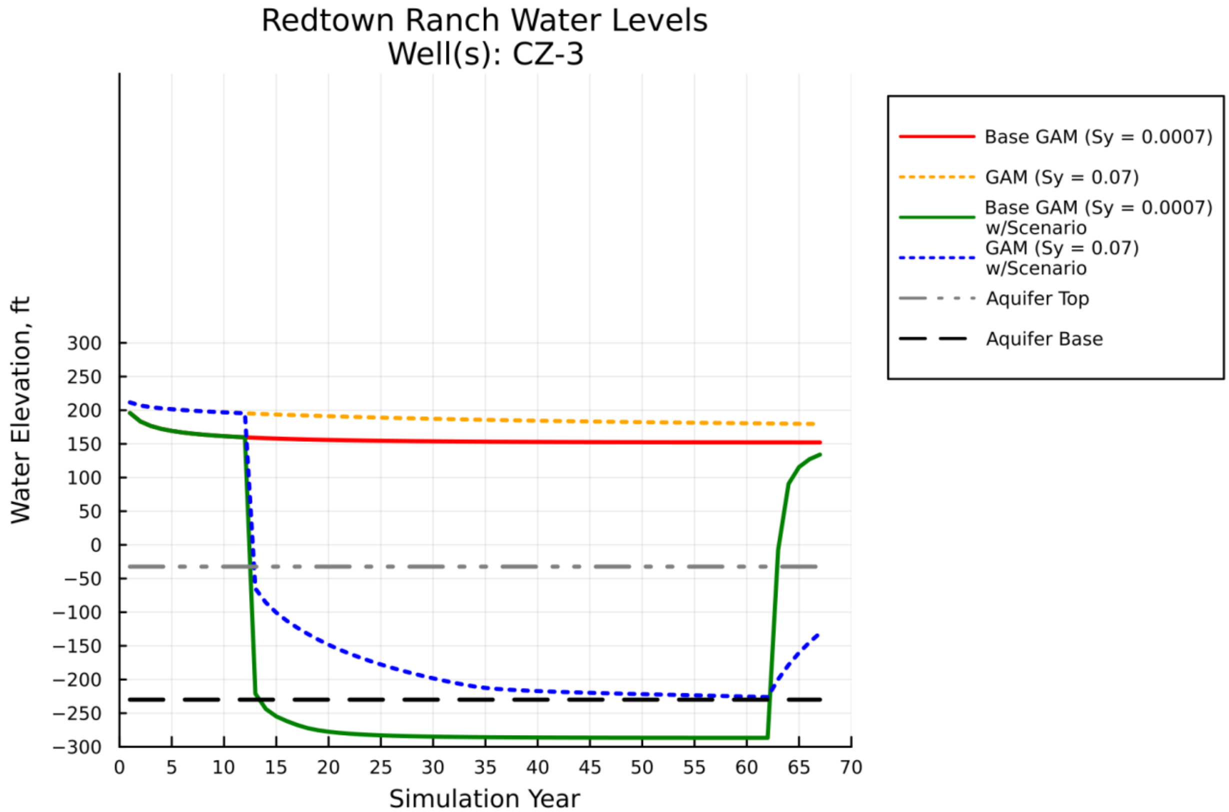
Redtown Ranch Water Levels
Well(s): CZ-3
Water Elevation, ft
Simulation Year
300
250
200
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−50
−100
−150
−200
−250
−300
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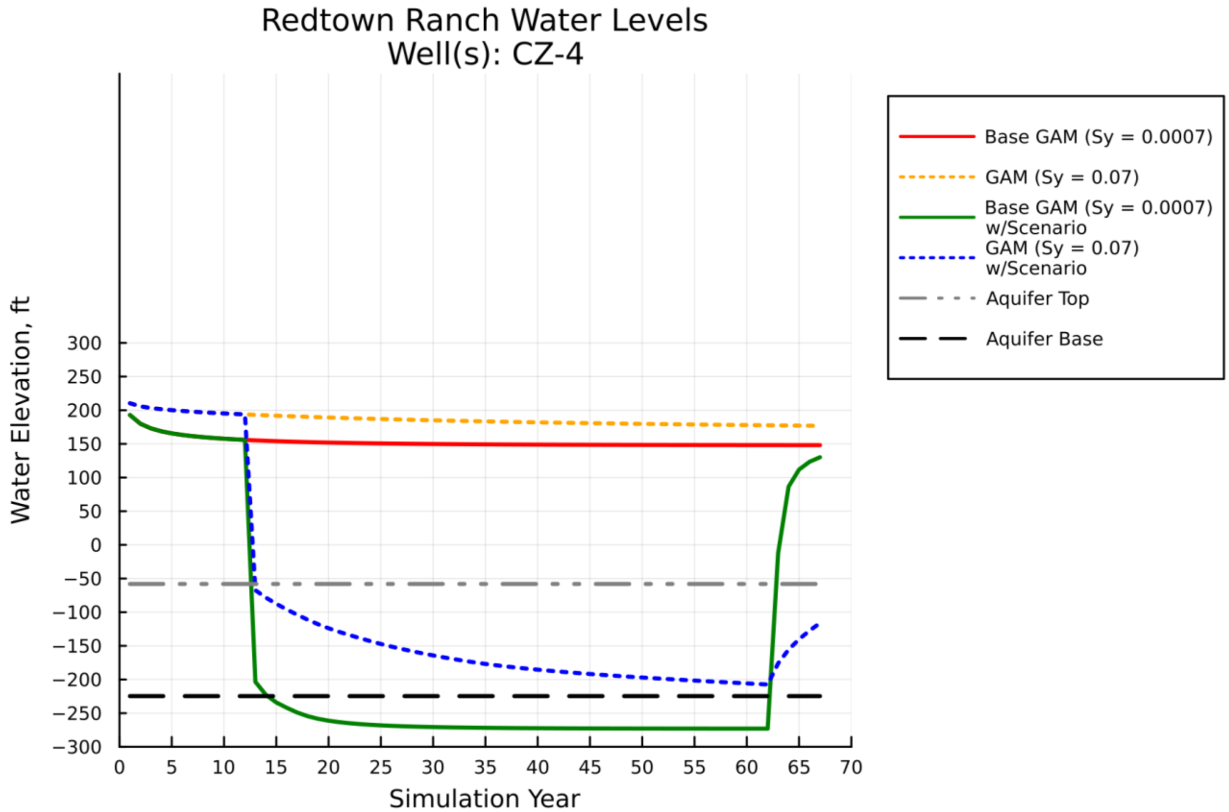
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): CZ-4
Water Elevation, ft
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250
200
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−100
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−200
−250
−300
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60
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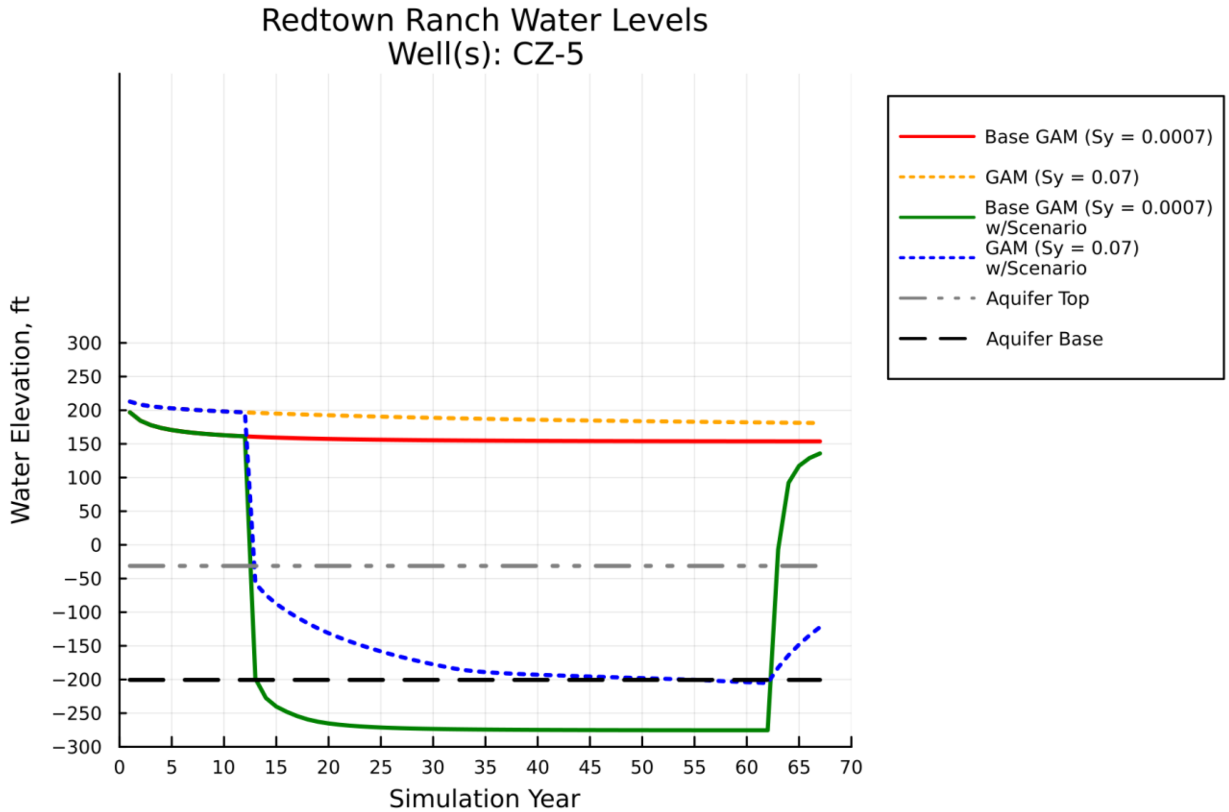
70
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): CZ-5
Water Elevation, ft
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250
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−50
−100
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−300
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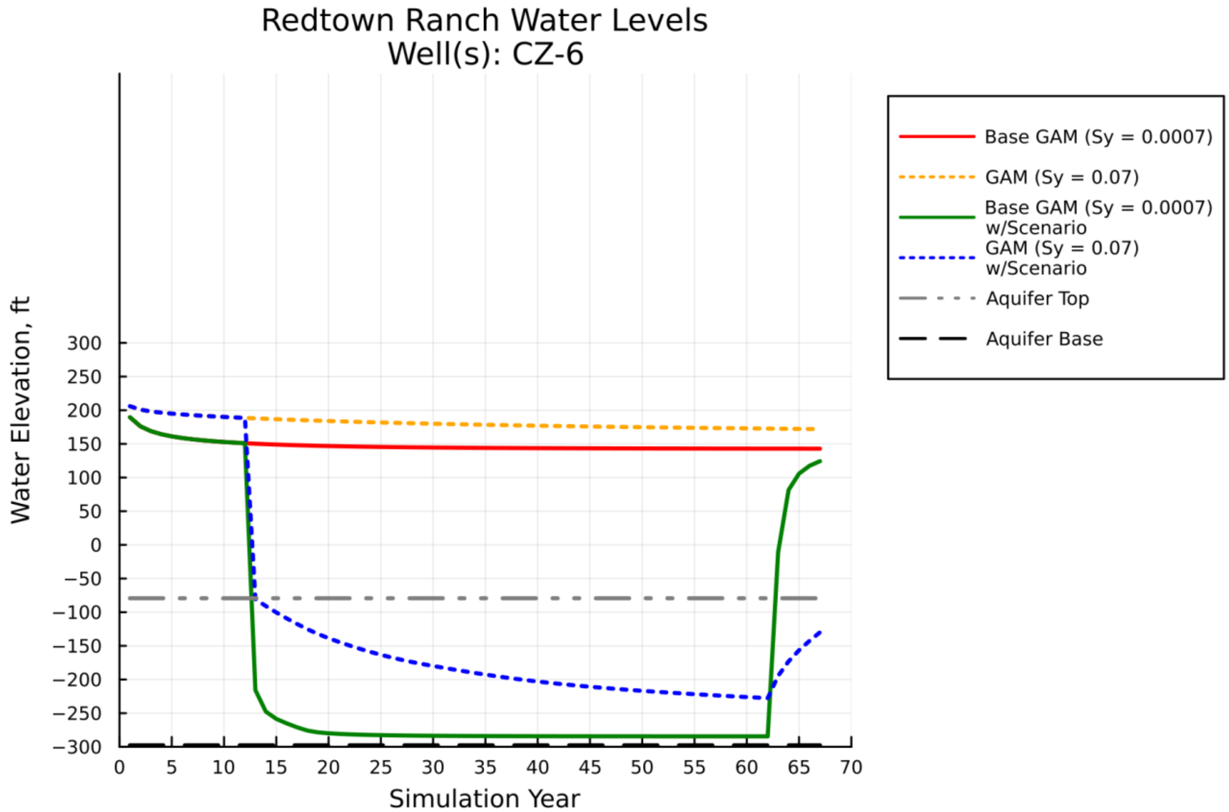
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): CZ-6
Water Elevation, ft
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250
200
150
100
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−50
−100
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−250
−300
0
5
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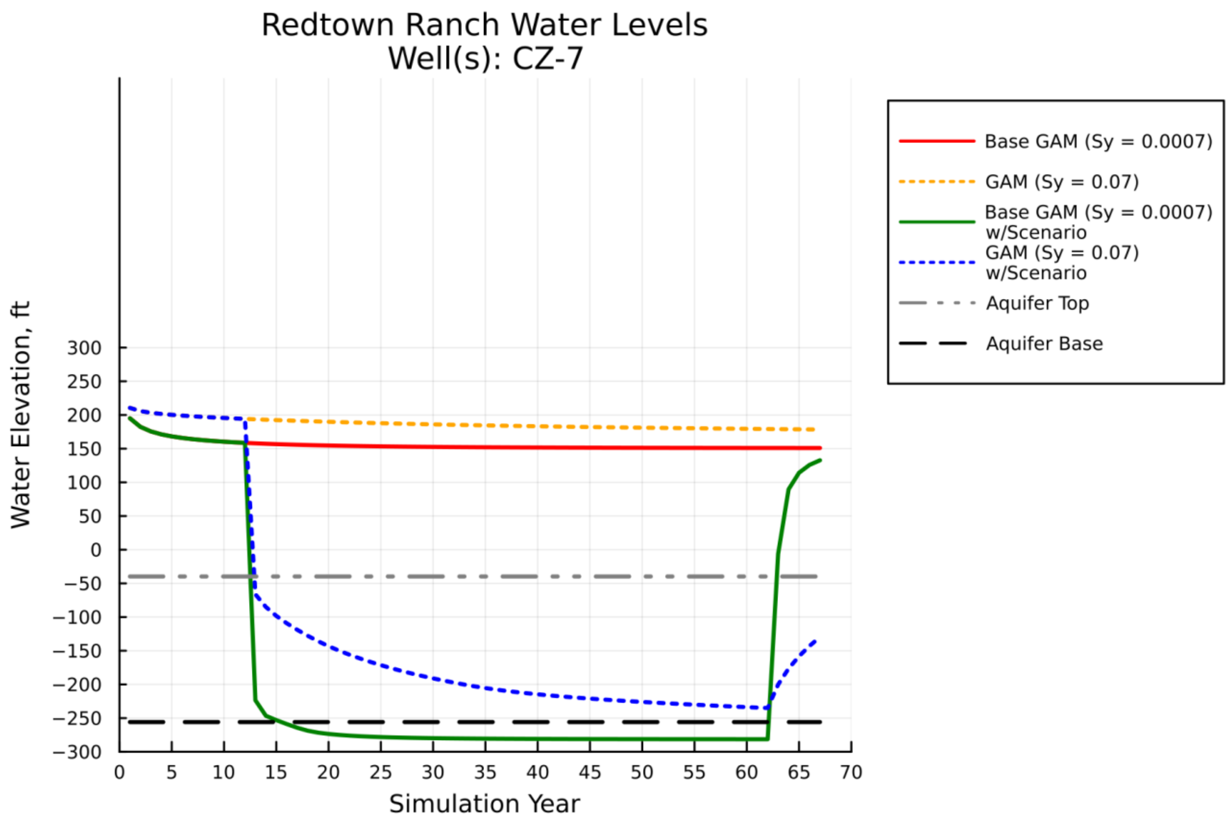
70
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): CZ-7
Water Elevation, ft
Simulation Year
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250
200
150
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50
0
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−200
−250
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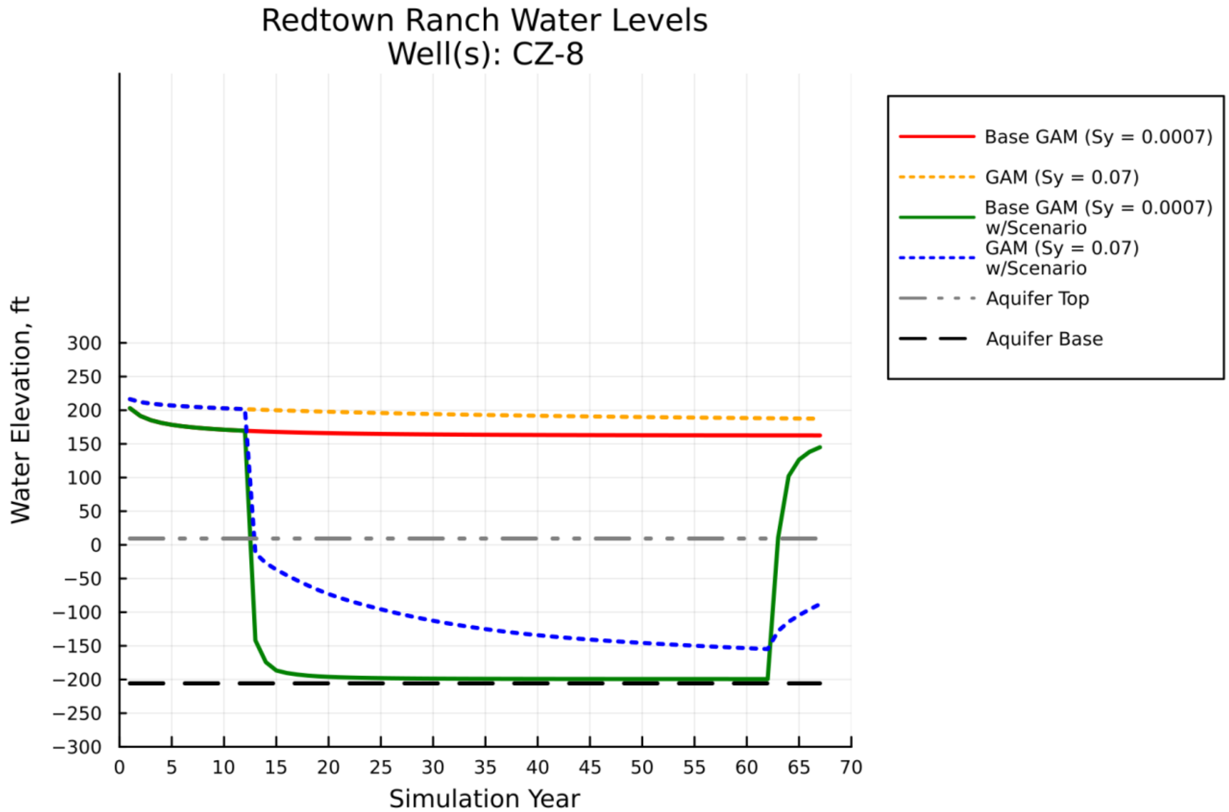
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): CZ-8
Water Elevation, ft
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−100
−150
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−250
−300
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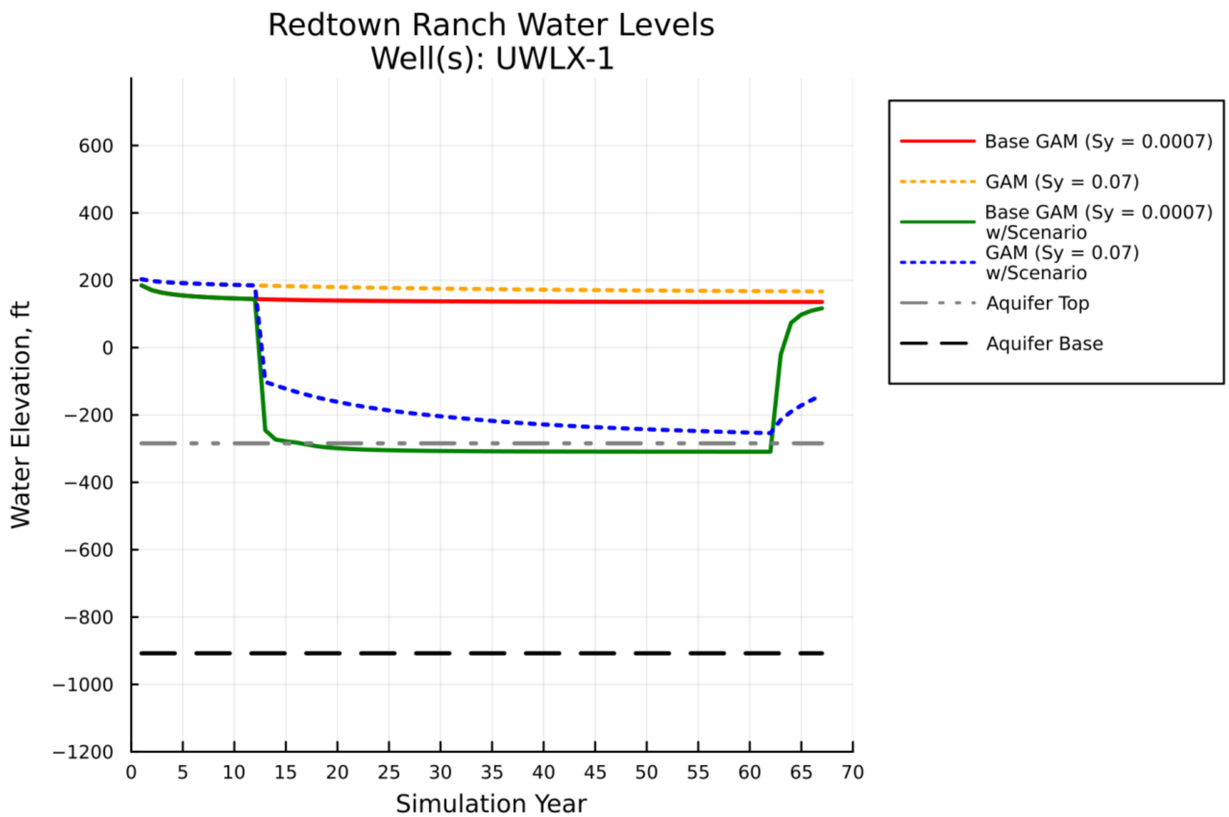
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): UWLX-1
Water Elevation, ft
600
400
200
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−200
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−800
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−1200
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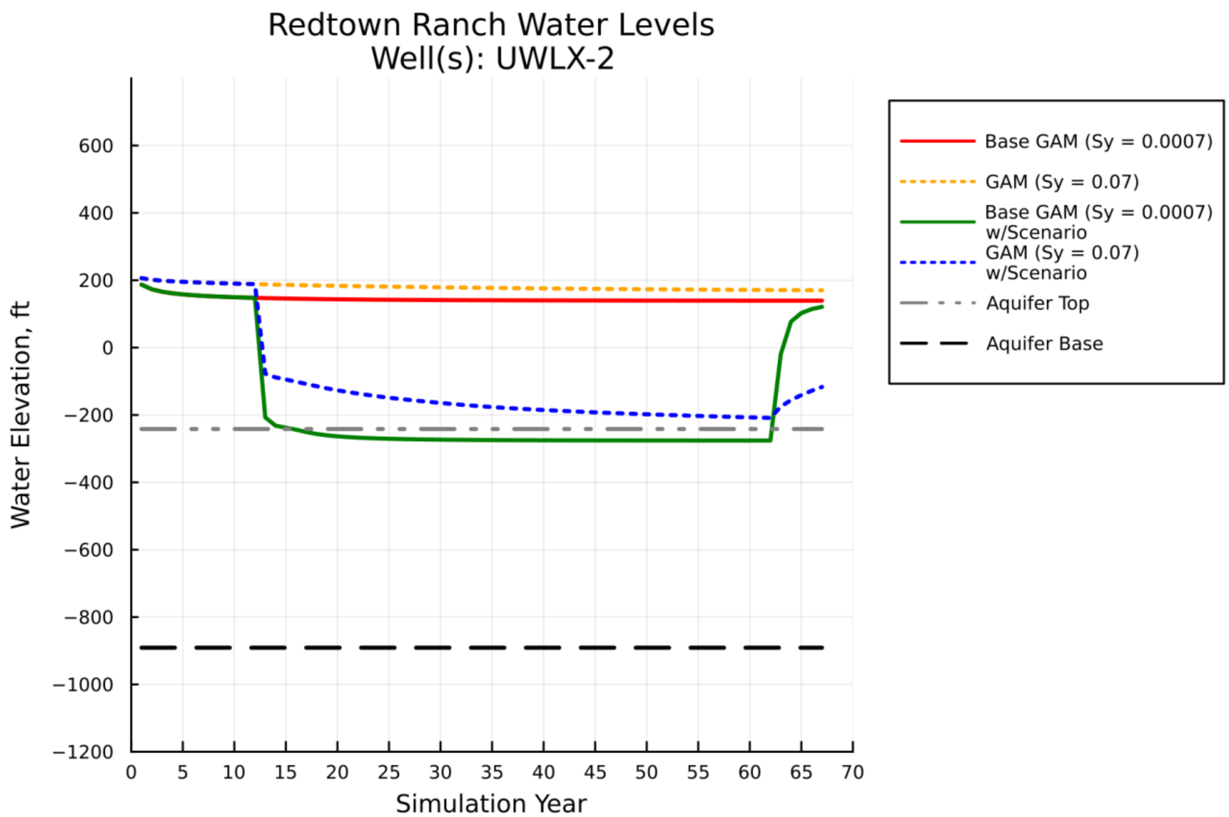
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): UWLX-2
Water Elevation, ft
600
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−800
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−1200
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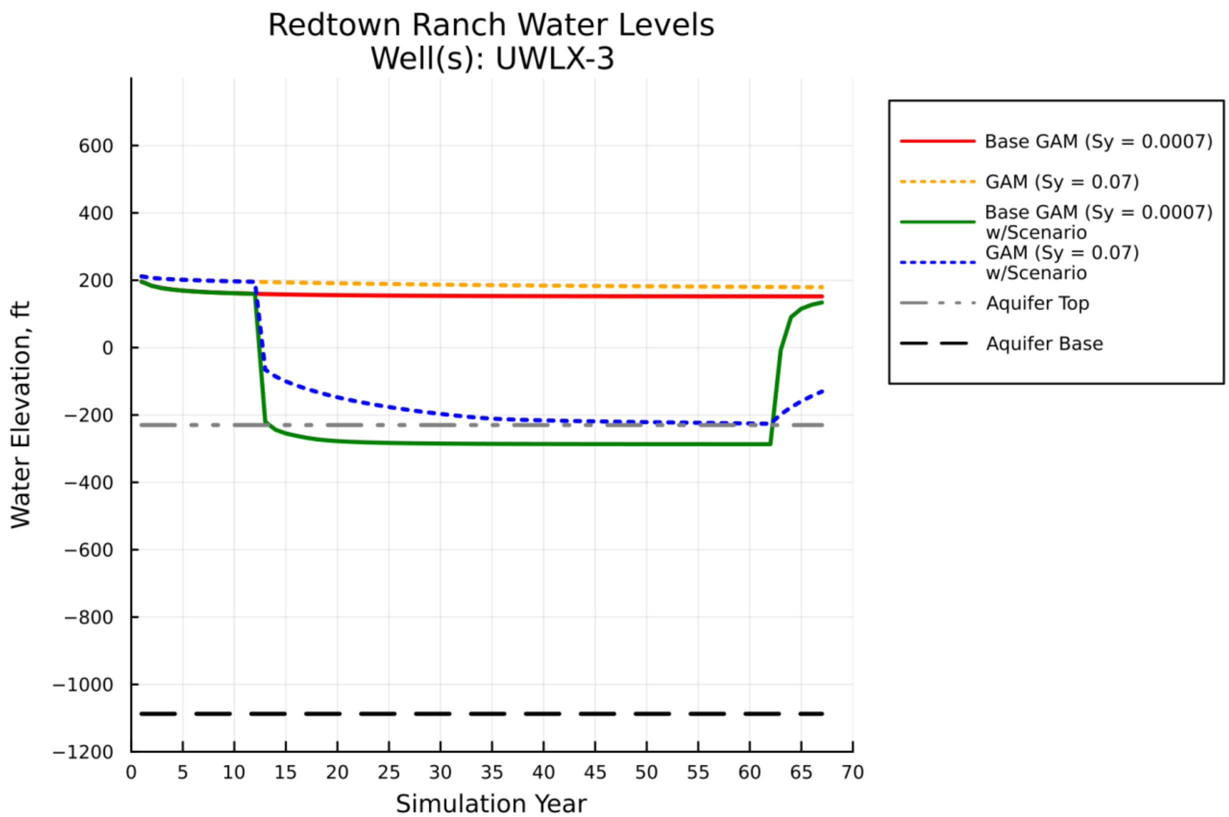
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): UWLX-3
Water Elevation, ft
Simulation Year
600
400
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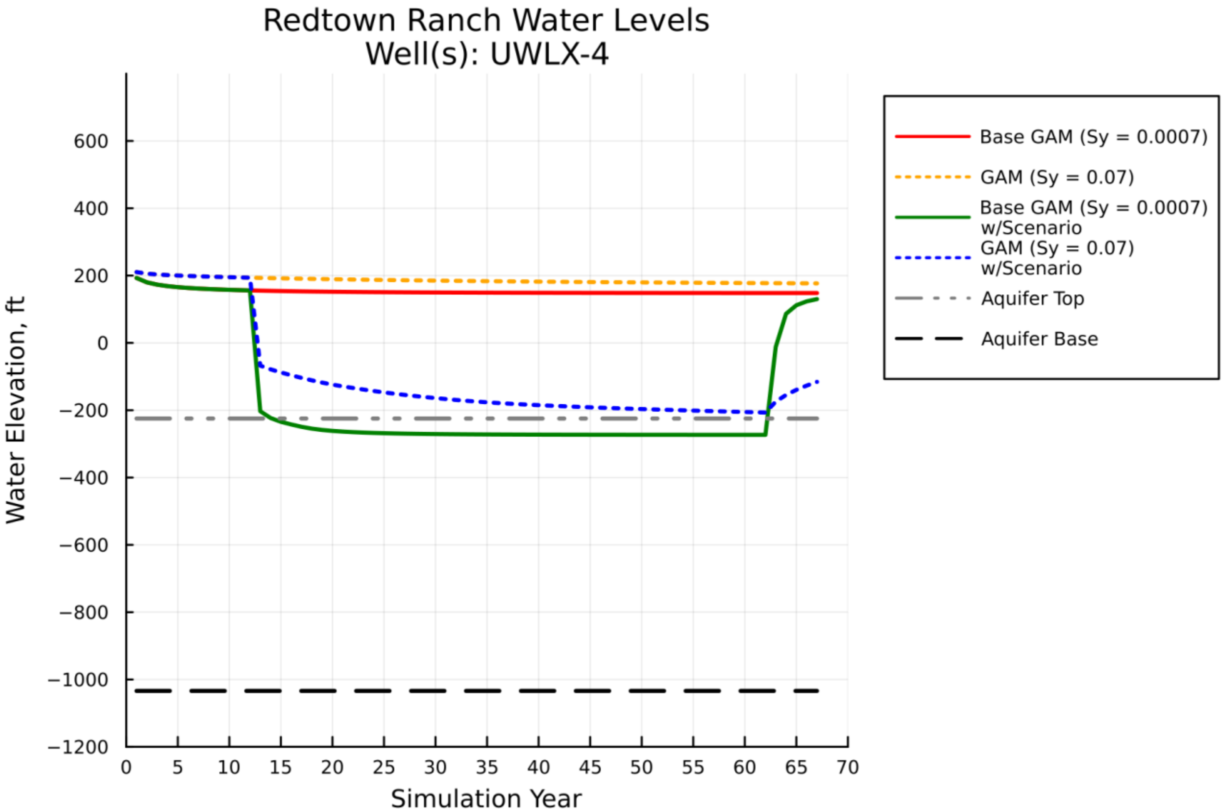
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): UWLX-4
Water Elevation, ft
Simulation Year
600
400
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0
−200
−400
−600
−800
−1000
−1200
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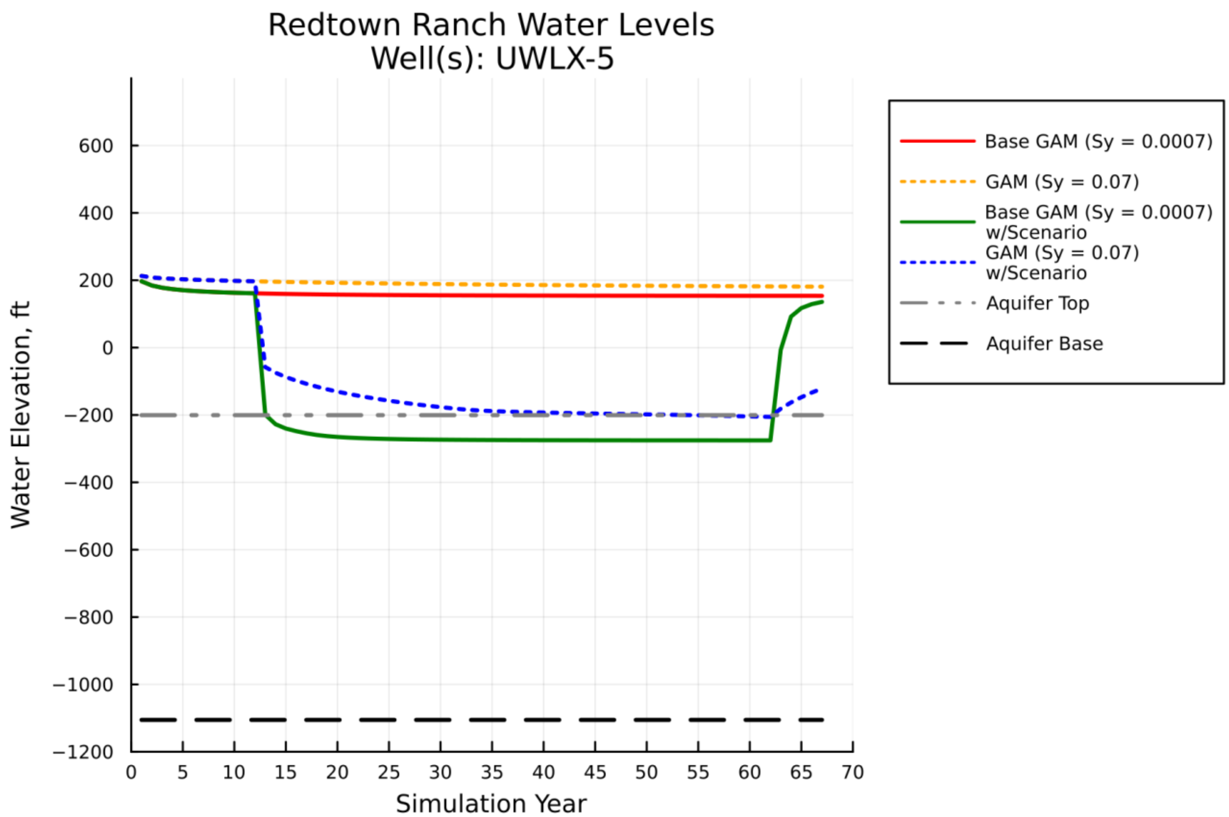
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): UWLX-5
Water Elevation, ft
Simulation Year
600
400
200
0
−200
−400
−600
−800
−1000
−1200
0
5
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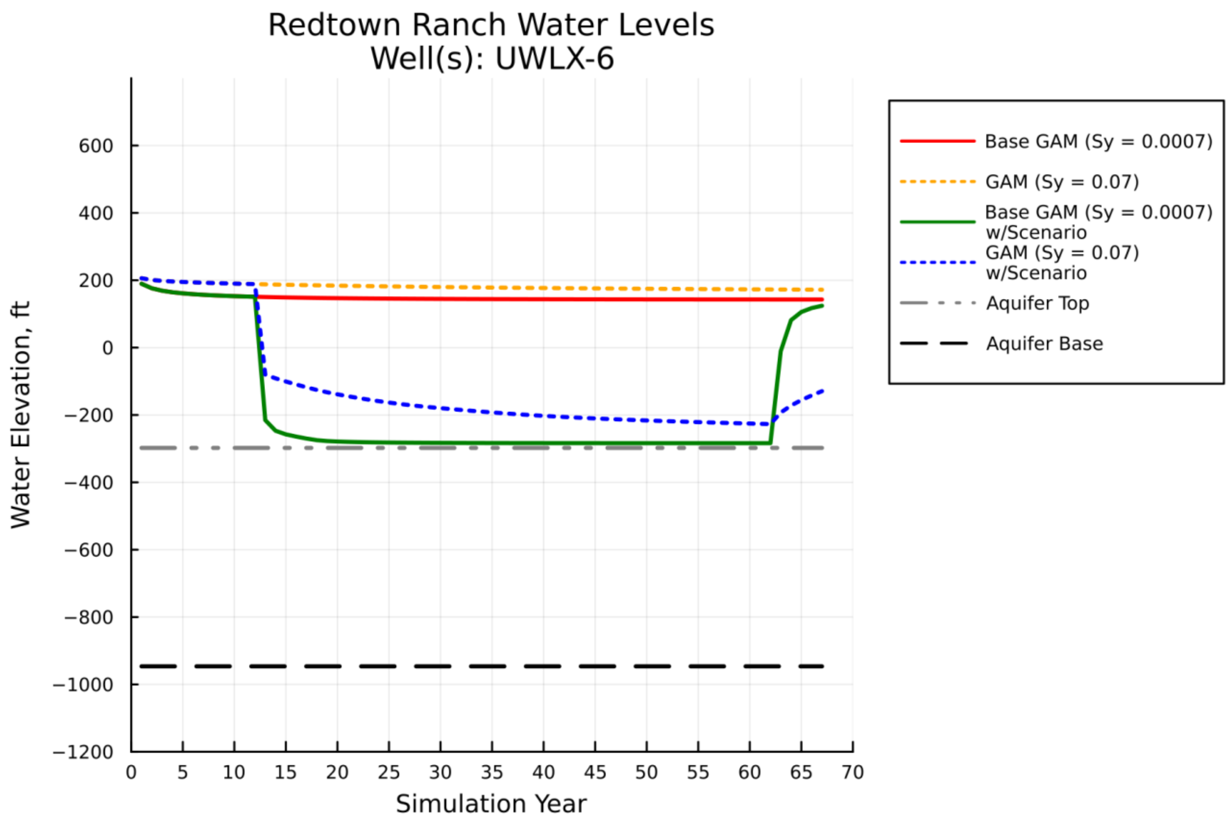
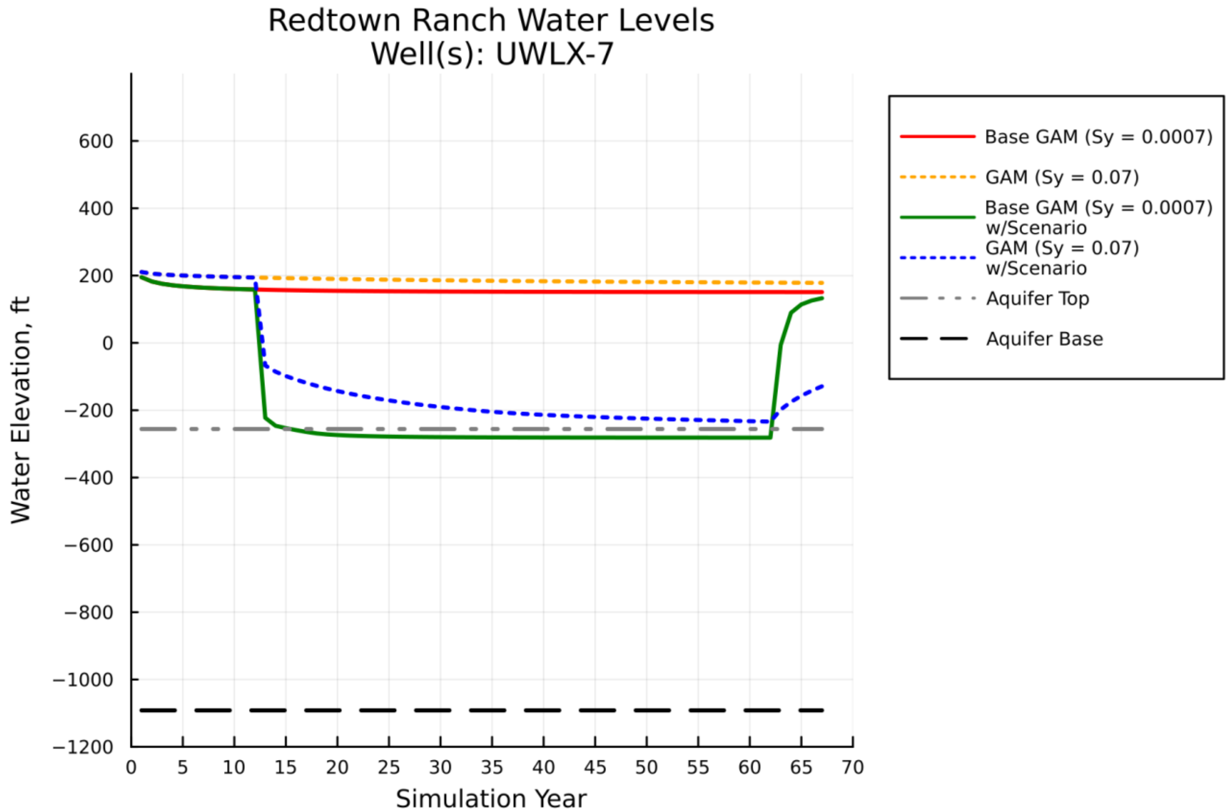
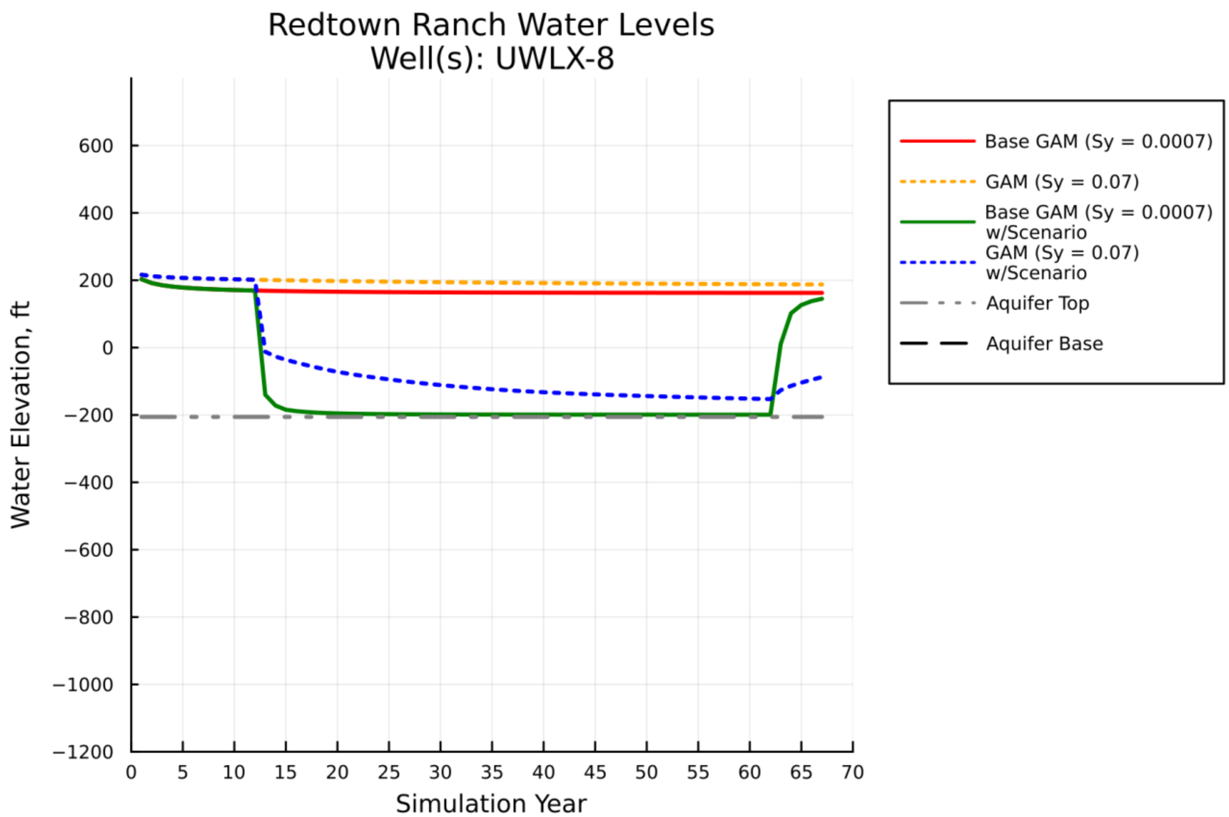
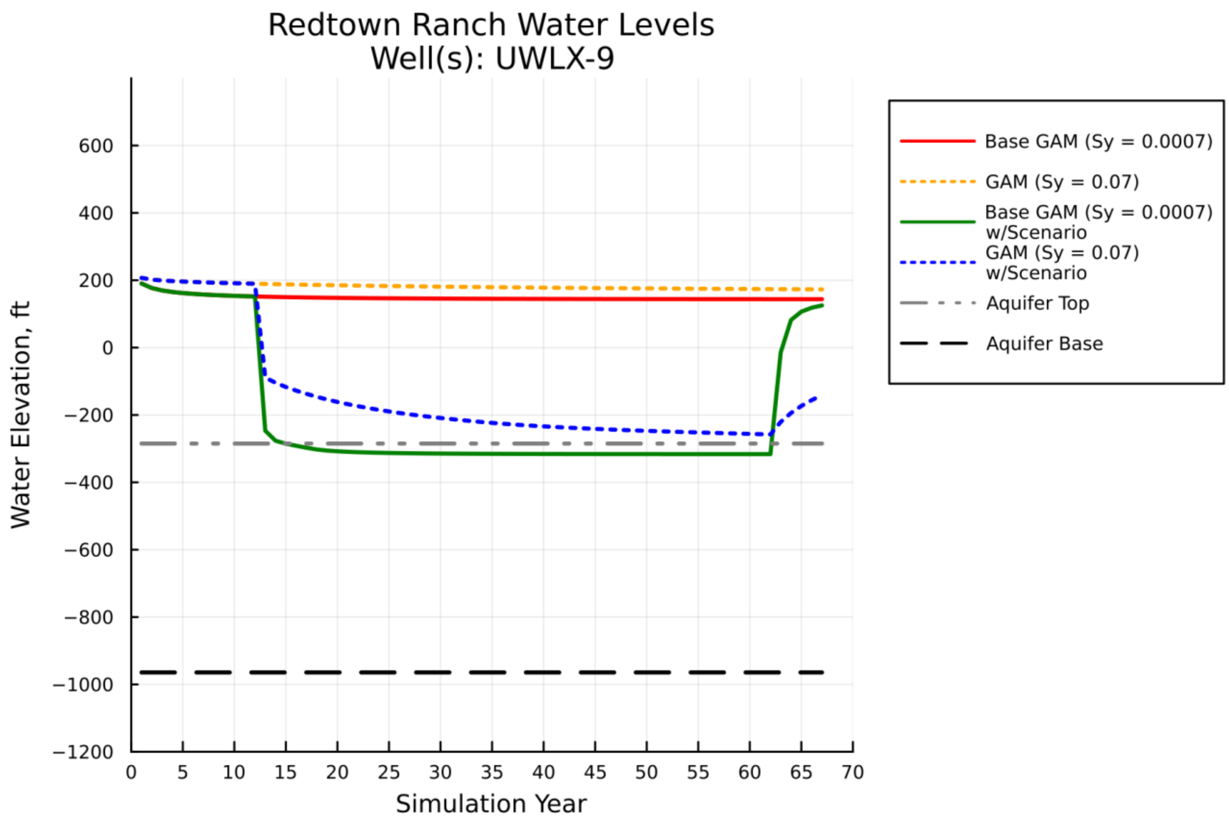
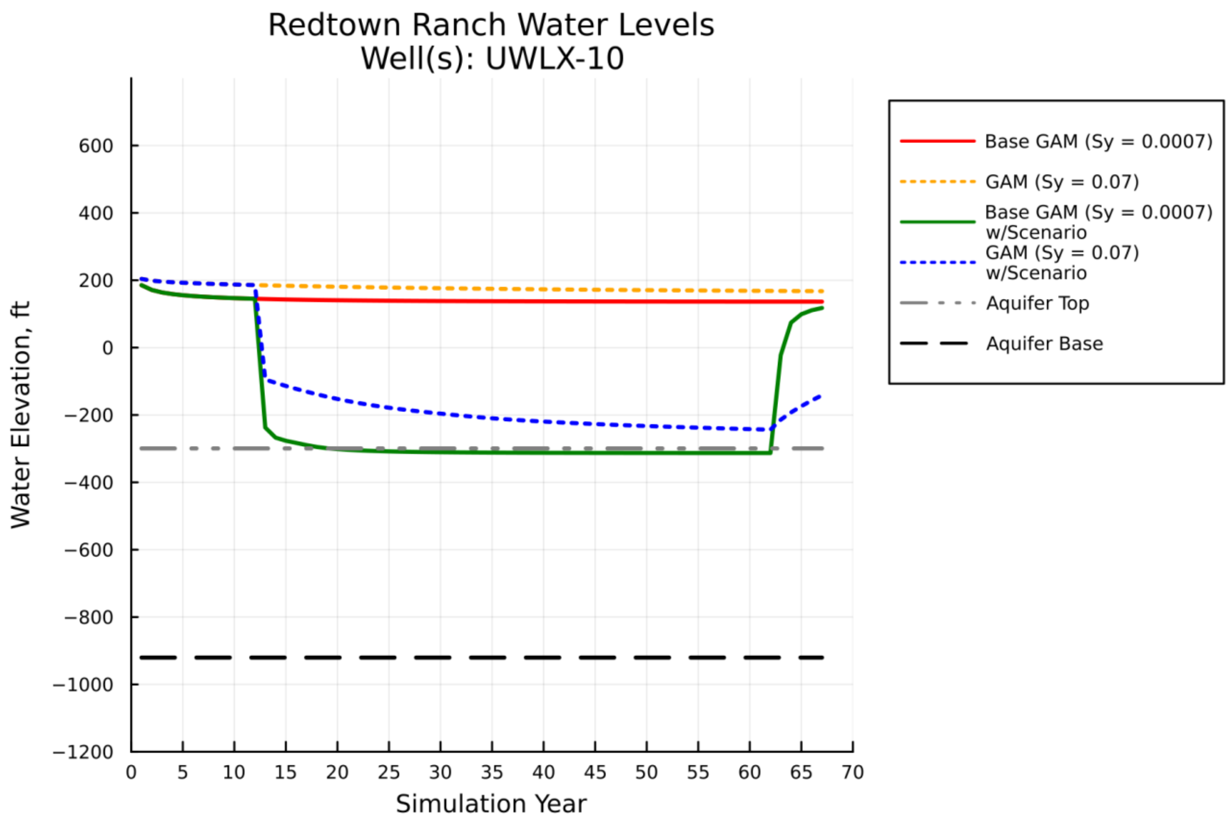
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

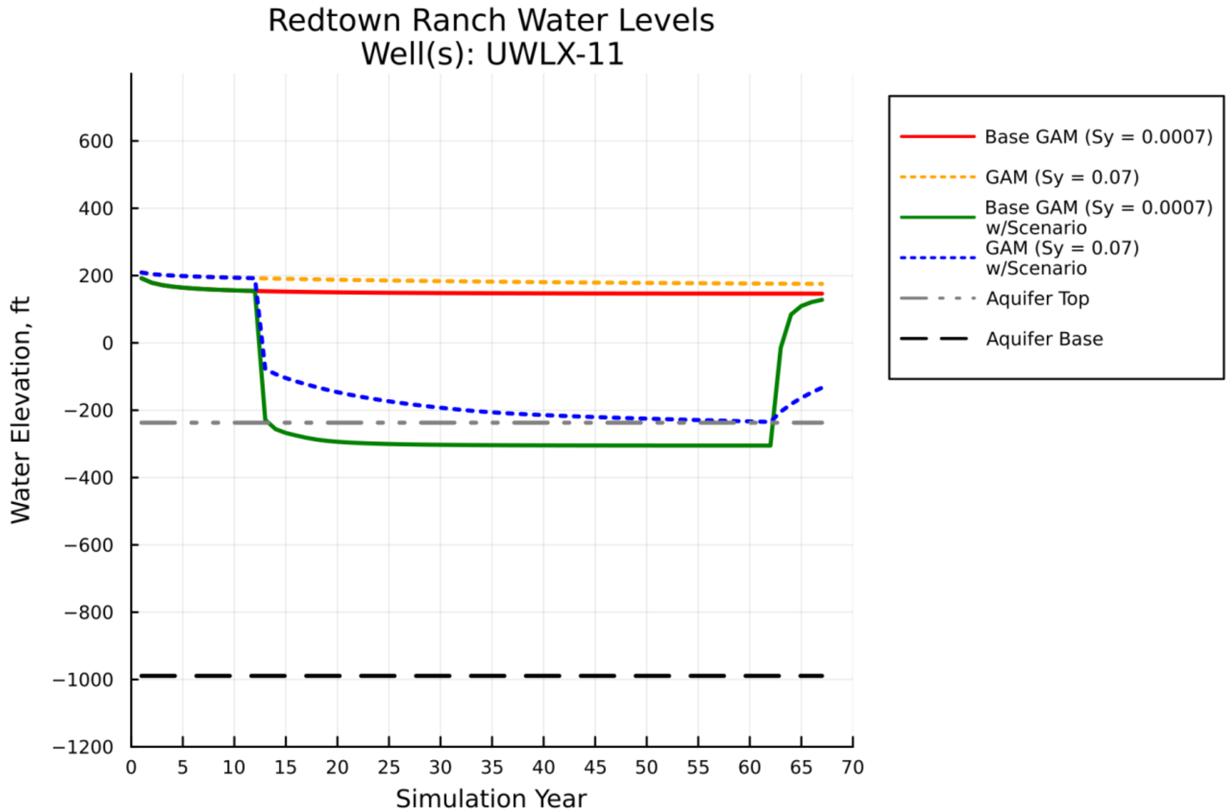

Redtown Ranch Water Levels
Well(s): UWLX-6
Water Elevation, ft
Simulation Year
600
400
200
0
−200
−400
−600
−800
−1000
−1200
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

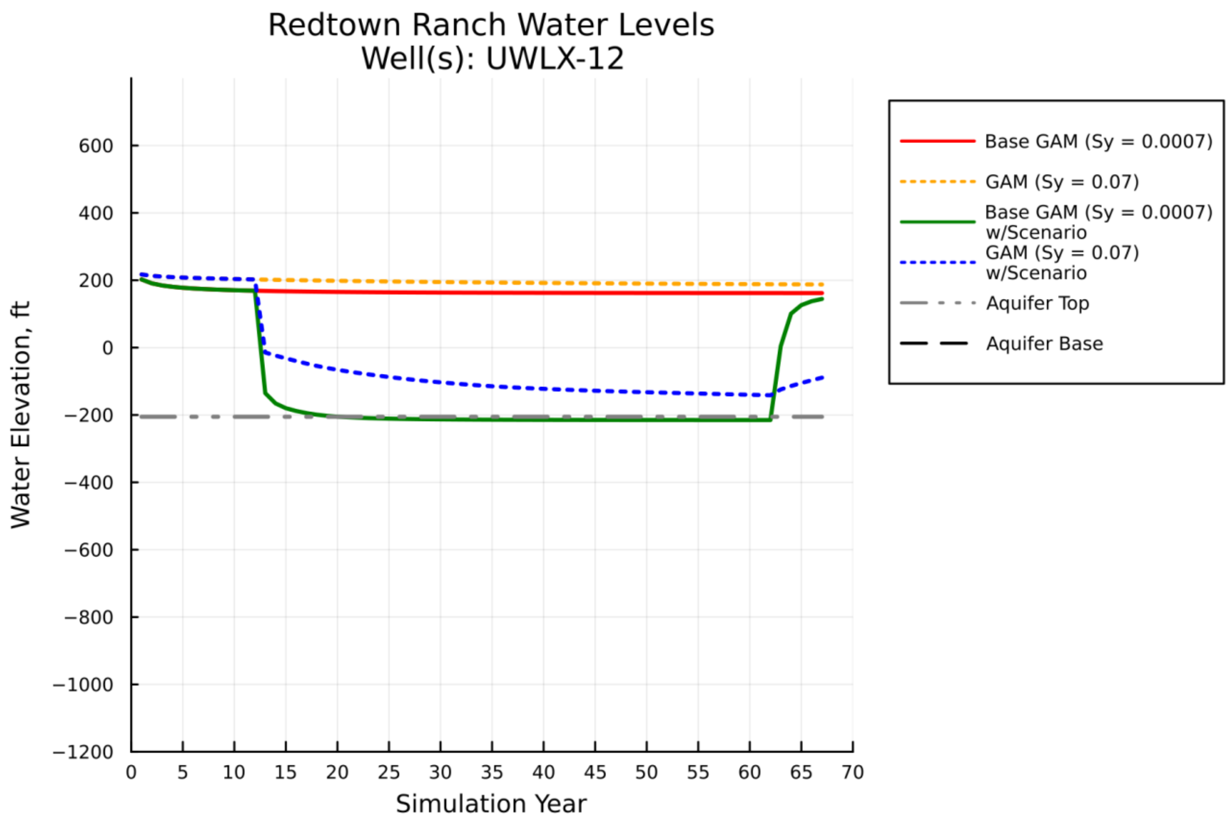

Redtown Ranch Water Levels
Well(s): UWLX-7
Water Elevation, ft
600
400
200
0
−200
−400
−600
−800
−1000
−1200
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

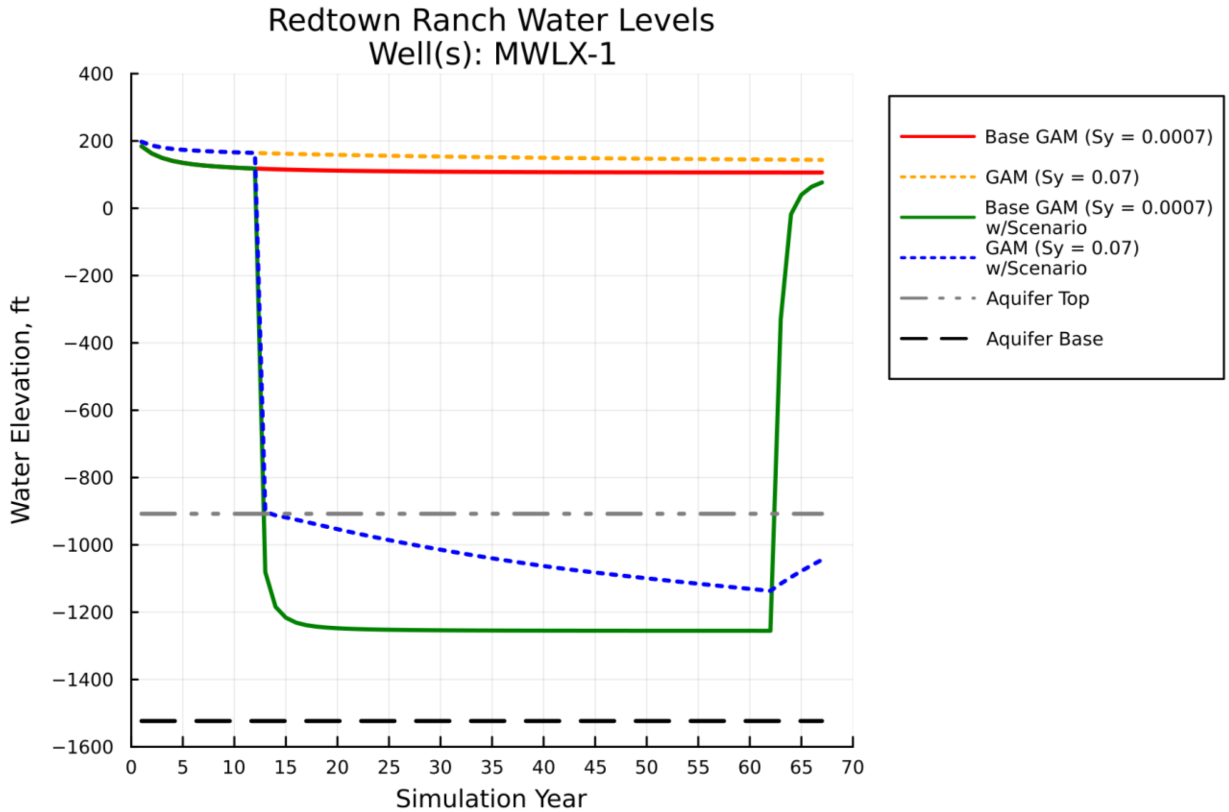

Redtown Ranch Water Levels
Well(s): UWLX-8
Water Elevation, ft
Simulation Year
600
400
200
0
−200
−400
−600
−800
−1000
−1200
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

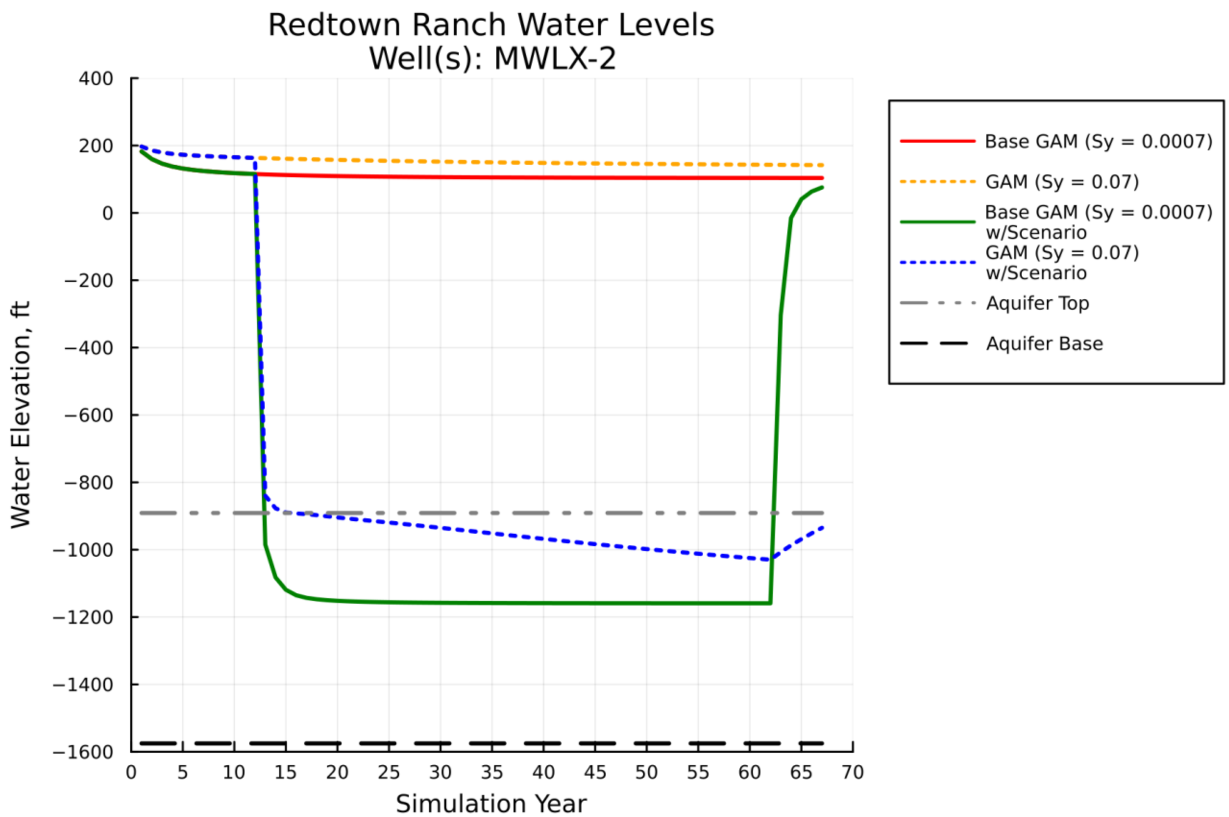

Redtown Ranch Water Levels
Well(s): UWLX-9
Water Elevation, ft
Simulation Year
600
400
200
0
−200
−400
−600
−800
−1000
−1200
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

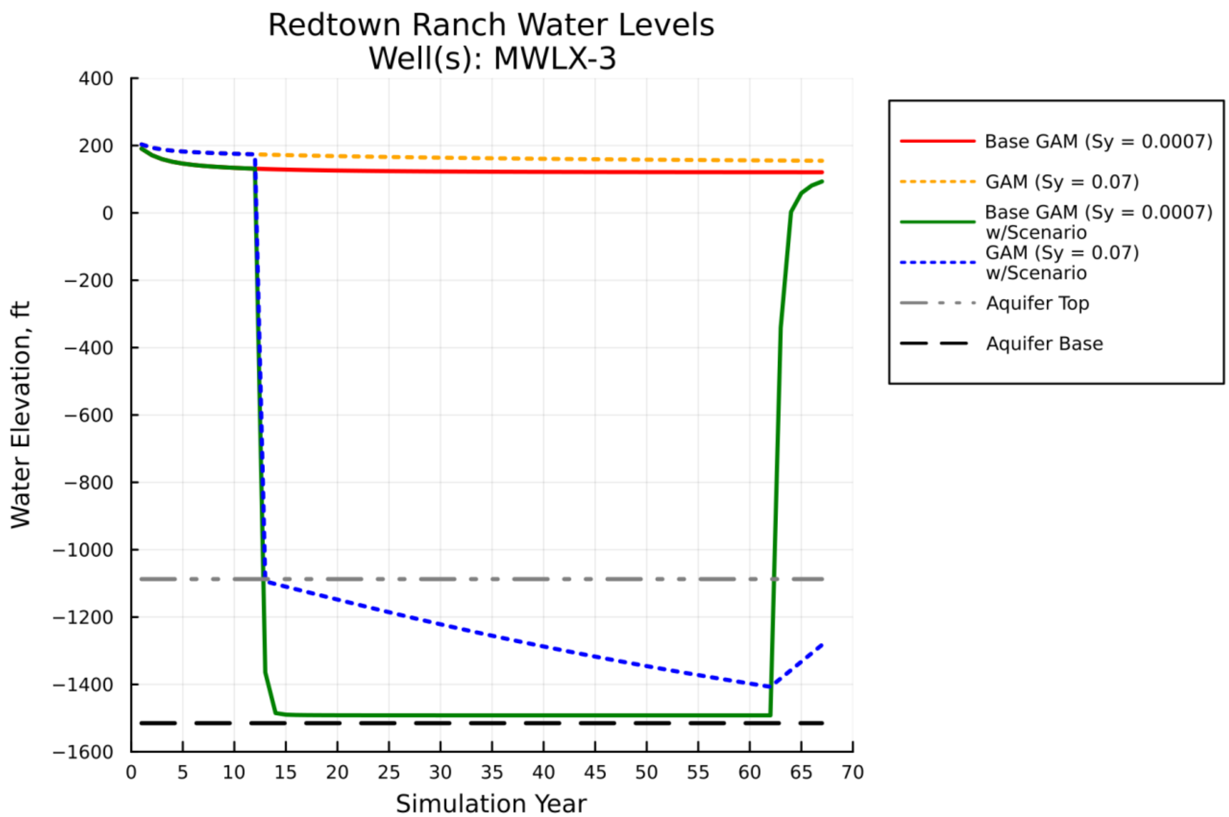

Redtown Ranch Water Levels
Well(s): UWLX-10
Water Elevation, ft
Simulation Year
600
400
200
0
−200
−400
−600
−800
−1000
−1200
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

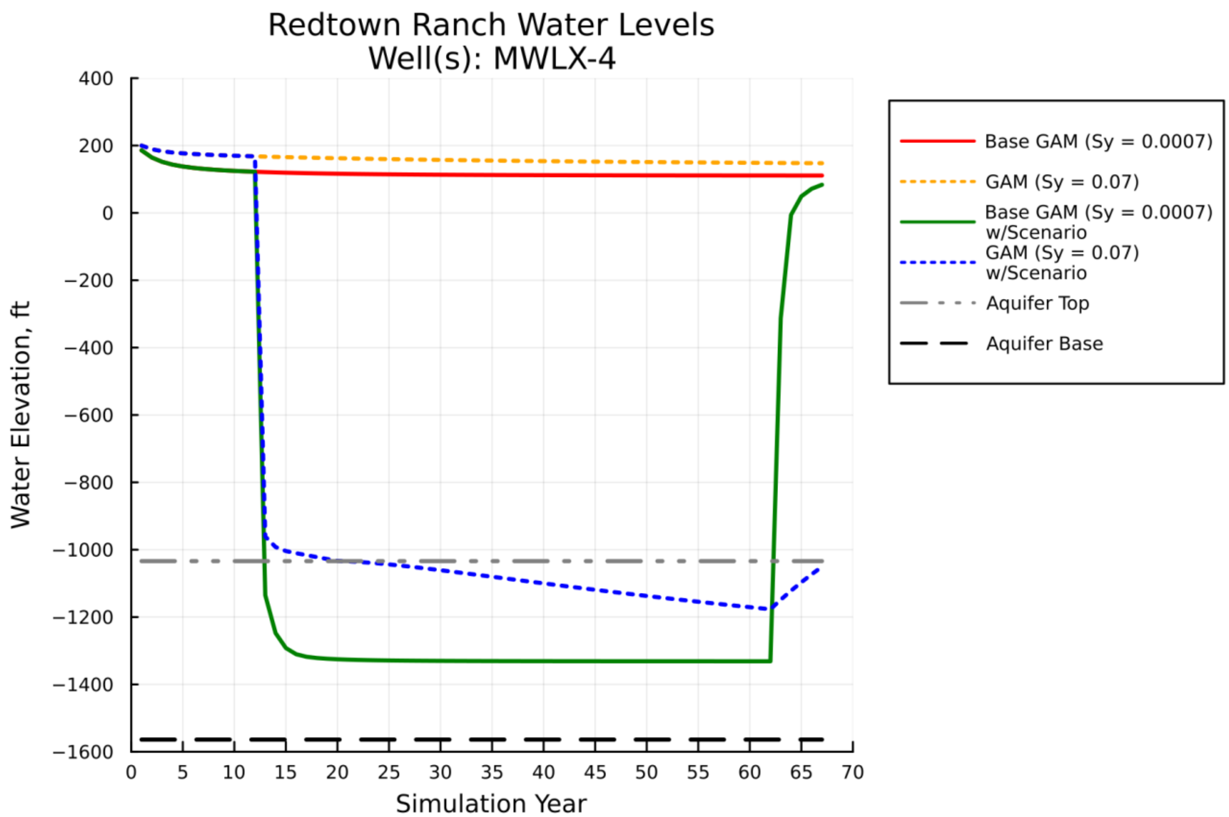

Redtown Ranch Water Levels
Well(s): UWLX-11
Water Elevation, ft
Simulation Year
600
400
200
0
−200
−400
−600
−800
−1000
−1200
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

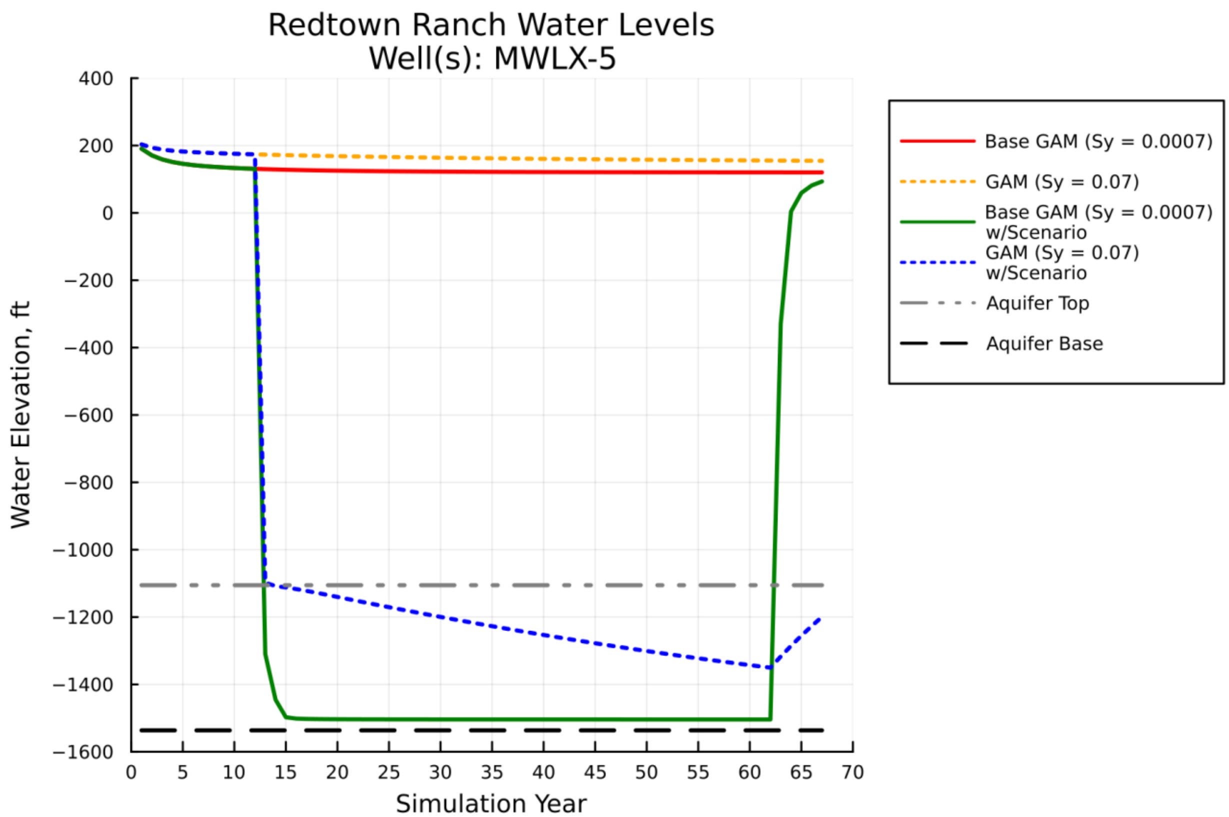

Redtown Ranch Water Levels
Well(s): UWLX-12
Water Elevation, ft
600
400
200
0
−200
−400
−600
−800
−1000
−1200
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

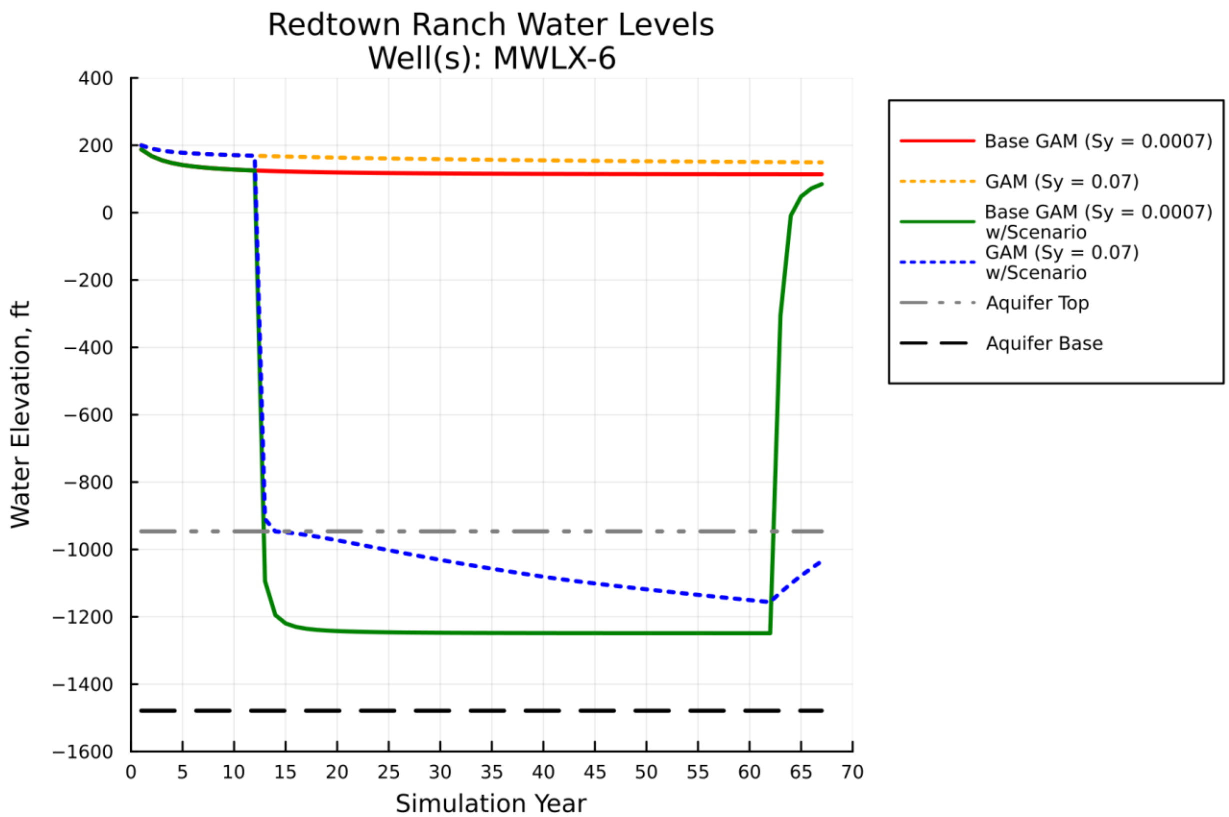

Redtown Ranch Water Levels
Well(s): MWLX-1
Water Elevation, ft
Simulation Year
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

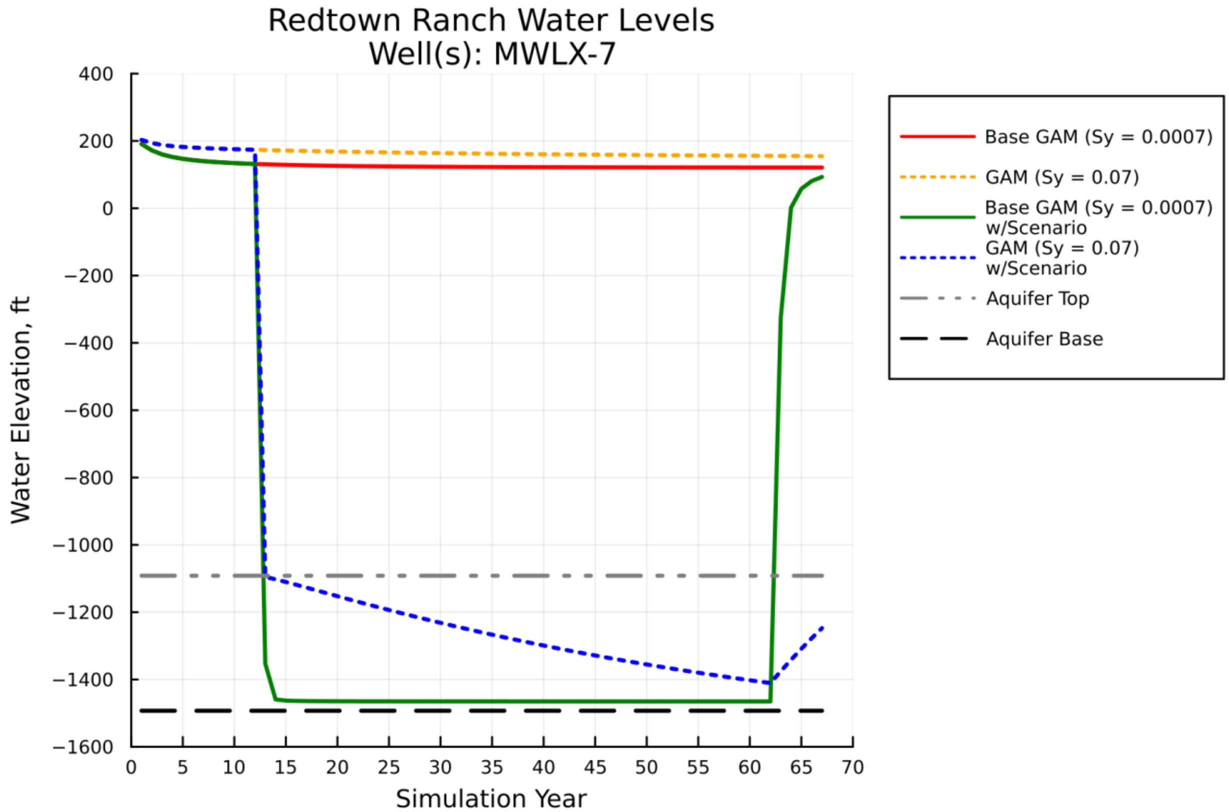

Redtown Ranch Water Levels
Well(s): MWLX-2
Water Elevation, ft
Simulation Year
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

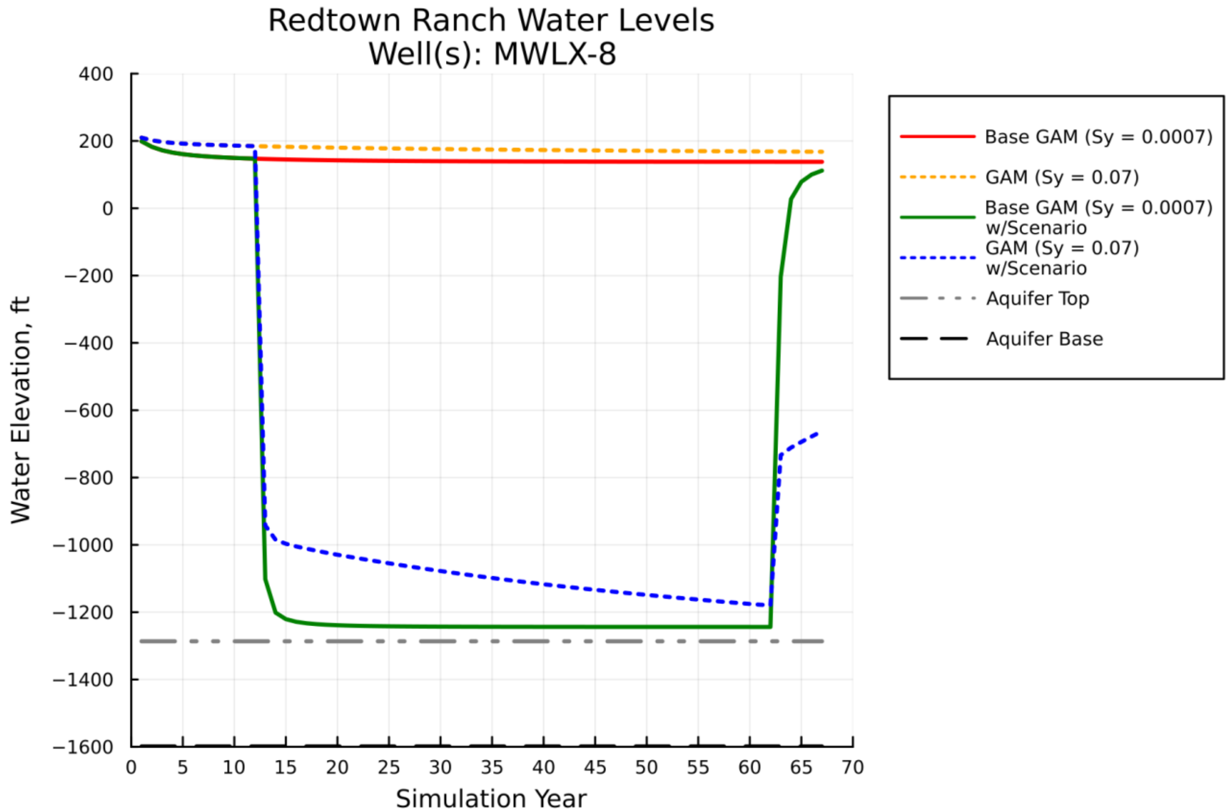

Redtown Ranch Water Levels
Well(s): MWLX-3
Water Elevation, ft
Simulation Year
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

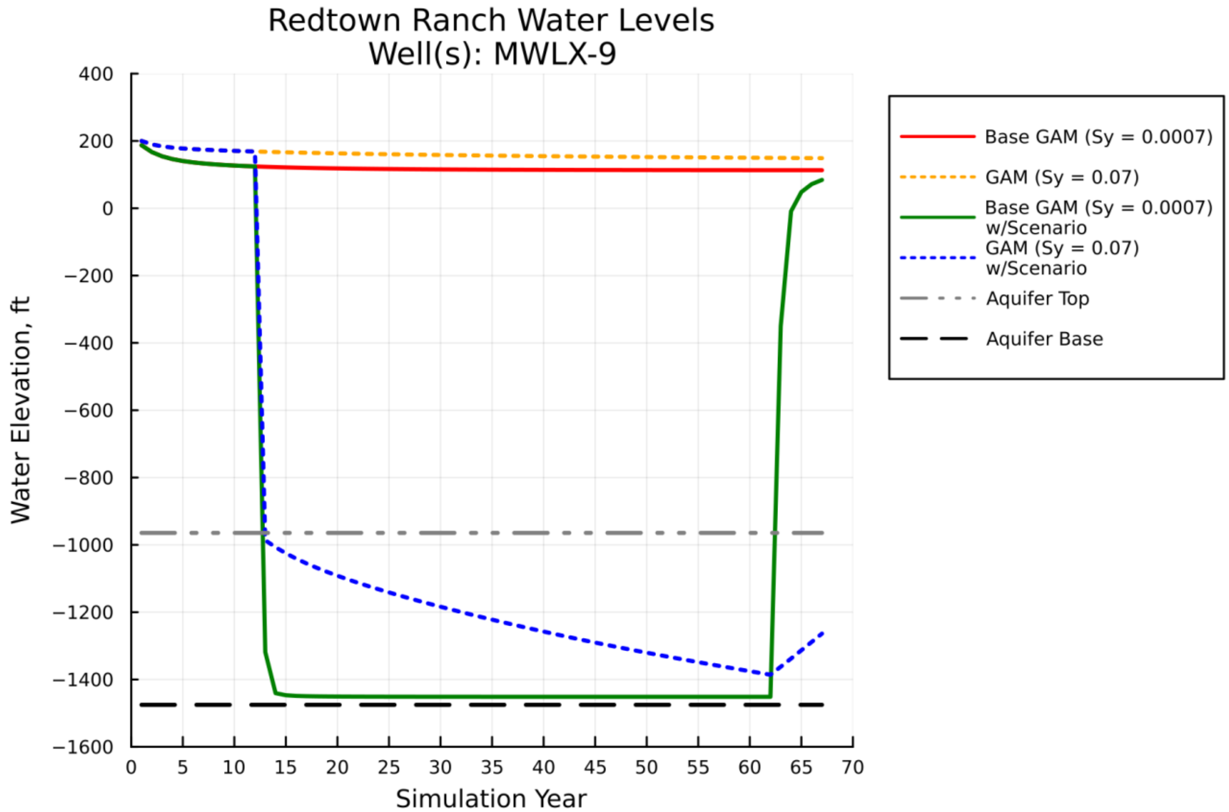

Redtown Ranch Water Levels
Well(s): MWLX-4
Water Elevation, ft
Simulation Year
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

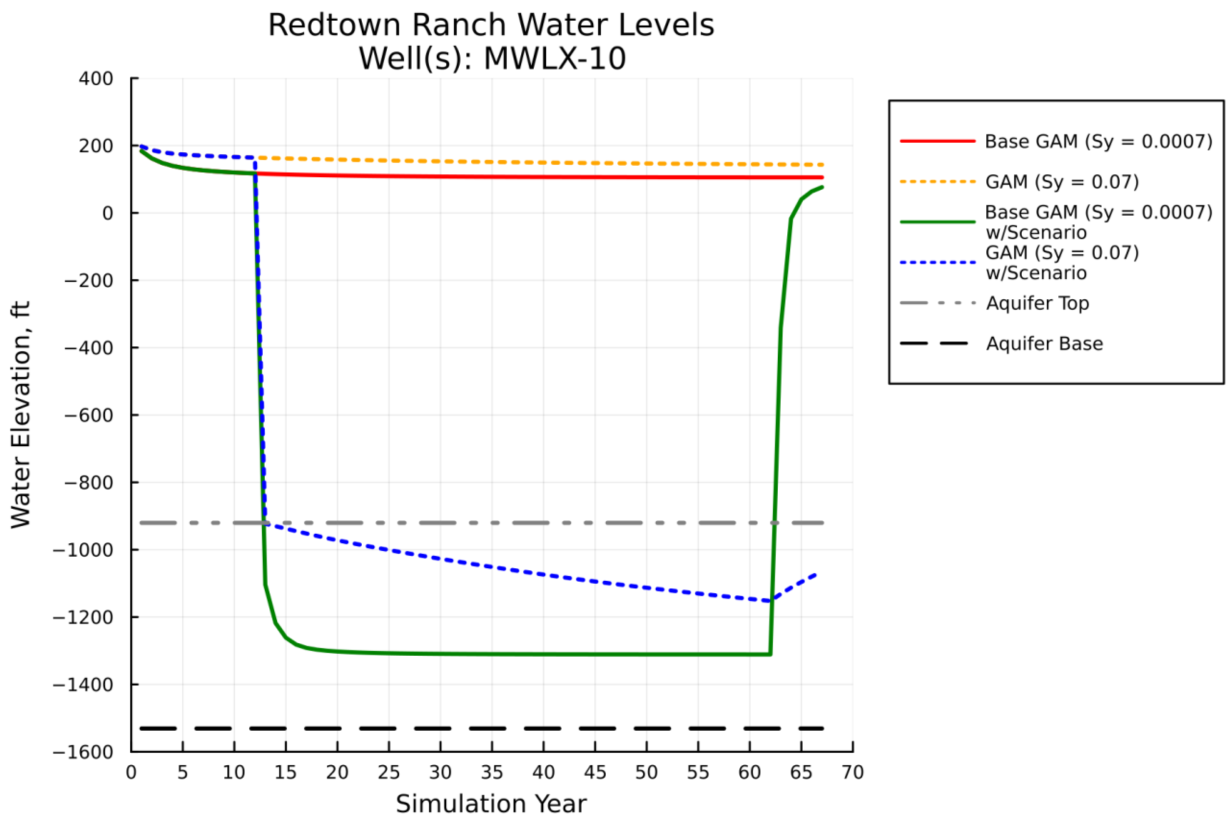

Redtown Ranch Water Levels
Well(s): MWLX-5
Water Elevation, ft
Simulation Year
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

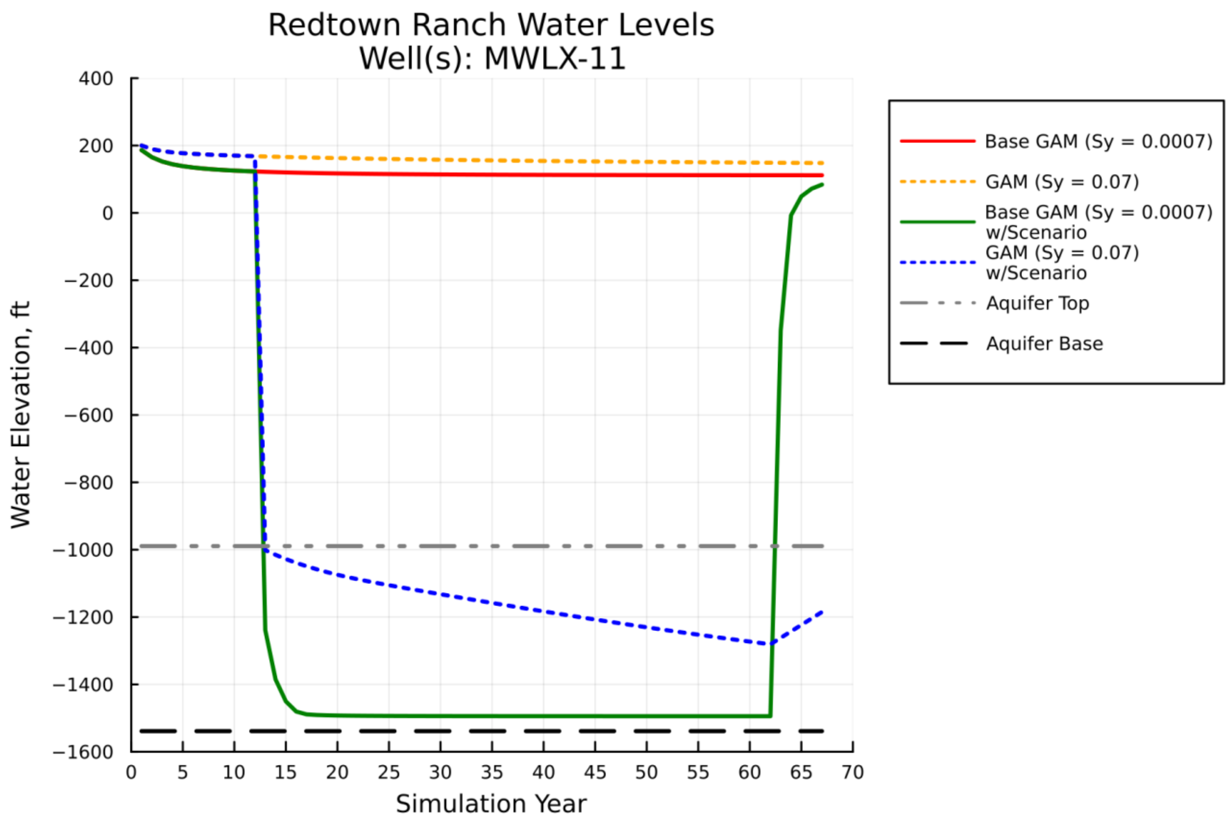

Redtown Ranch Water Levels
Well(s): MWLX-6
Water Elevation, ft
Simulation Year
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

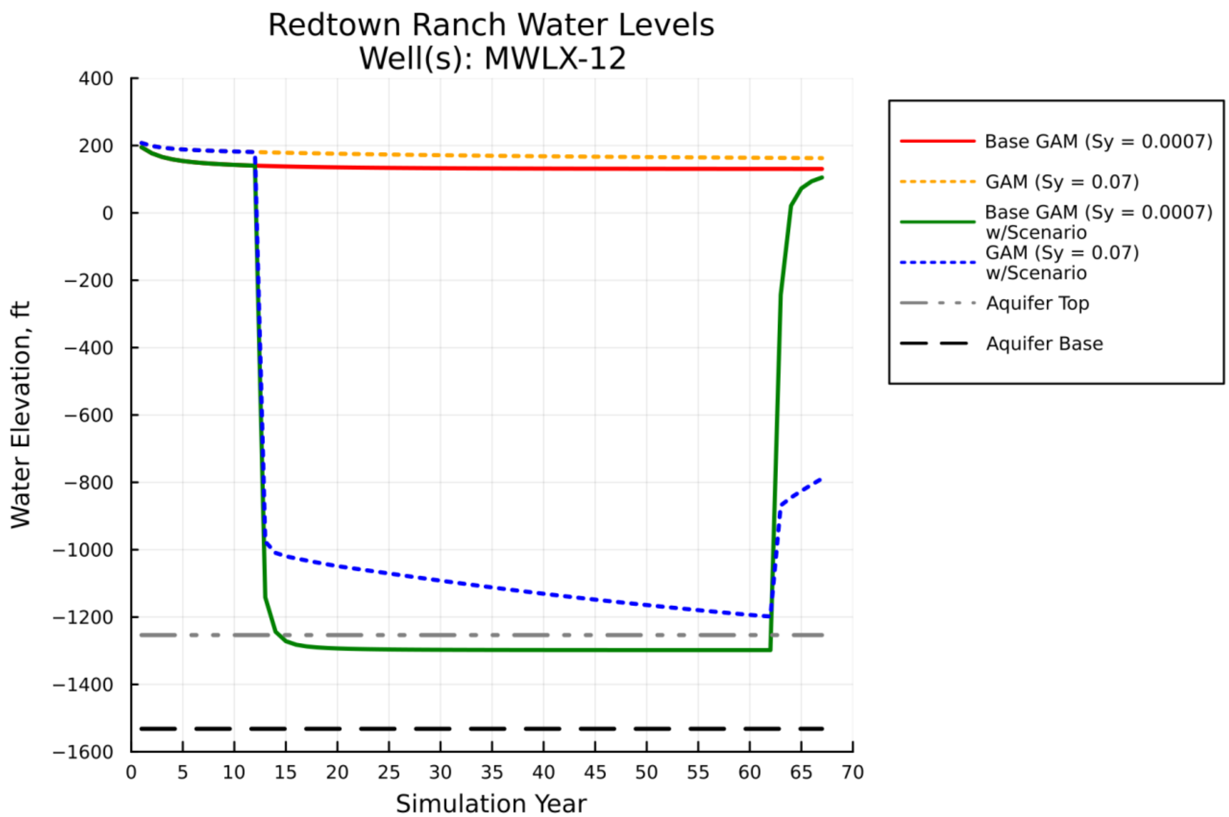

Redtown Ranch Water Levels
Well(s): MWLX-7
Water Elevation, ft
Simulation Year
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): MWLX-8
Water Elevation, ft
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base


Redtown Ranch Water Levels
Well(s): MWLX-9
Water Elevation, ft
Simulation Year
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

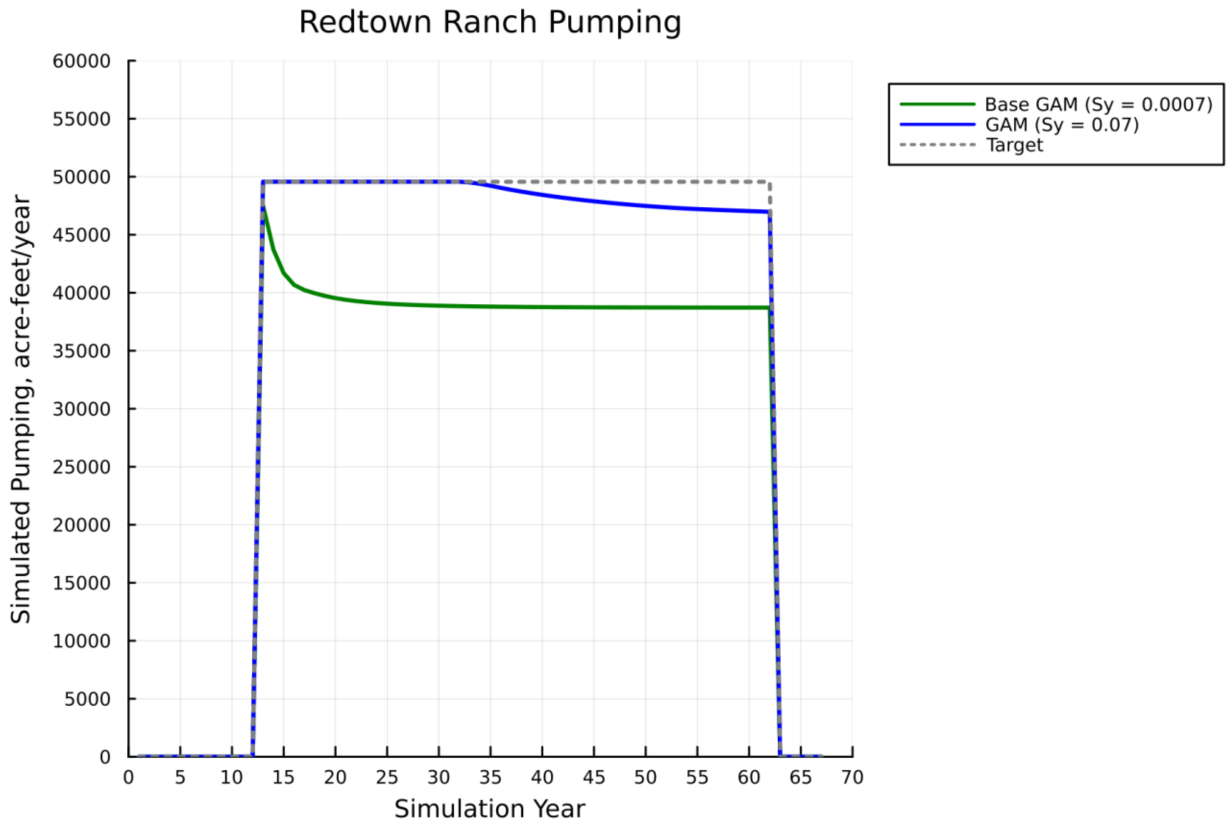

Redtown Ranch Water Levels
Well(s): MWLX-10
Water Elevation, ft
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

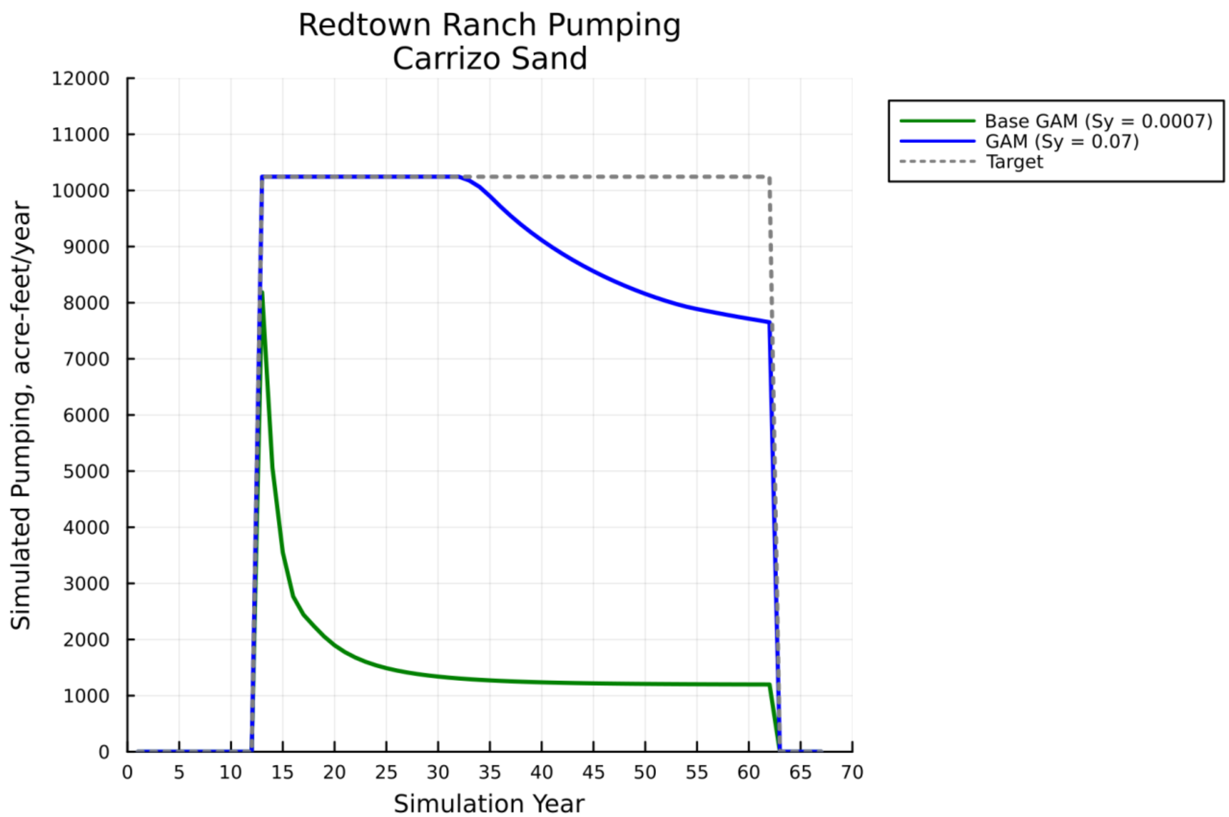

Redtown Ranch Water Levels
Well(s): MWLX-11
Water Elevation, ft
Simulation Year
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

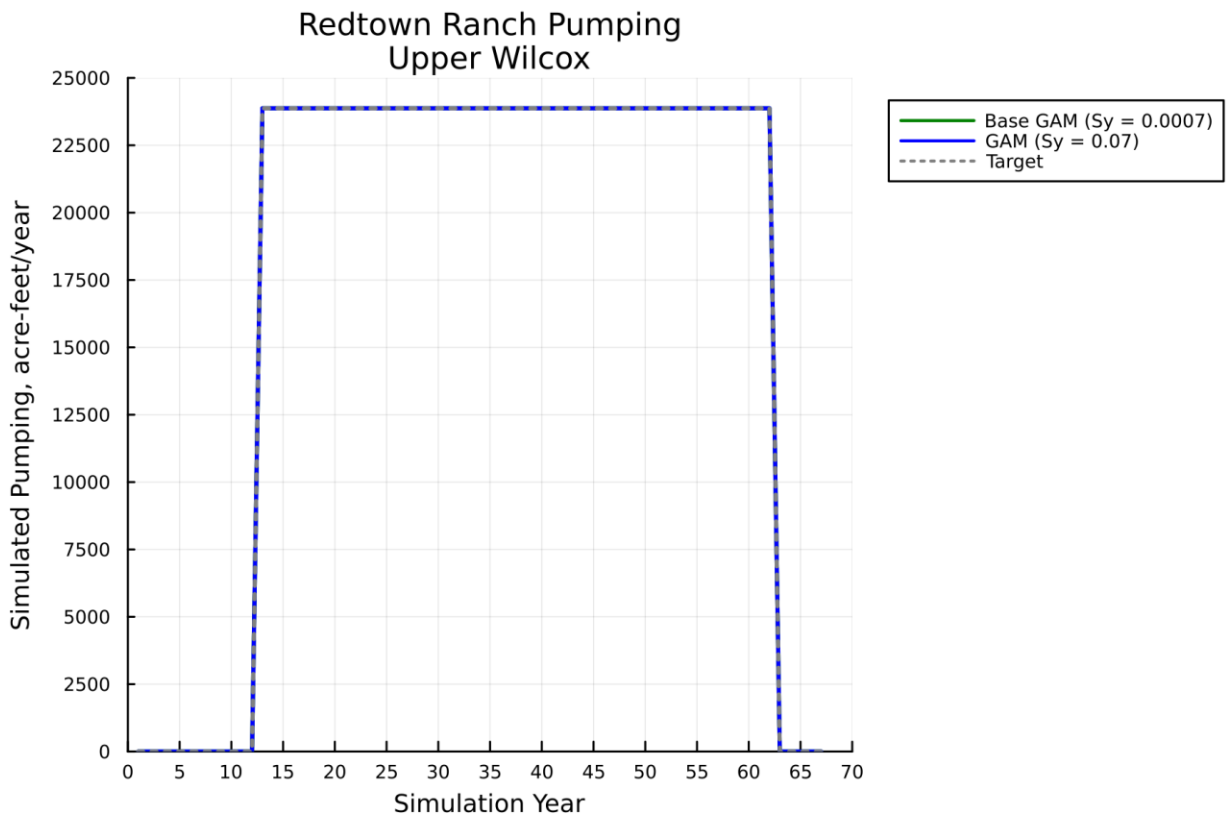

Redtown Ranch Water Levels
Well(s): MWLX-12
Water Elevation, ft
Simulation Year
400
200
0
−200
−400
−600
−800
−1000
−1200
−1400
−1600
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Base GAM (Sy = 0.0007) w/Scenario
GAM (Sy = 0.07) w/Scenario
Aquifer Top
Aquifer Base

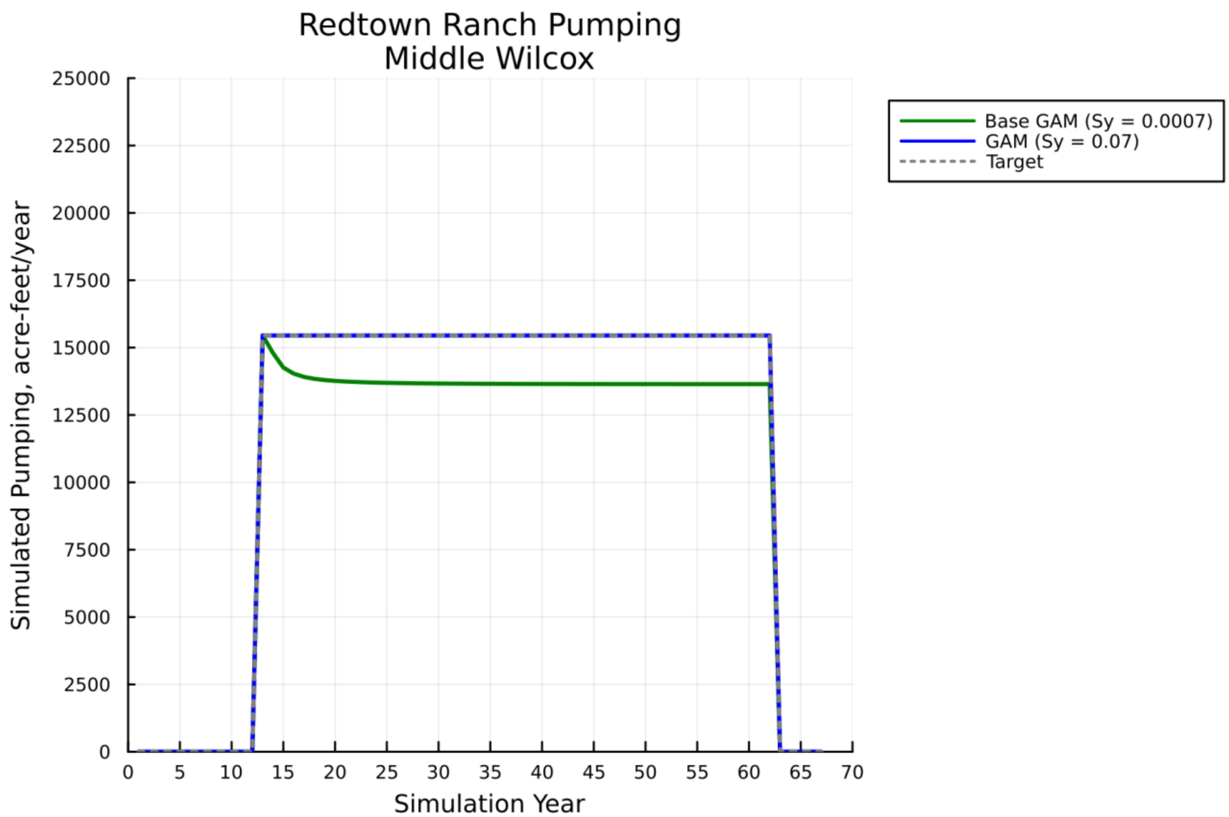
Simulated Pumping for
Redtown Ranch Proposed Wells

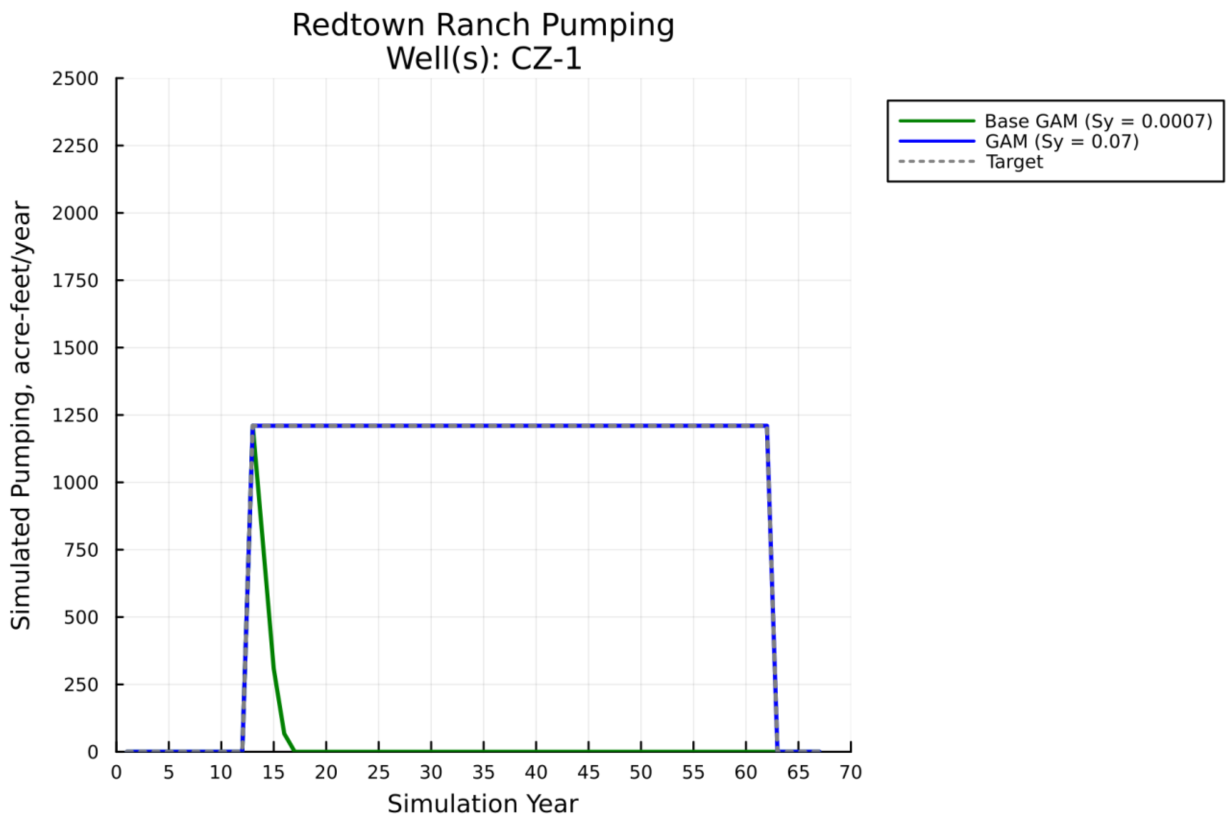
KT GROUNDWATER

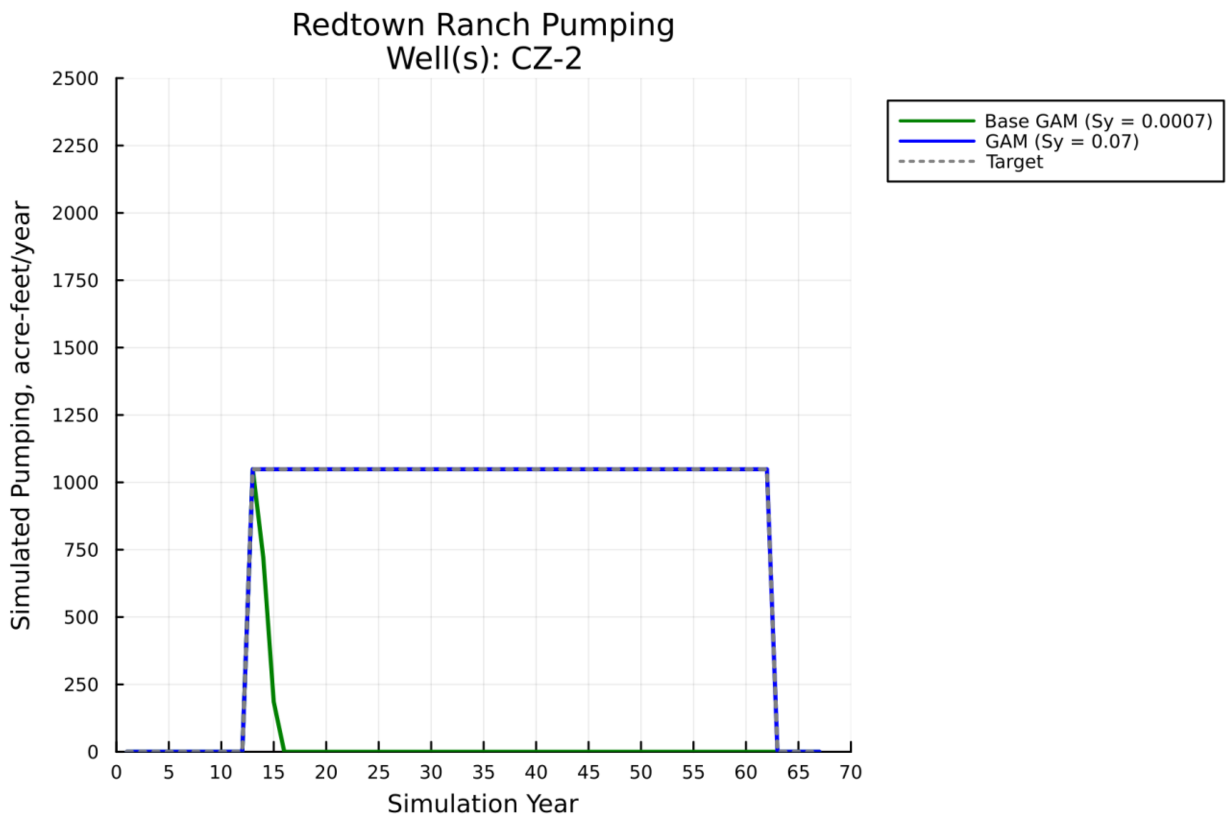

Redtown Ranch Pumping
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

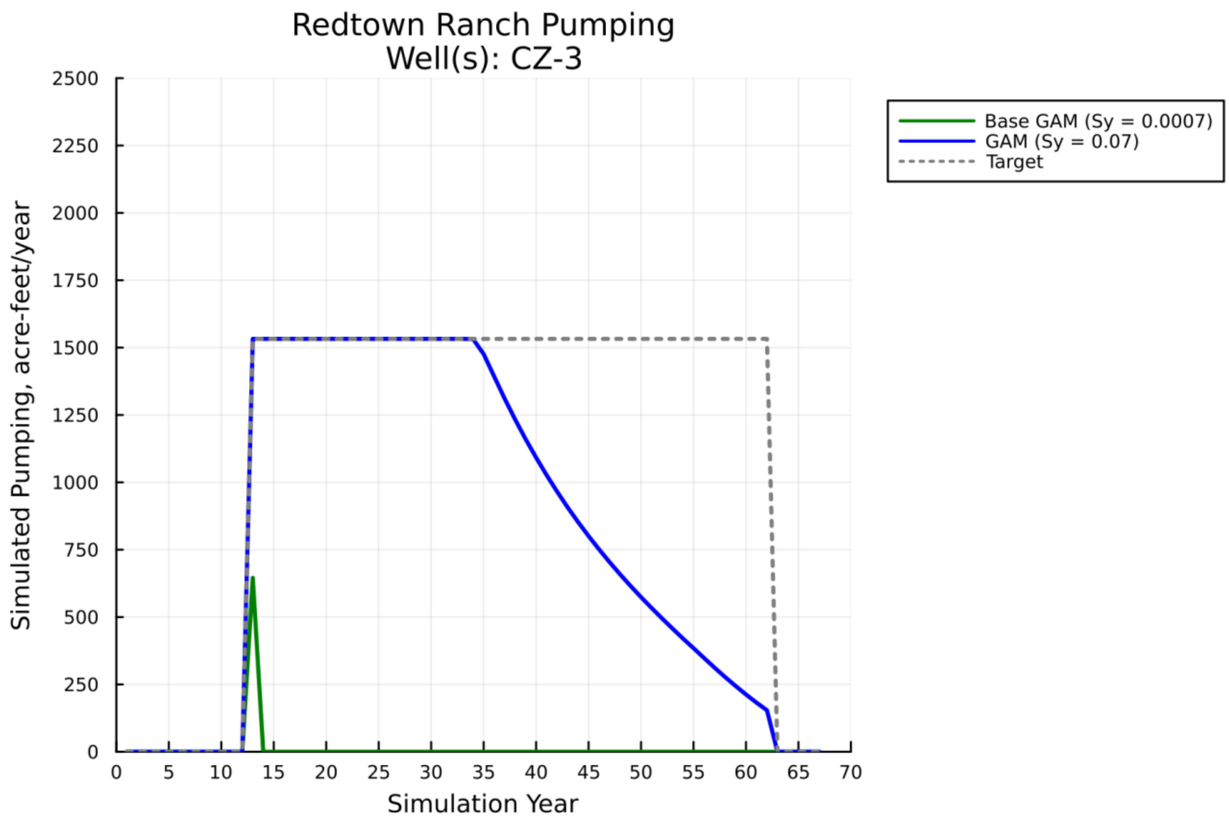

Redtown Ranch Pumping
Carrizo Sand
Simulated Pumping, acre-feet/year
Simulation Year
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

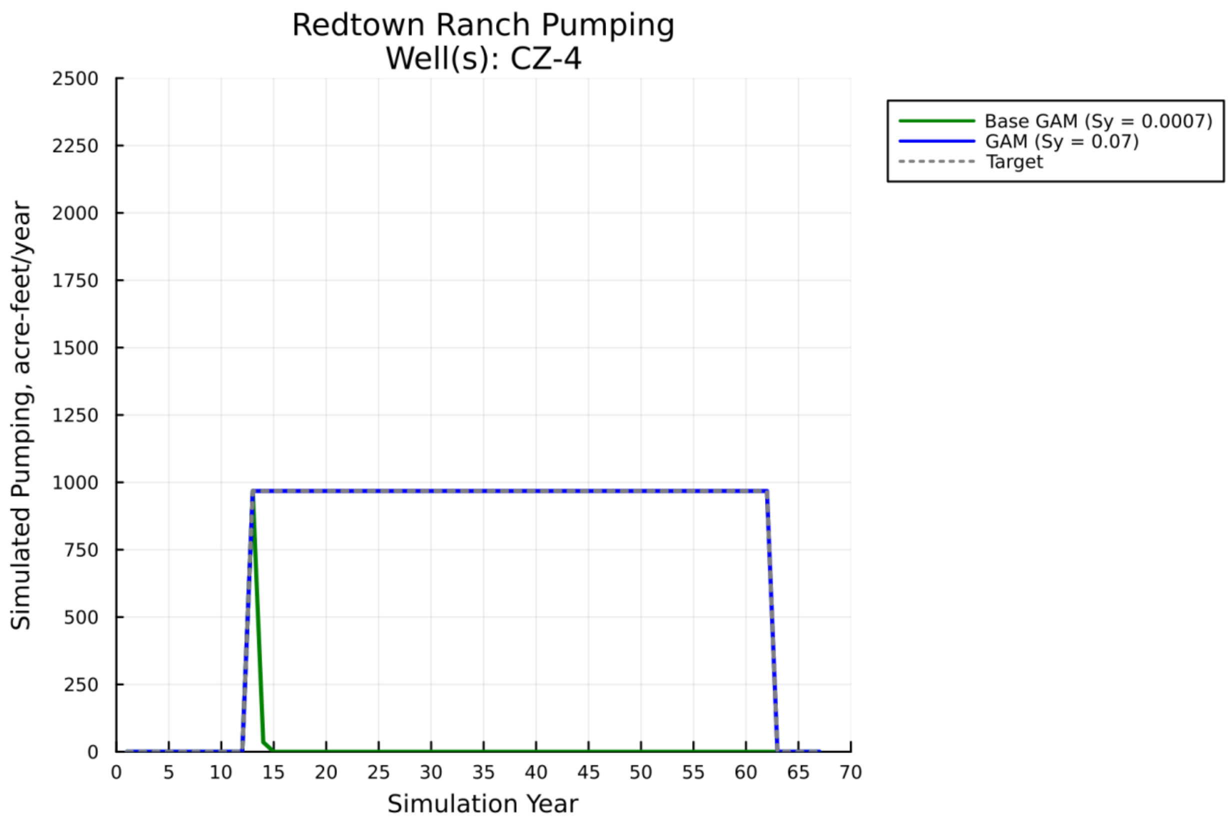

Redtown Ranch Pumping
Upper Wilcox
Simulated Pumping, acre-feet/year
Simulation Year
25000
22500
20000
17500
15000
12500
10000
7500
5000
2500
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

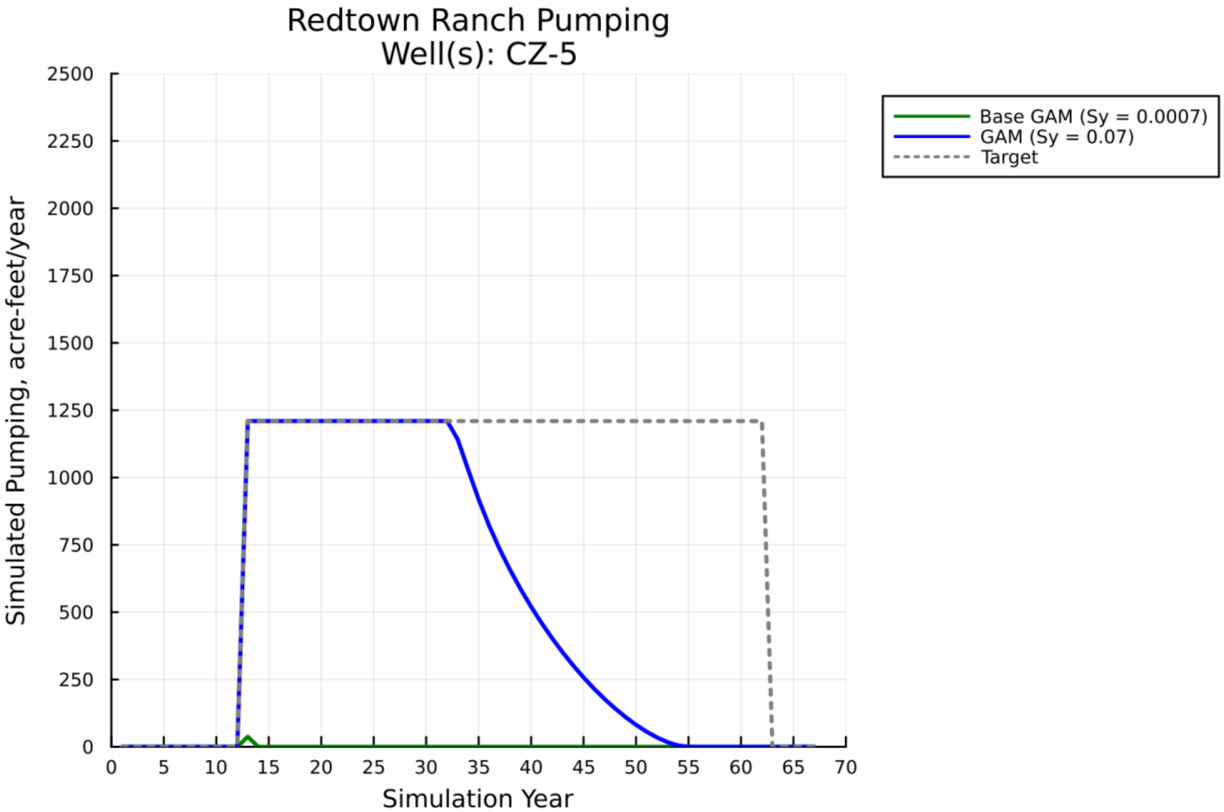

Redtown Ranch Pumping
Middle Wilcox
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
Simulated Pumping, acre-feet/year
Simulation Year
25000
22500
20000
17500
15000
12500
10000
7500
5000
2500
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

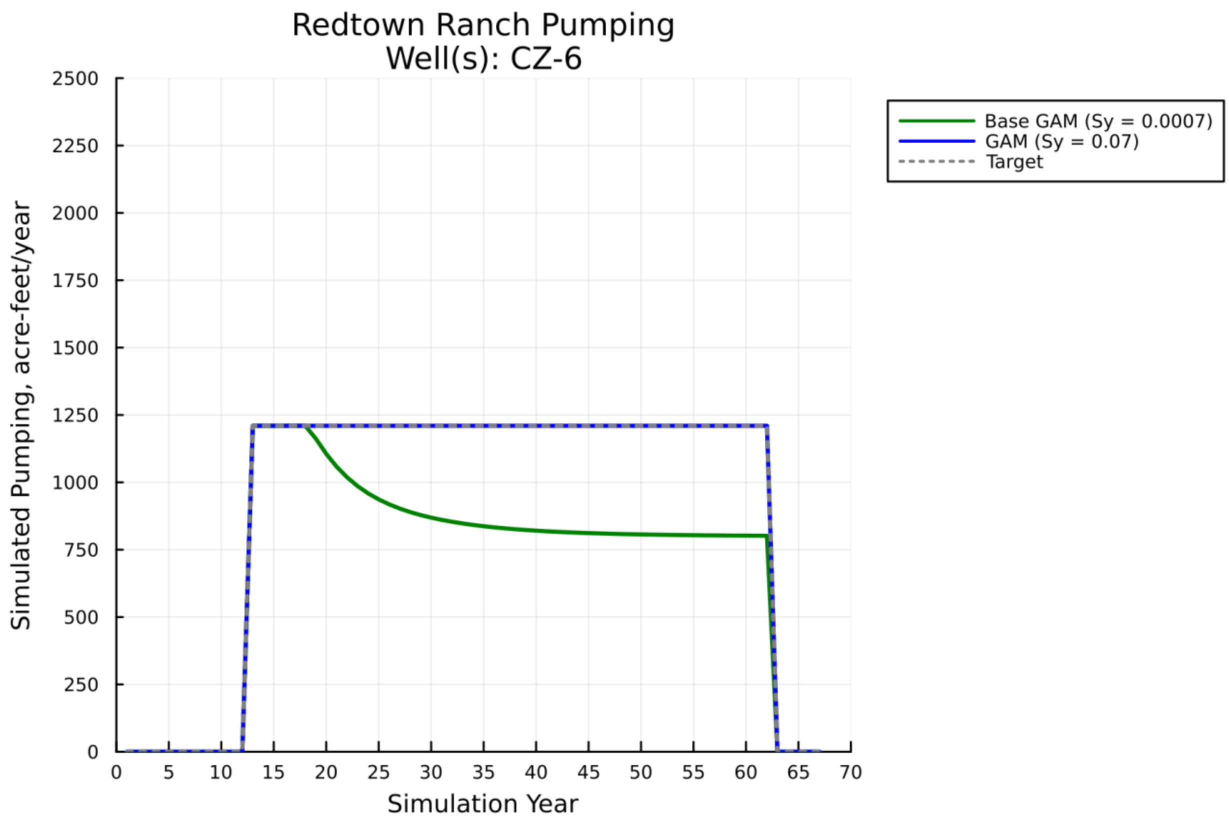

Redtown Ranch Pumping
Well(s): CZ-1
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

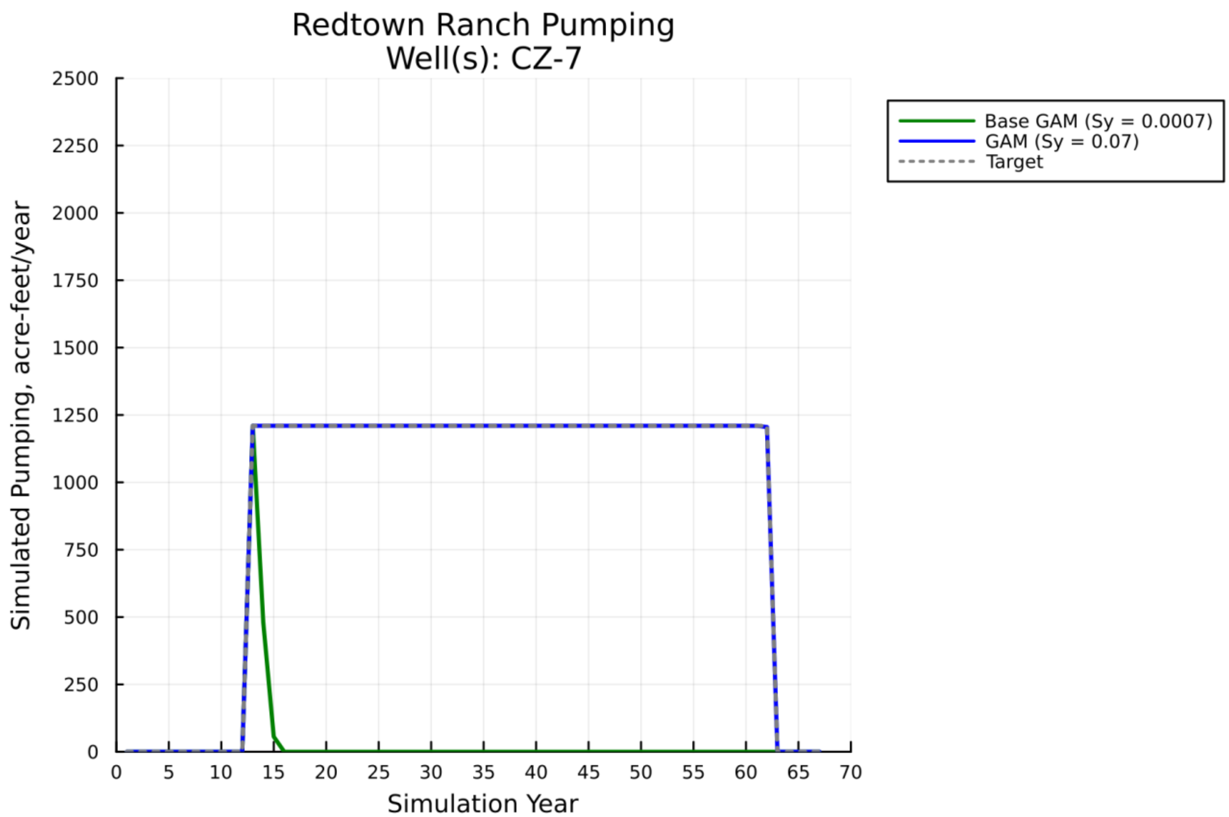

Redtown Ranch Pumping
Well(s): CZ-2
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

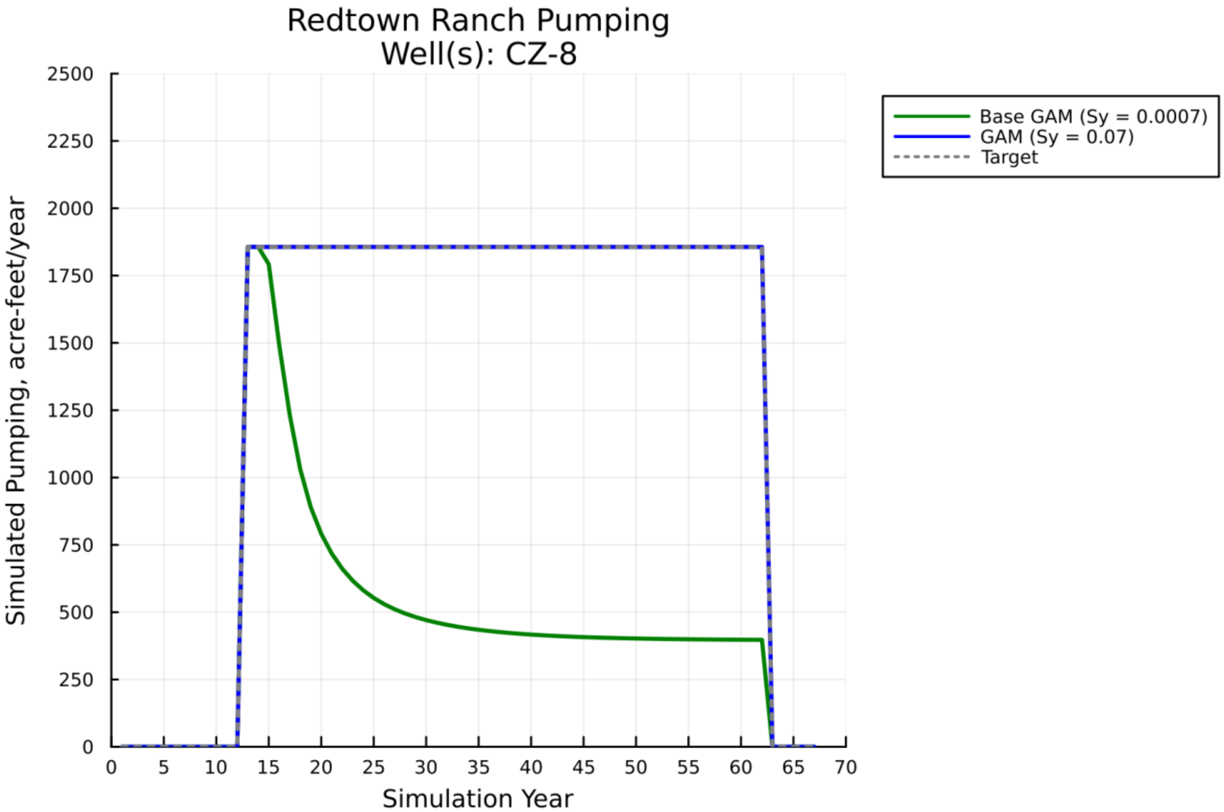

Redtown Ranch Pumping
Well(s): CZ-3
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

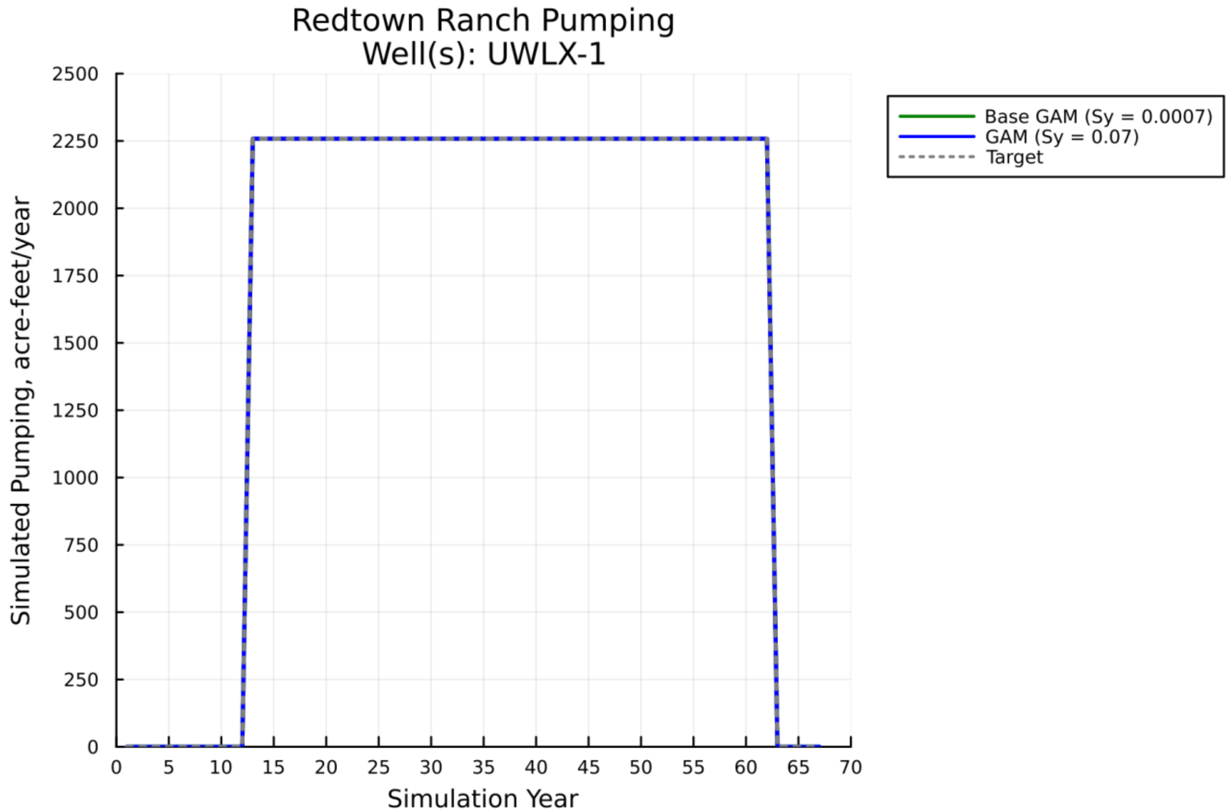

Redtown Ranch Pumping
Well(s): CZ-4
Simulated Pumping, acre-feet/year
Simulation Year
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

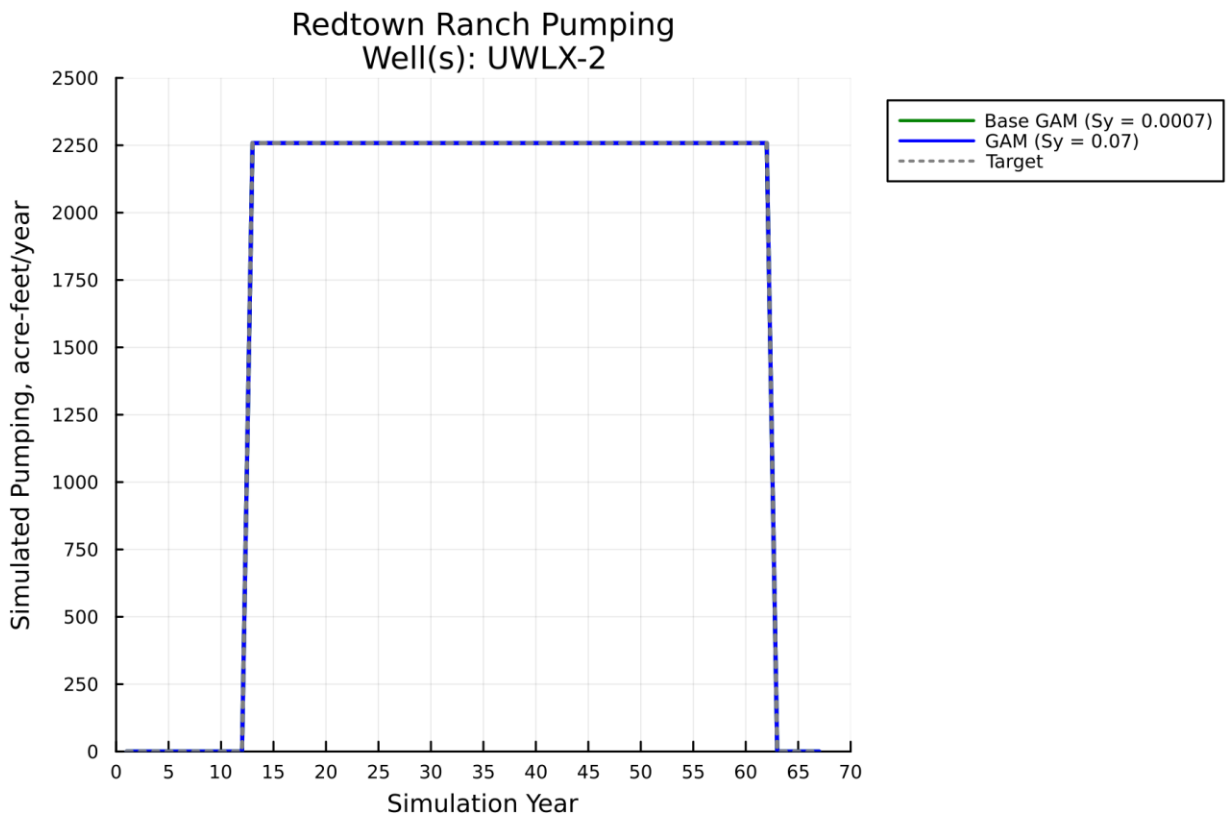

Redtown Ranch Pumping
Well(s): CZ-5
Simulated Pumping, acre-feet/year
Simulation Year
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

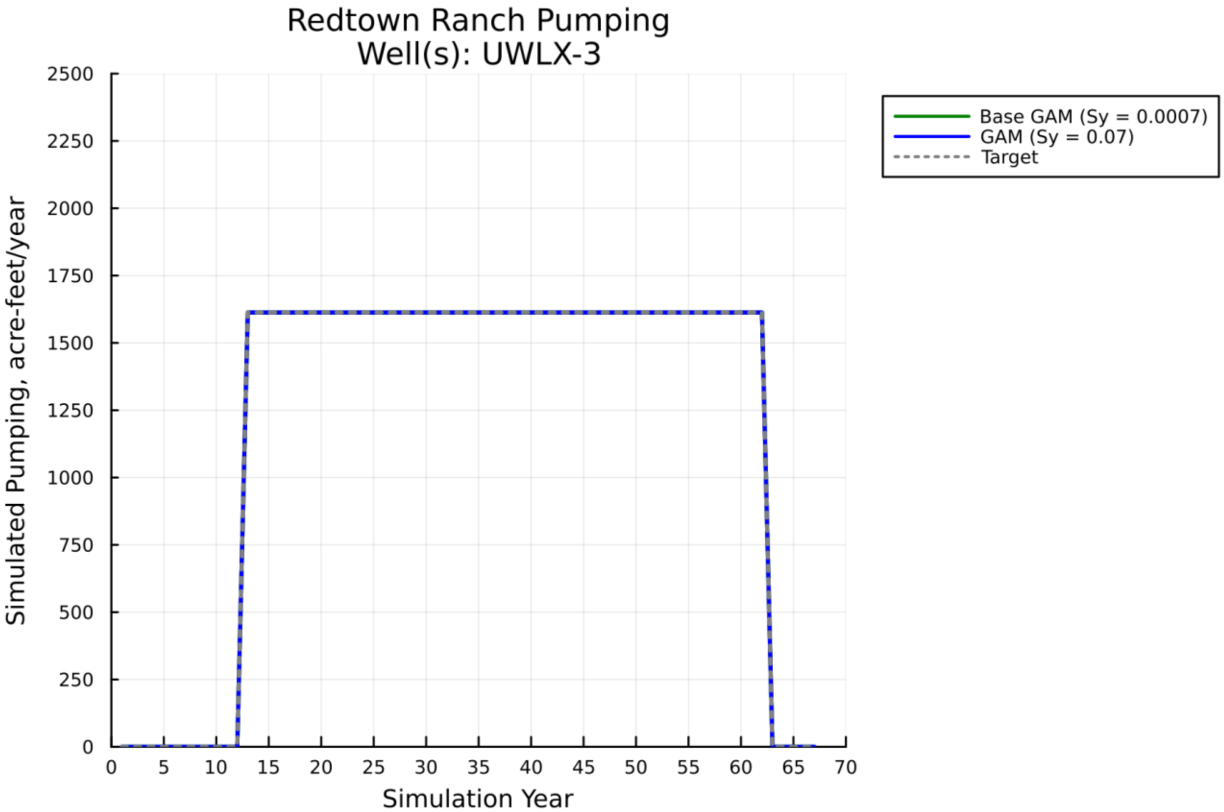

Redtown Ranch Pumping
Well(s): CZ-6
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

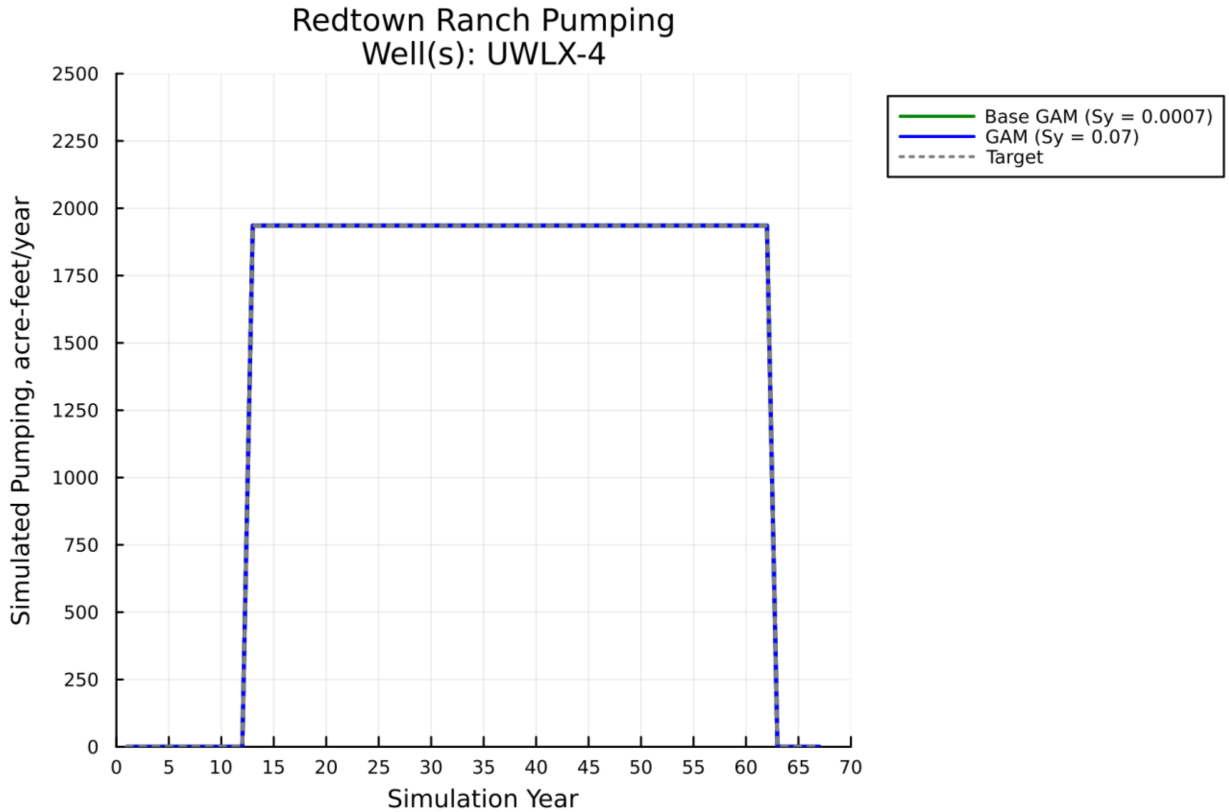

Redtown Ranch Pumping
Well(s): CZ-7
Simulated Pumping, acre-feet/year
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target


Redtown Ranch Pumping
Well(s): CZ-8
Simulated Pumping, acre-feet/year
Simulation Year
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

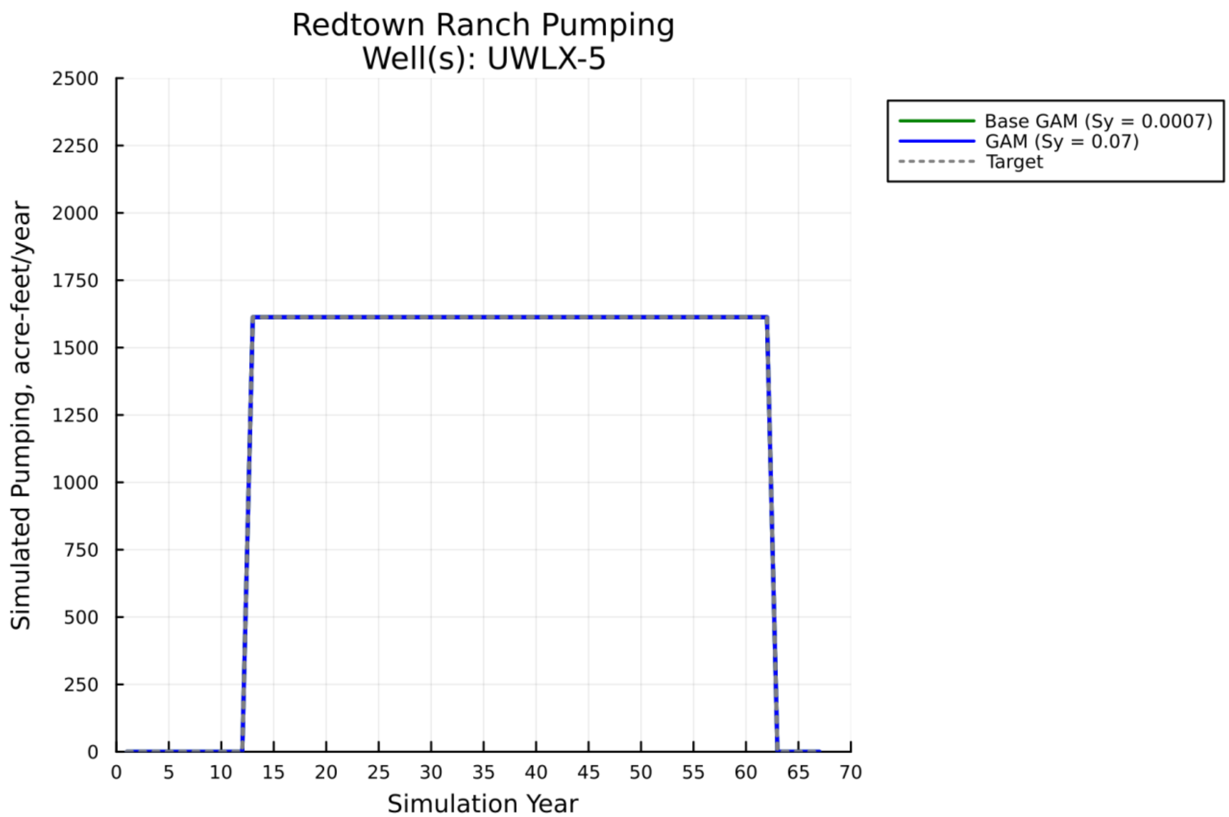

Redtown Ranch Pumping
Well(s): UWLX-1
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

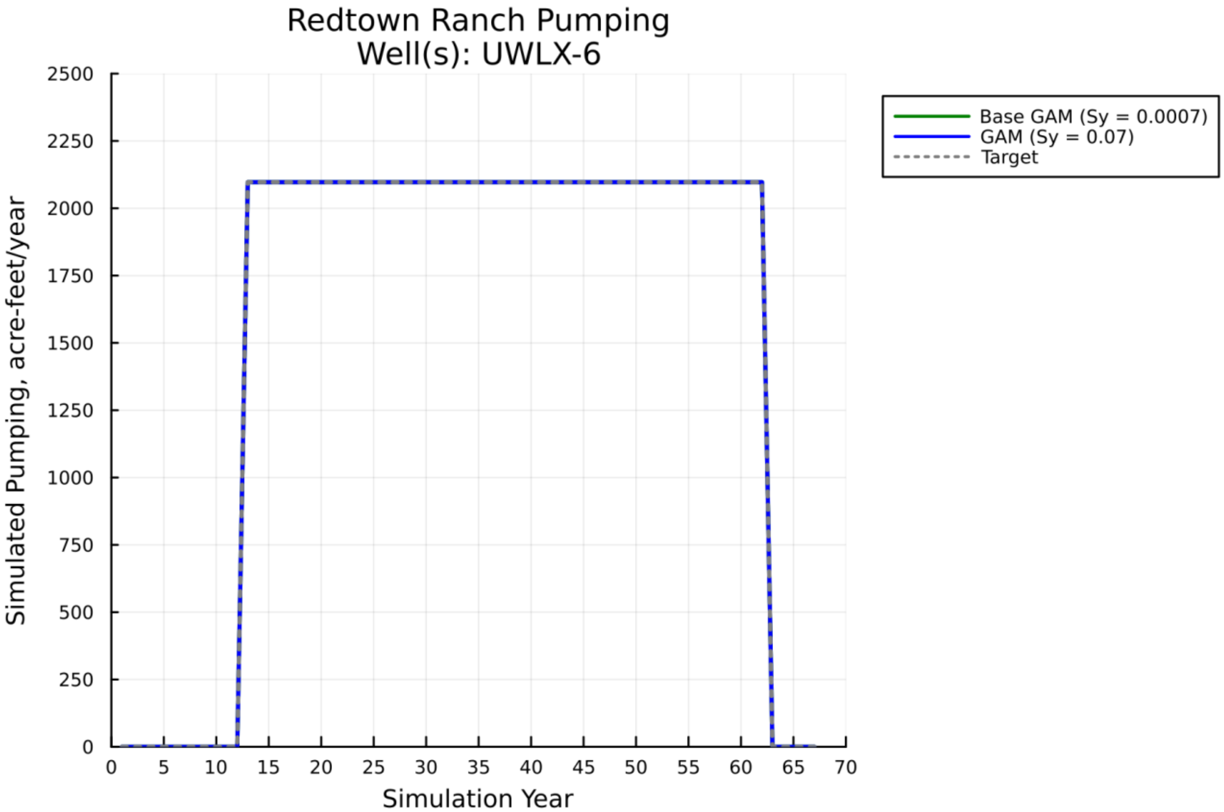

Redtown Ranch Pumping
Well(s): UWLX-2
Simulated Pumping, acre-feet/year
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

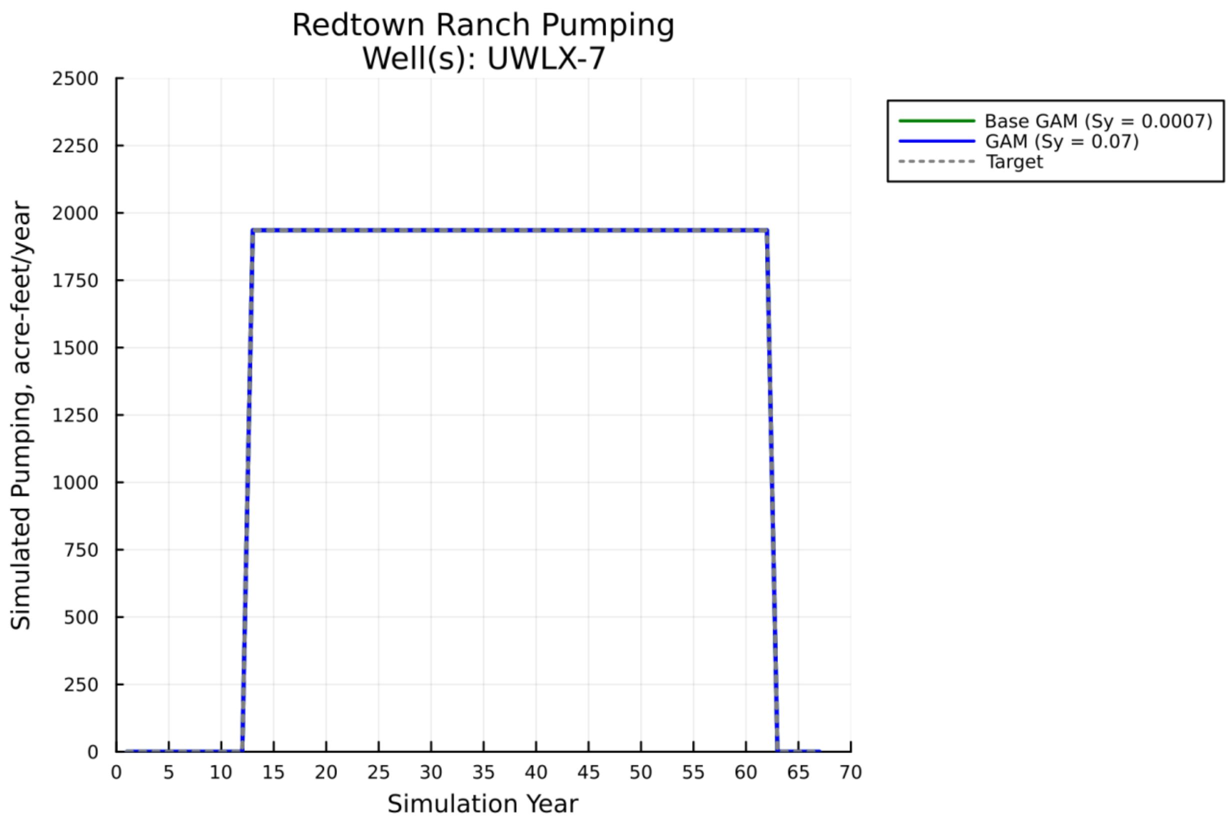

Redtown Ranch Pumping
Well(s): UWLX-3
Simulated Pumping, acre-feet/year
Simulation Year
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

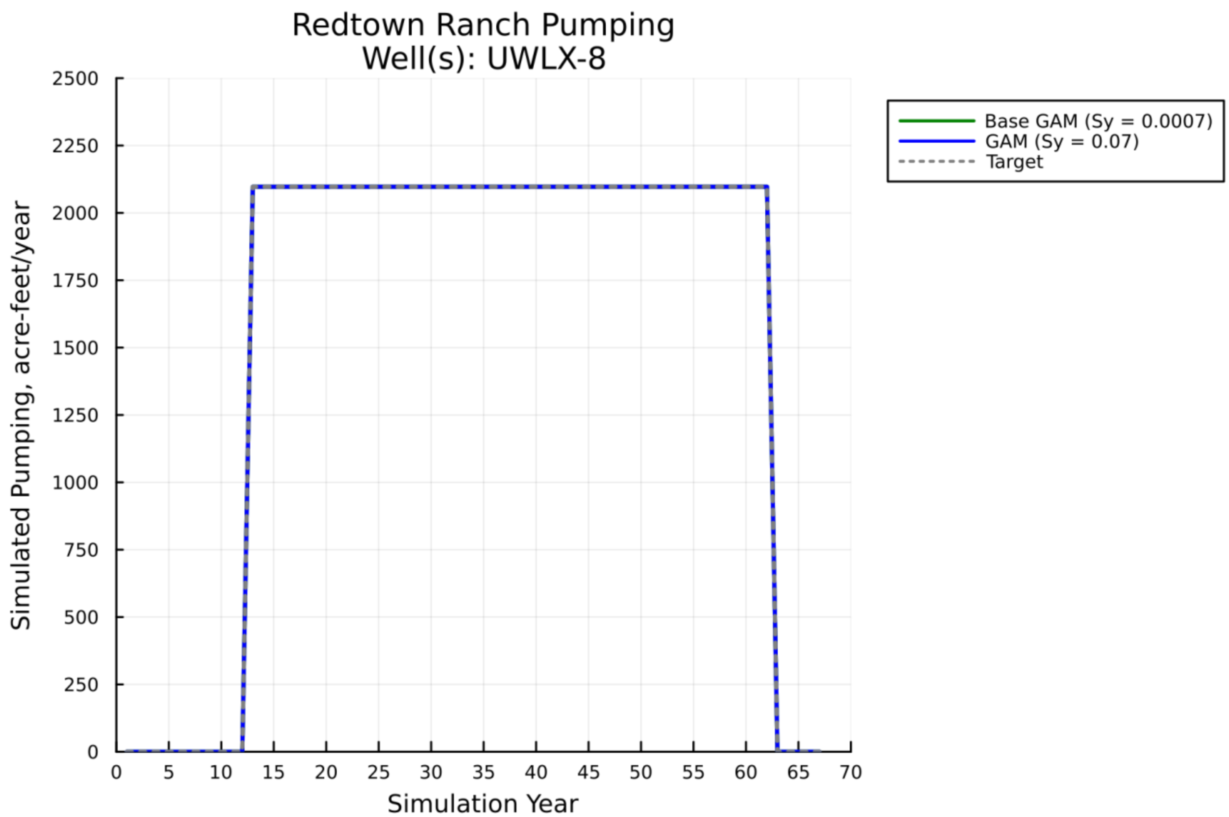


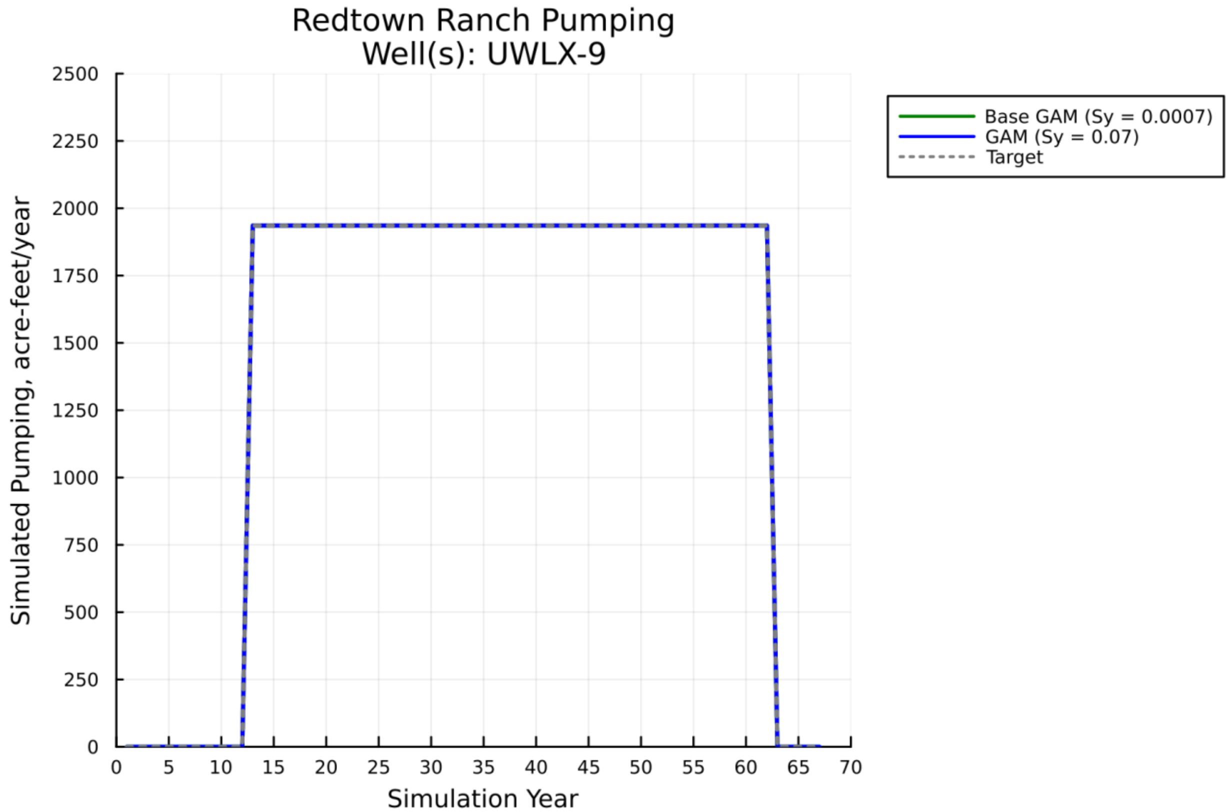
KT GROUNDWATER

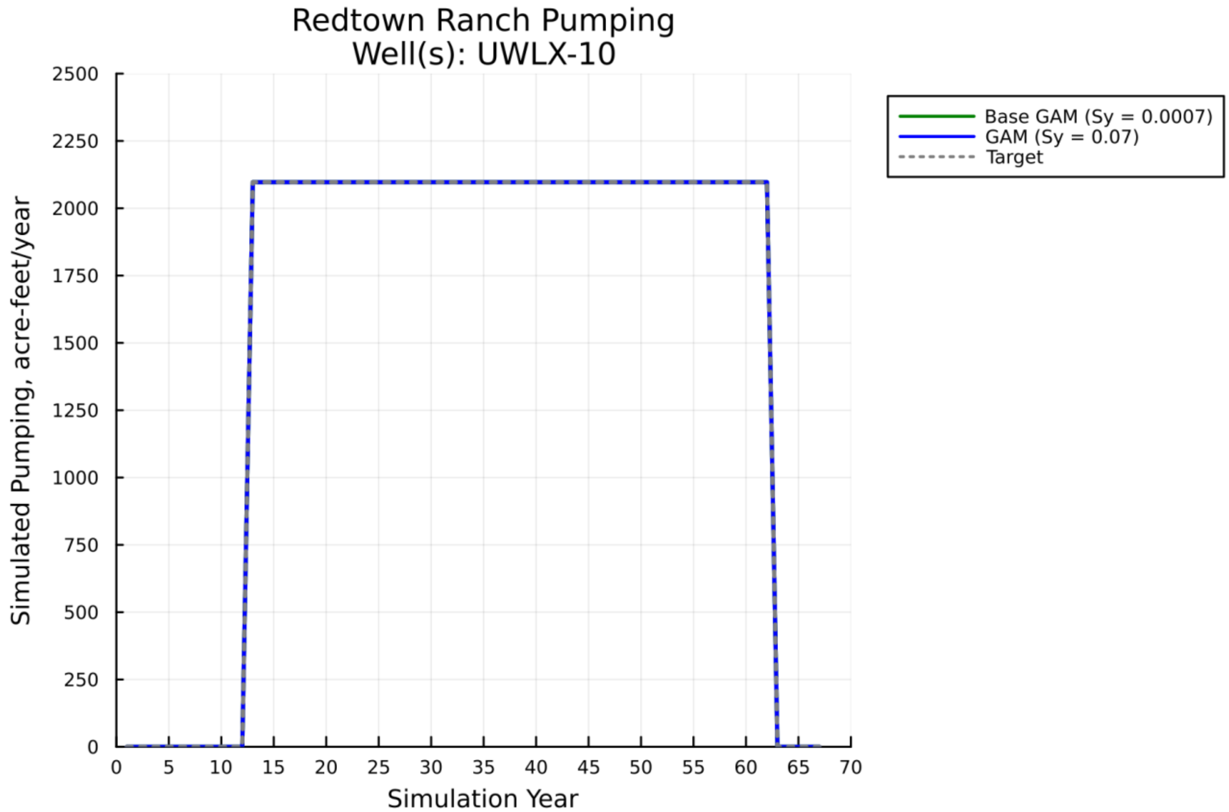

Redtown Ranch Pumping
Well(s): UWLX-5
Simulated Pumping, acre-feet/year
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

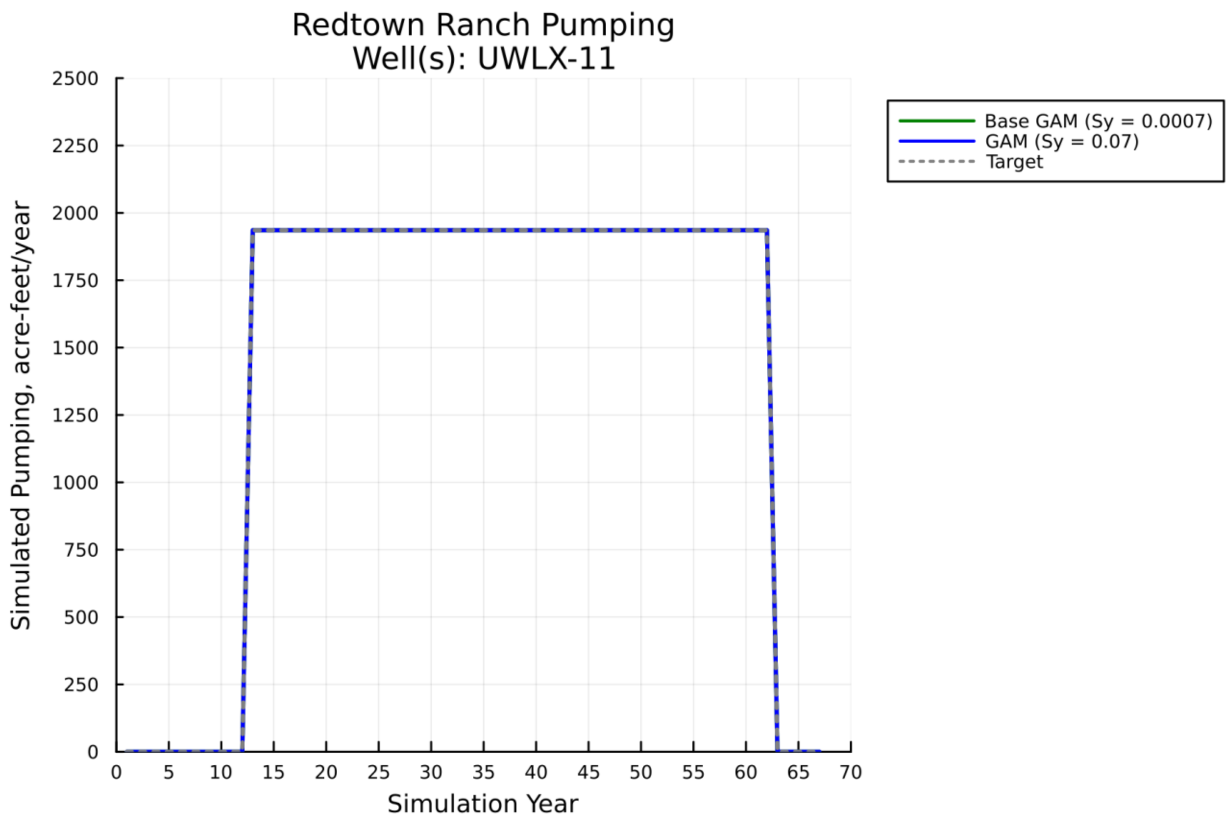

Redtown Ranch Pumping
Well(s): UWLX-6
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

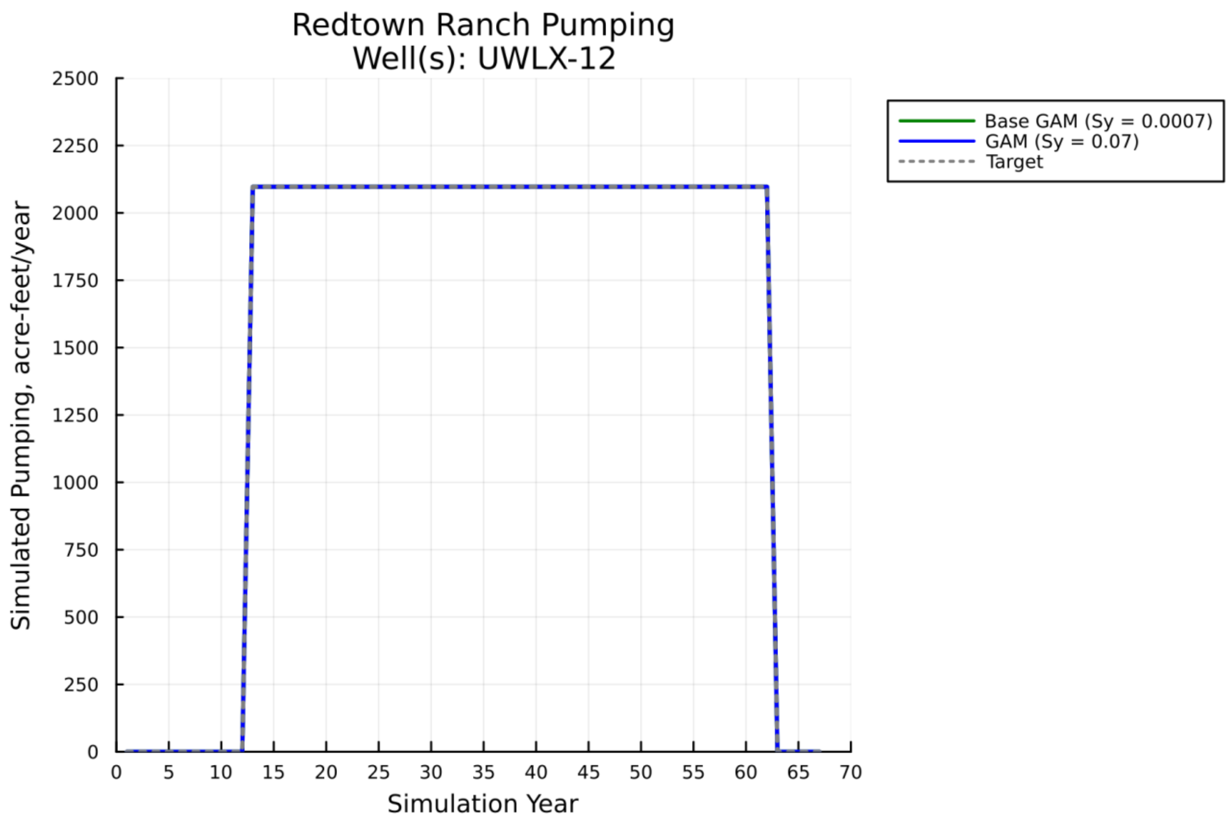

Redtown Ranch Pumping
Well(s): UWLX-7
Simulated Pumping, acre-feet/year
Simulation Year
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

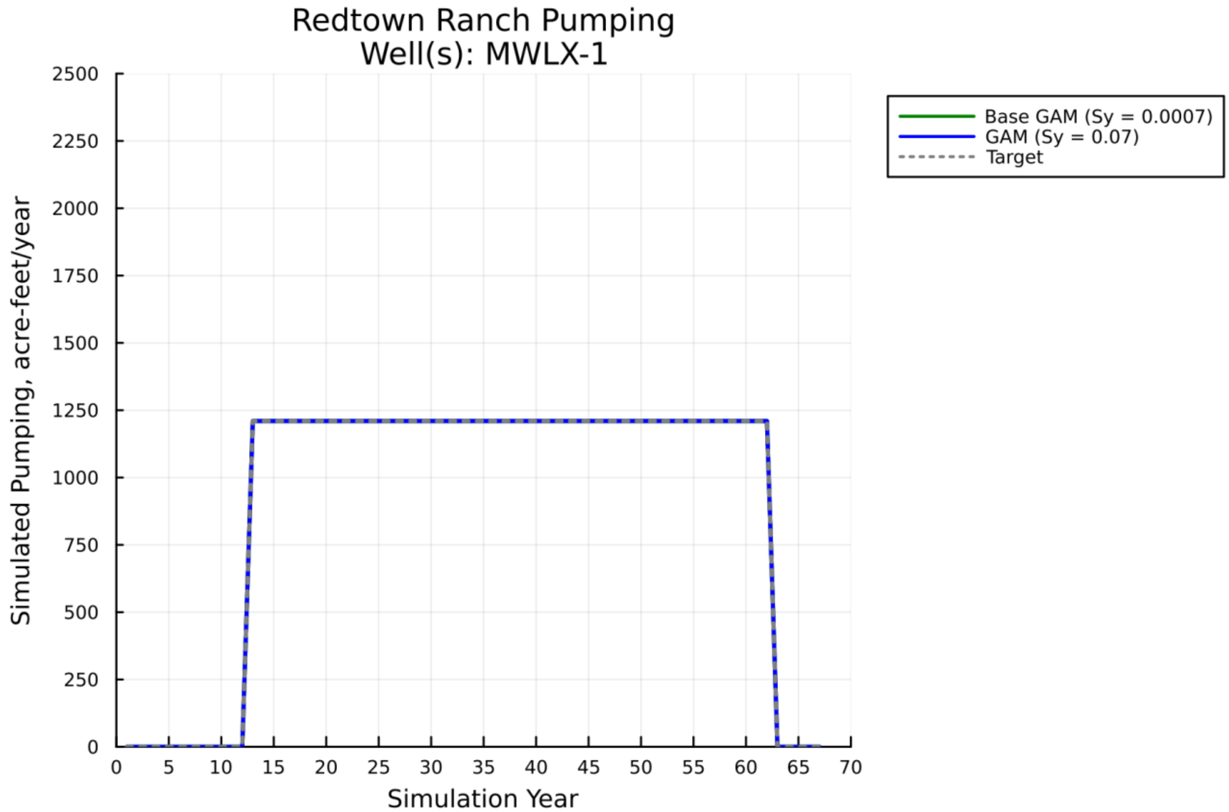

Redtown Ranch Pumping
Well(s): UWLX-8
Simulated Pumping, acre-feet/year
Simulation Year
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

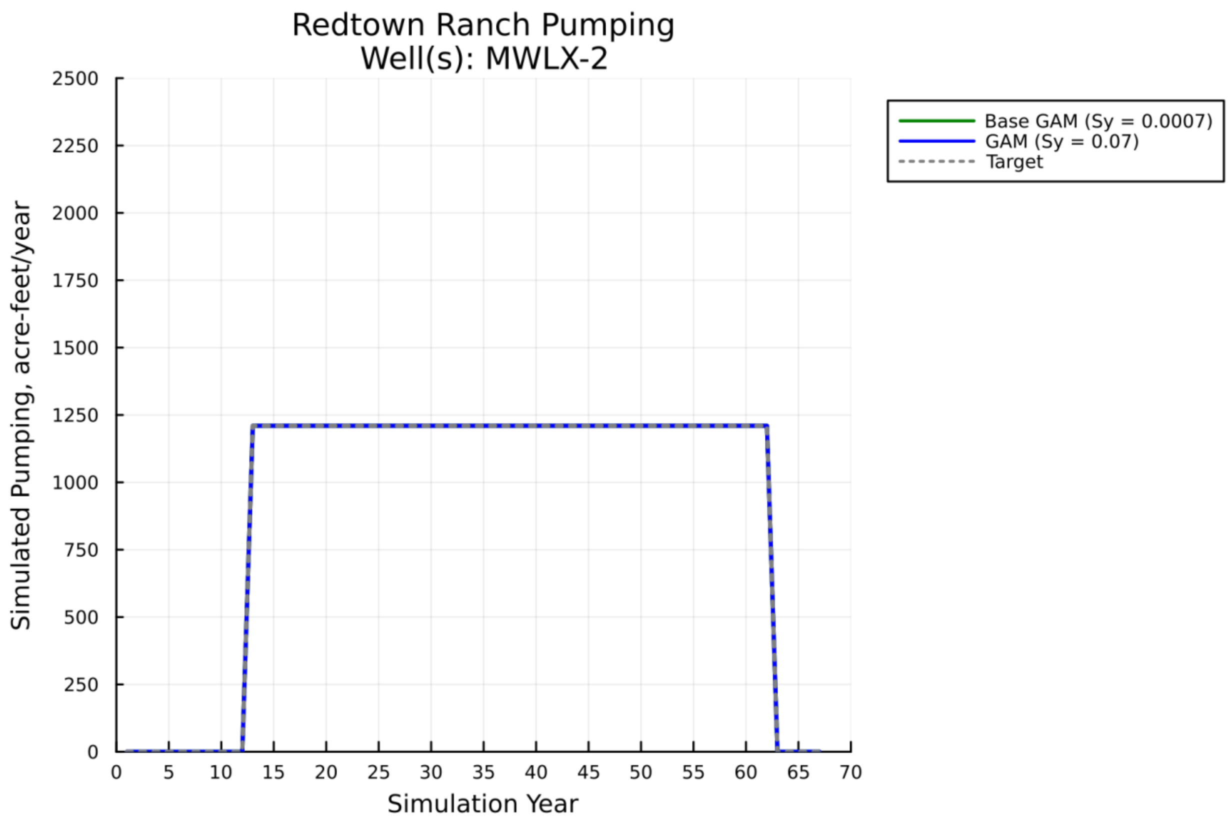

Redtown Ranch Pumping
Well(s): UWLX-9
Simulated Pumping, acre-feet/year
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

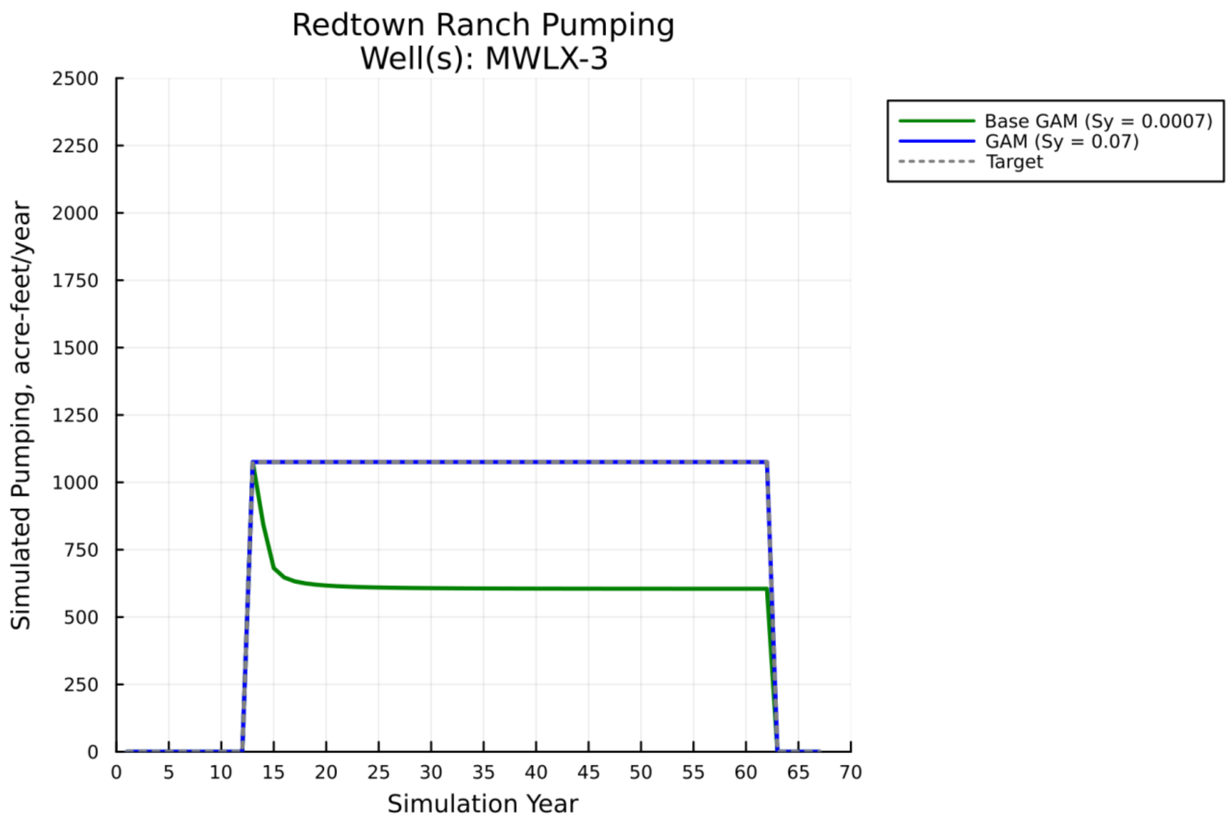

Redtown Ranch Pumping
Well(s): UWLX-10
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

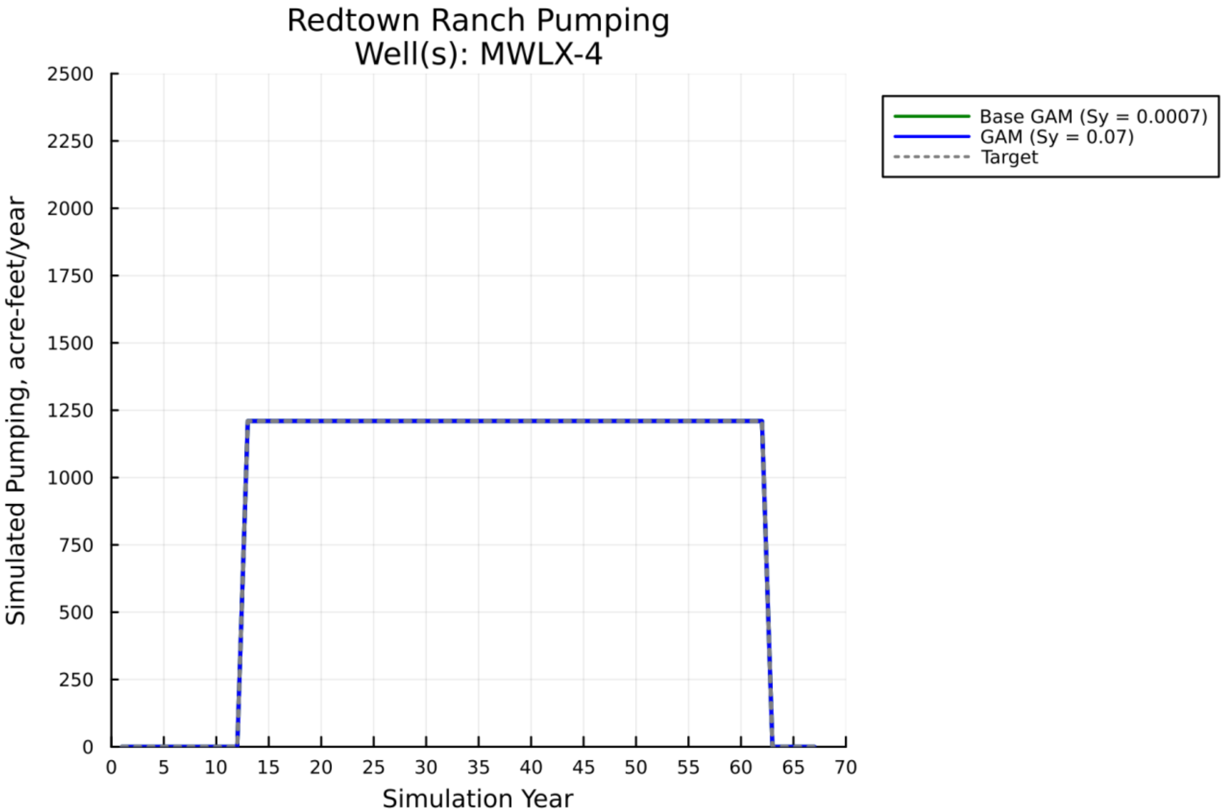

Redtown Ranch Pumping
Well(s): UWLX-11
Simulated Pumping, acre-feet/year
Simulation Year
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

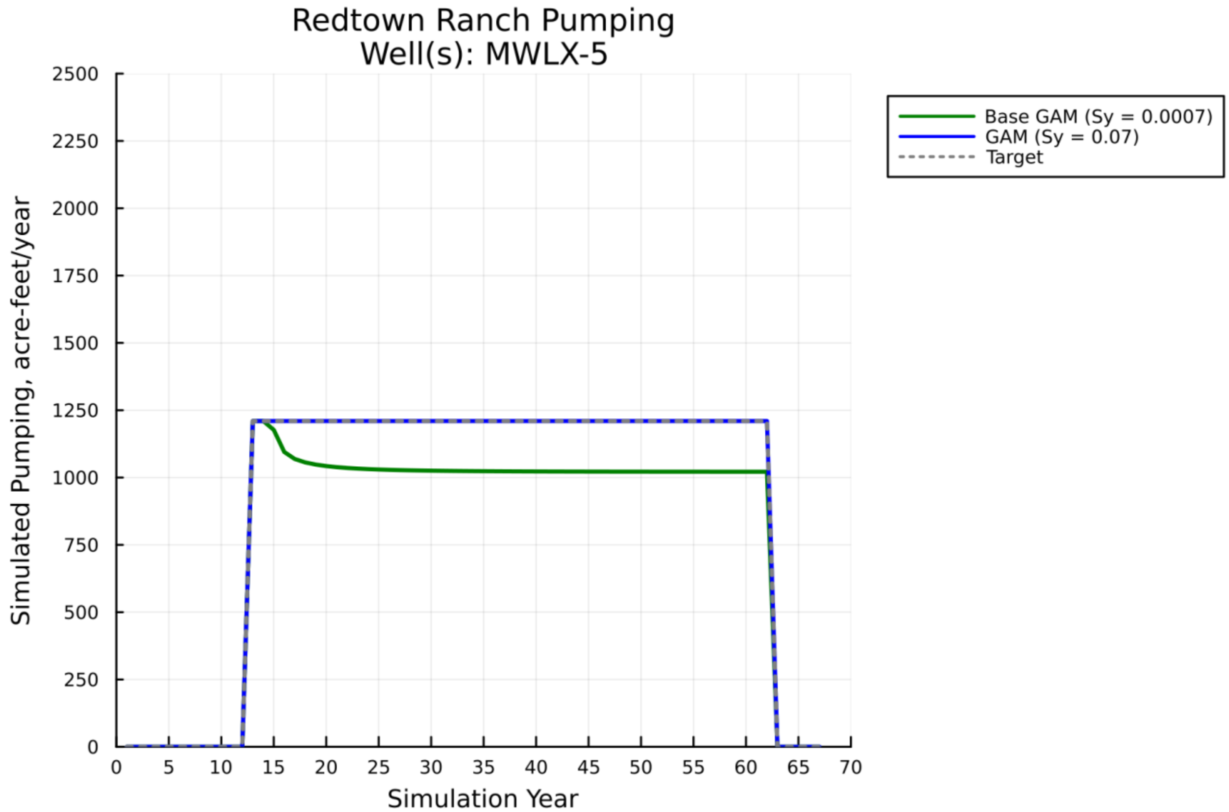

Redtown Ranch Pumping
Well(s): UWLX-12
Simulated Pumping, acre-feet/year
Simulation Year
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

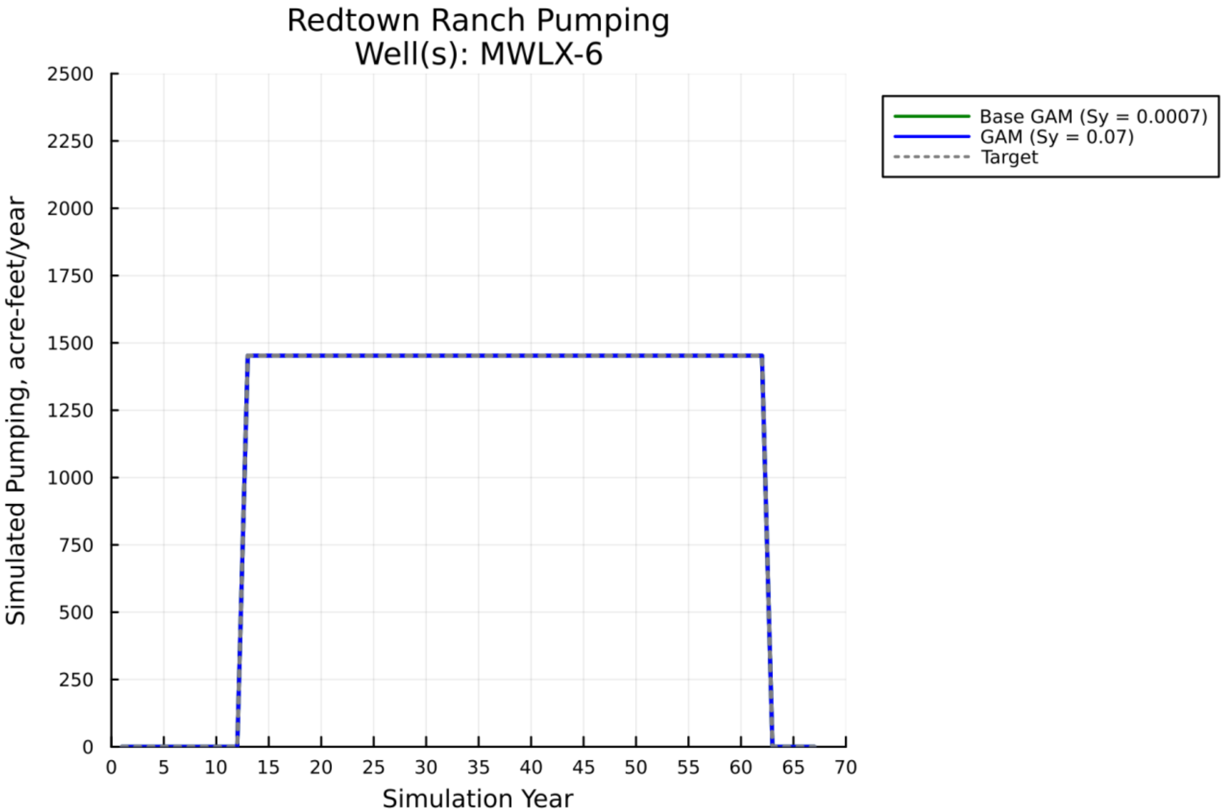

Redtown Ranch Pumping
Well(s): MWLX-1
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

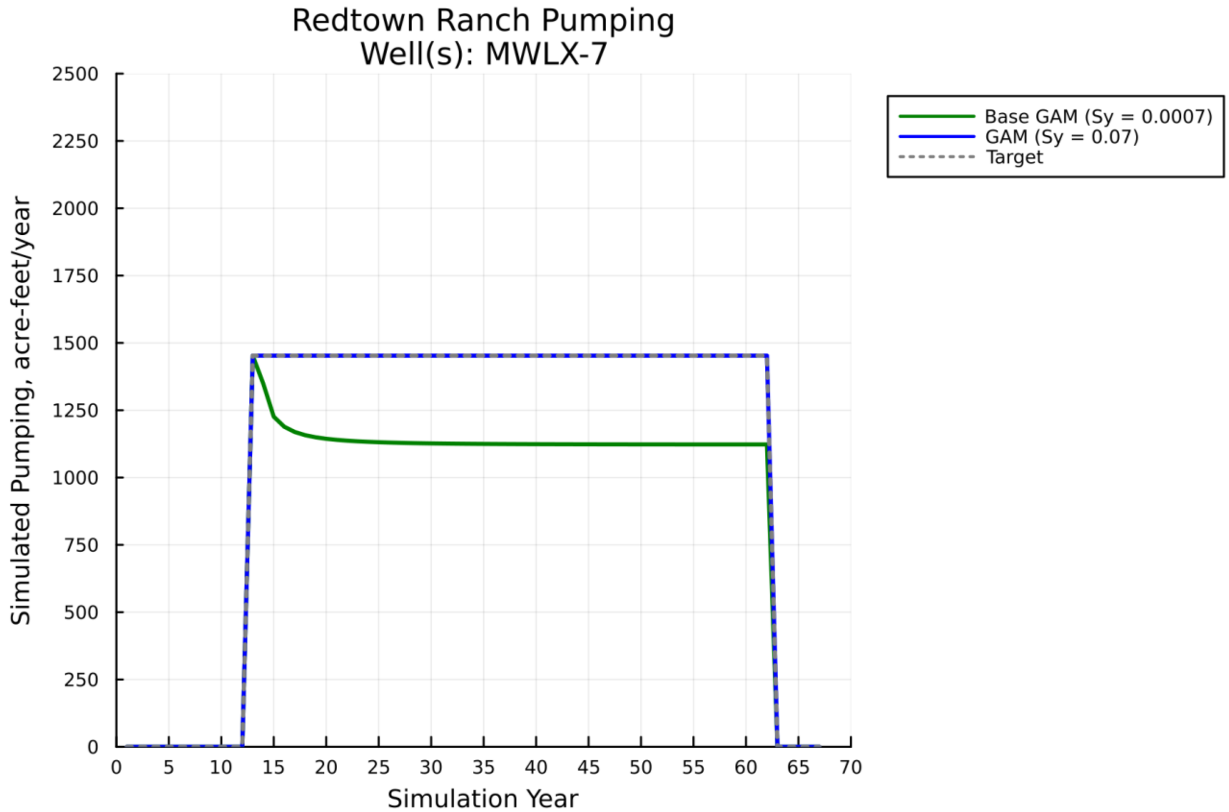

Redtown Ranch Pumping
Well(s): MWLX-2
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
Simulated Pumping, acre-feet/year
Simulation Year
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

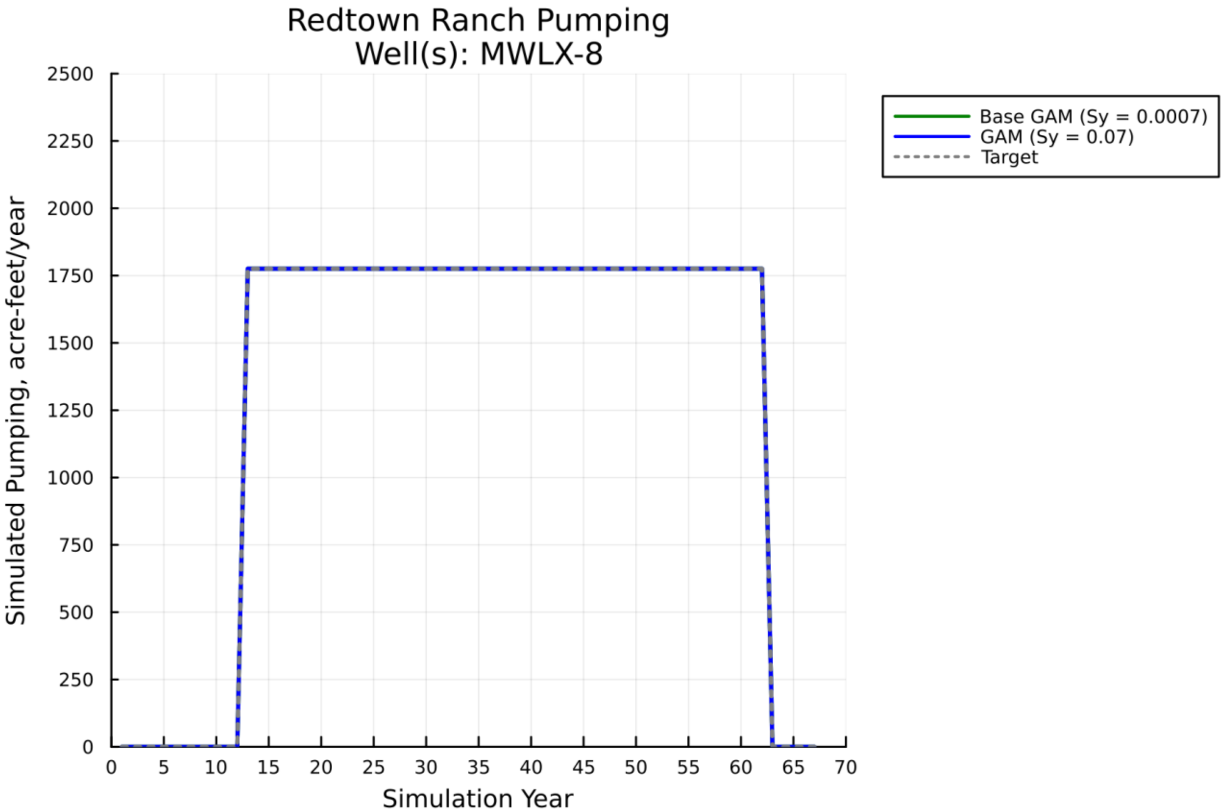

Redtown Ranch Pumping
Well(s): MWLX-3
Simulated Pumping, acre-feet/year
Simulation Year
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

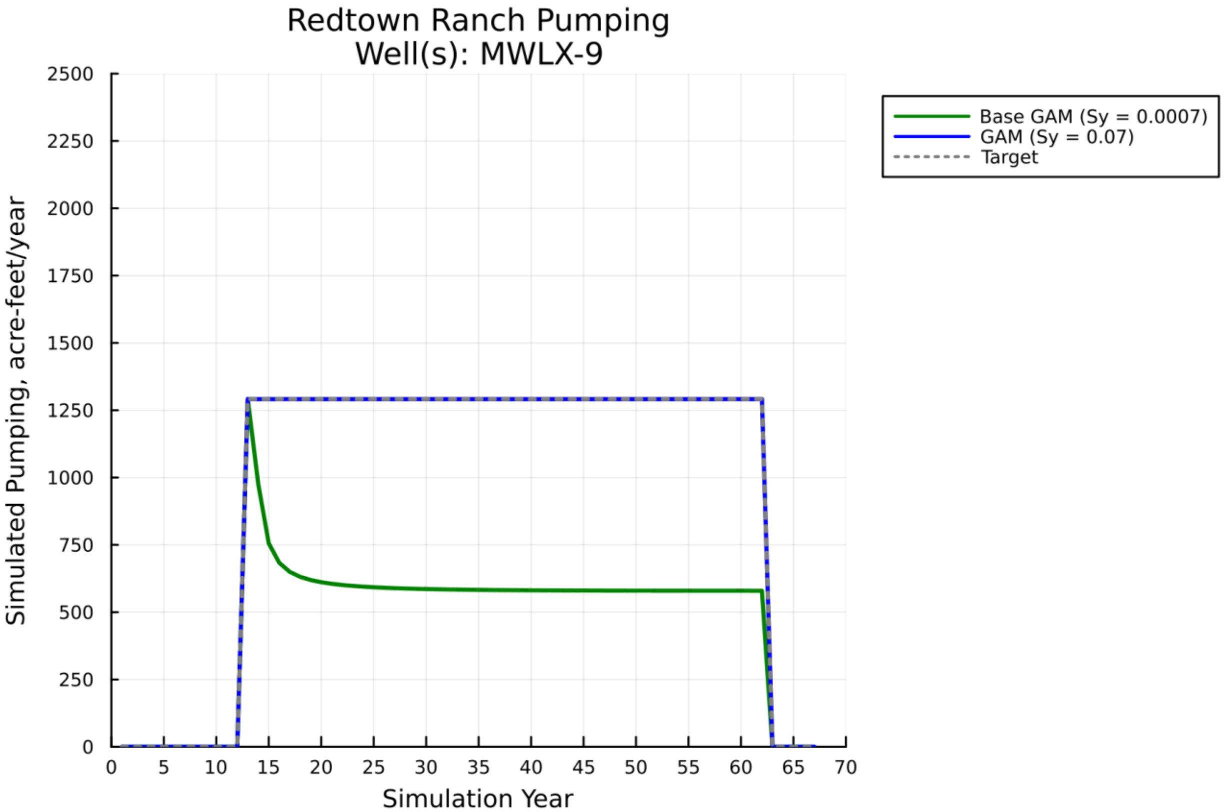

Redtown Ranch Pumping
Well(s): MWLX-4
Simulated Pumping, acre-feet/year
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

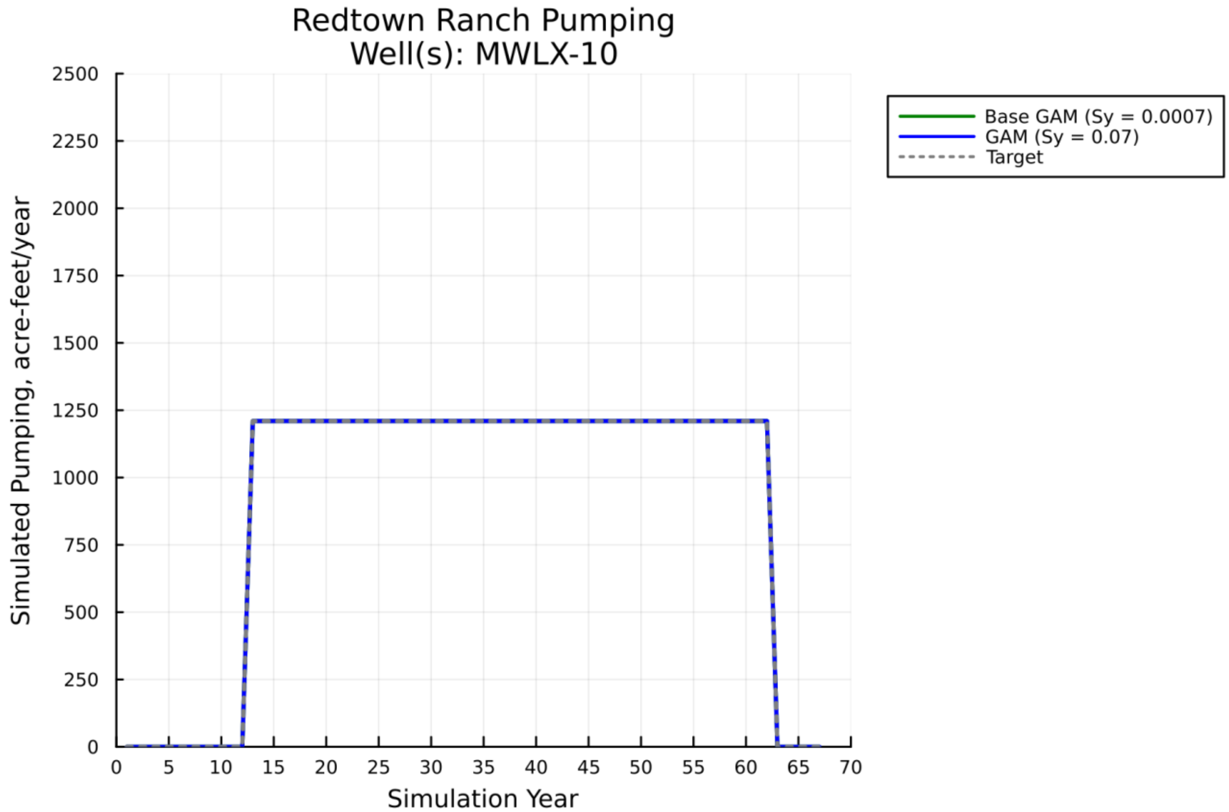

Redtown Ranch Pumping
Well(s): MWLX-5
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

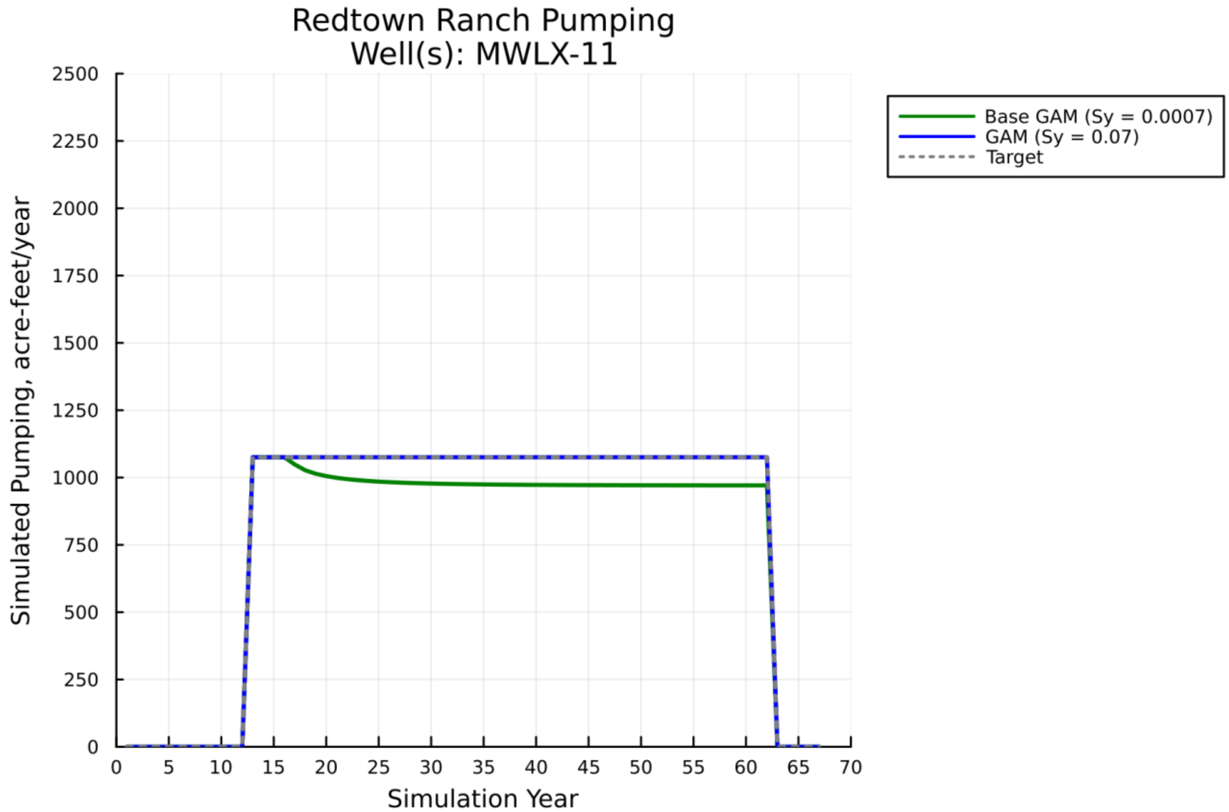

Redtown Ranch Pumping
Well(s): MWLX-6
Simulated Pumping, acre-feet/year
Simulation Year
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target

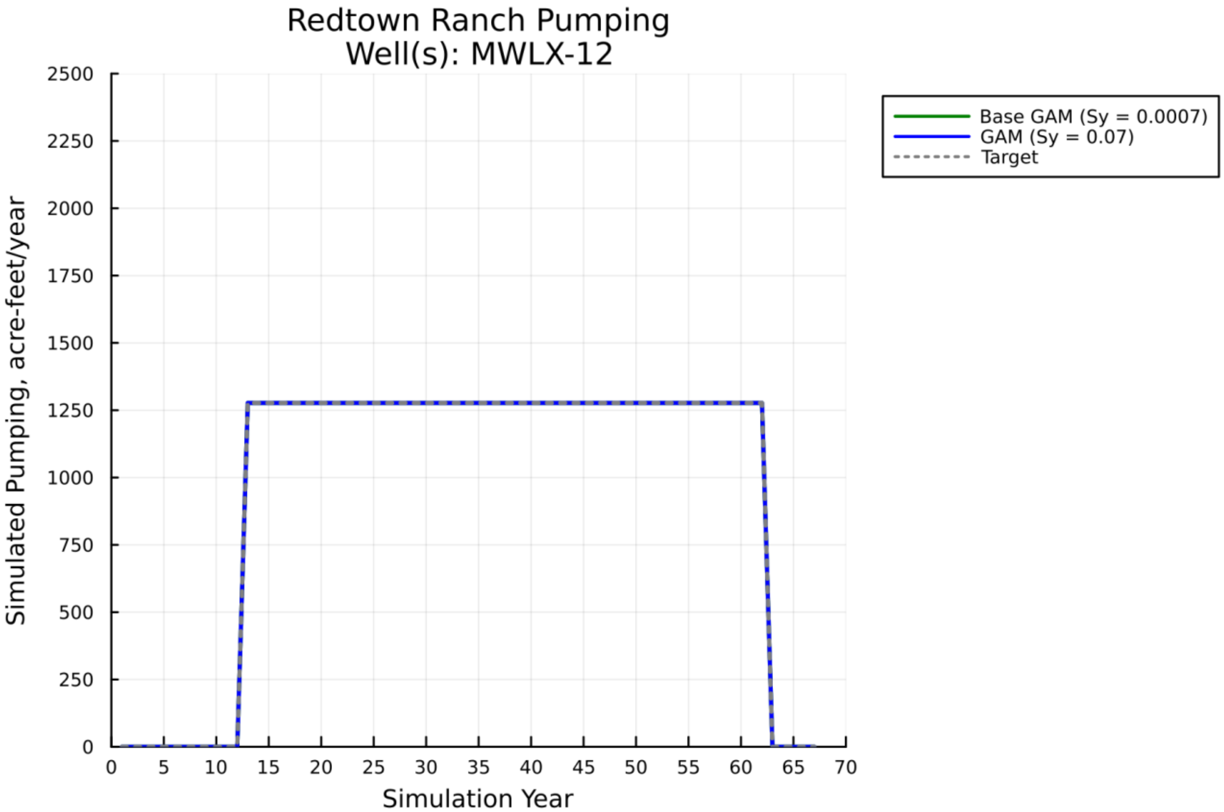

Redtown Ranch Pumping
Well(s): MWLX-7
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70


Redtown Ranch Pumping
Well(s): MWLX-8
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70


Redtown Ranch Pumping
Well(s): MWLX-9
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70


Redtown Ranch Pumping
Well(s): MWLX-10
Simulated Pumping, acre-feet/year
Simulation Year
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target


Redtown Ranch Pumping
Well(s): MWLX-11
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
Simulated Pumping, acre-feet/year
Simulation Year
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70


Redtown Ranch Pumping
Well(s): MWLX-12
Simulated Pumping, acre-feet/year
Simulation Year
Base GAM (Sy = 0.0007)
GAM (Sy = 0.07)
Target
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70