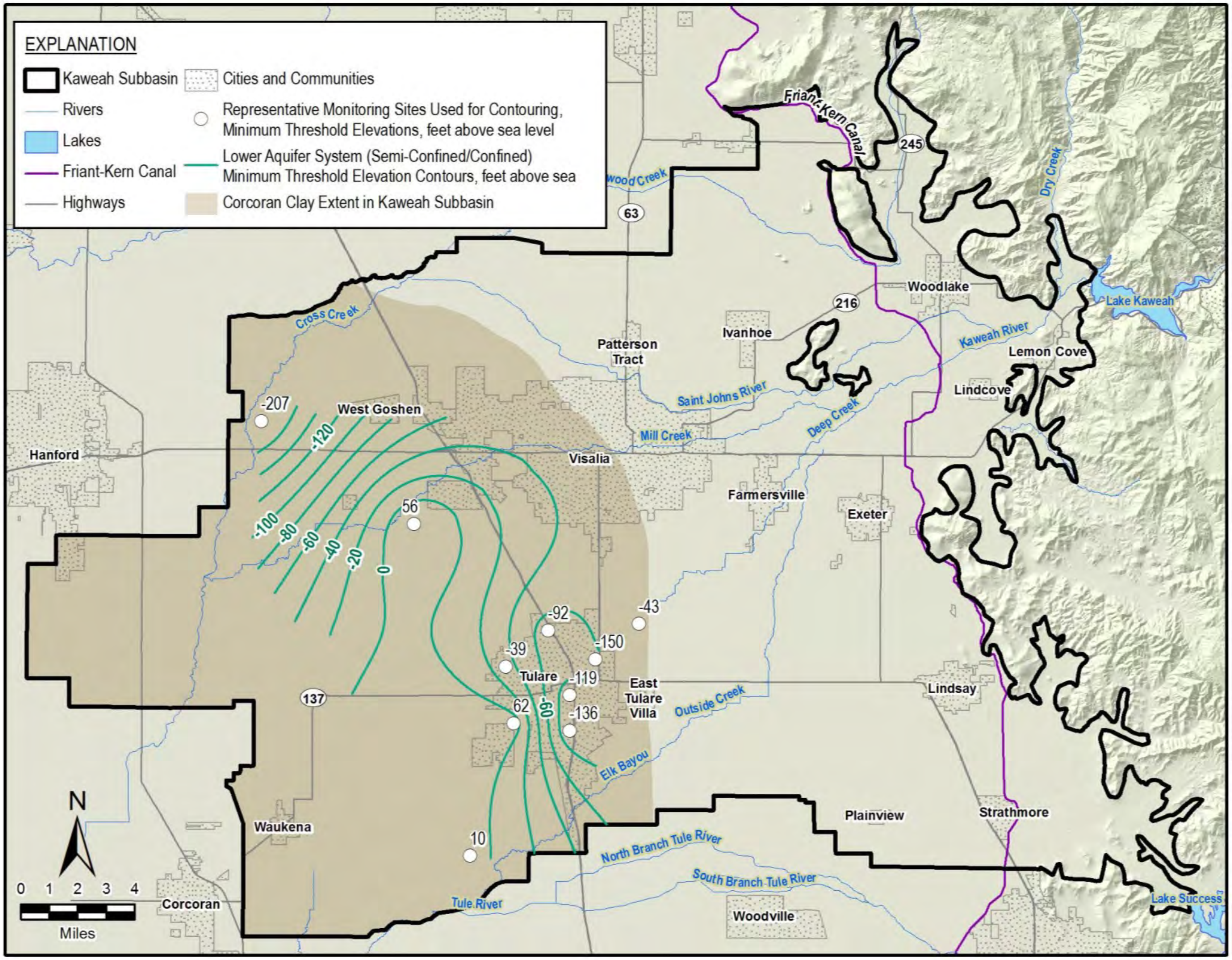


Figure 16. Lower Aquifer (Semi-Confined/Confined) System Minimum Threshold Contours Across the Kaweah Subbasin

3 PROCESS USED TO ESTABLISH MEASURABLE OBJECTIVES AND INTERIM MILESTONES

3.1 Measurable Objective Methodologies

Measurable objectives (MOs) are established at groundwater elevations higher than MTs to provide operational flexibility and reflect the GSAs' desired groundwater conditions in 2040. The margin of operational flexibility accounts for droughts, climate change, conjunctive use operations, other groundwater management activities, and data uncertainty. The GSAs in the Kaweah Subbasin are managing their groundwater sustainability to meet the MO in 2040.

The EKGSA MOs are based on Spring 2017 groundwater levels. Spring 2017 was a wet year that followed the 2012-2016 drought. This approach applies to wells where the MT is based on the 1997-2017 groundwater level trend projection described in Section 1.1 and shown on Figure 17.

The GKGSA and MKGSA MOs are based on one of two methods, depending on which methodology was used to set MTs. Figure 17 graphically shows the relationship between the different MT and MO methodologies.

MO Method 1, Groundwater Level Trend Projection to 2030:

- For GKGSA and MKGSA representative monitoring sites with MTs derived from the groundwater level trend projection, the MO is the 2006-2016 groundwater elevation projected to 2030 (Figure 18).
- For representative monitoring sites where the MT is set using the protective elevation, and the difference between the MT and groundwater elevation trend projected to 2030 is 20 feet or more, the MO is the 2006-2016 groundwater elevation projected to 2030 (Figure 18).

MO Method 2: 5-Year Drought Storage Based on 2006-2016 Trend

- For representative monitoring sites where the MT is set using the protective elevation, and the difference between the MT and groundwater elevation trend projected to 2030 is less than 20 feet, the MO is set at an elevation that provides for 5 years of drought storage above the MT. Five years of drought storage is determined as the groundwater level change occurring over 5 years using the 2006-2016 groundwater level trend (Figure 19). The groundwater level change is added to the MT elevation to establish the MO elevation (Figure 19).

- For representative monitoring sites where anomalously low MTs are adjusted by interpolating from MT contours, the MO is set at an elevation that provides for 5 years of drought storage above the adjusted MT.

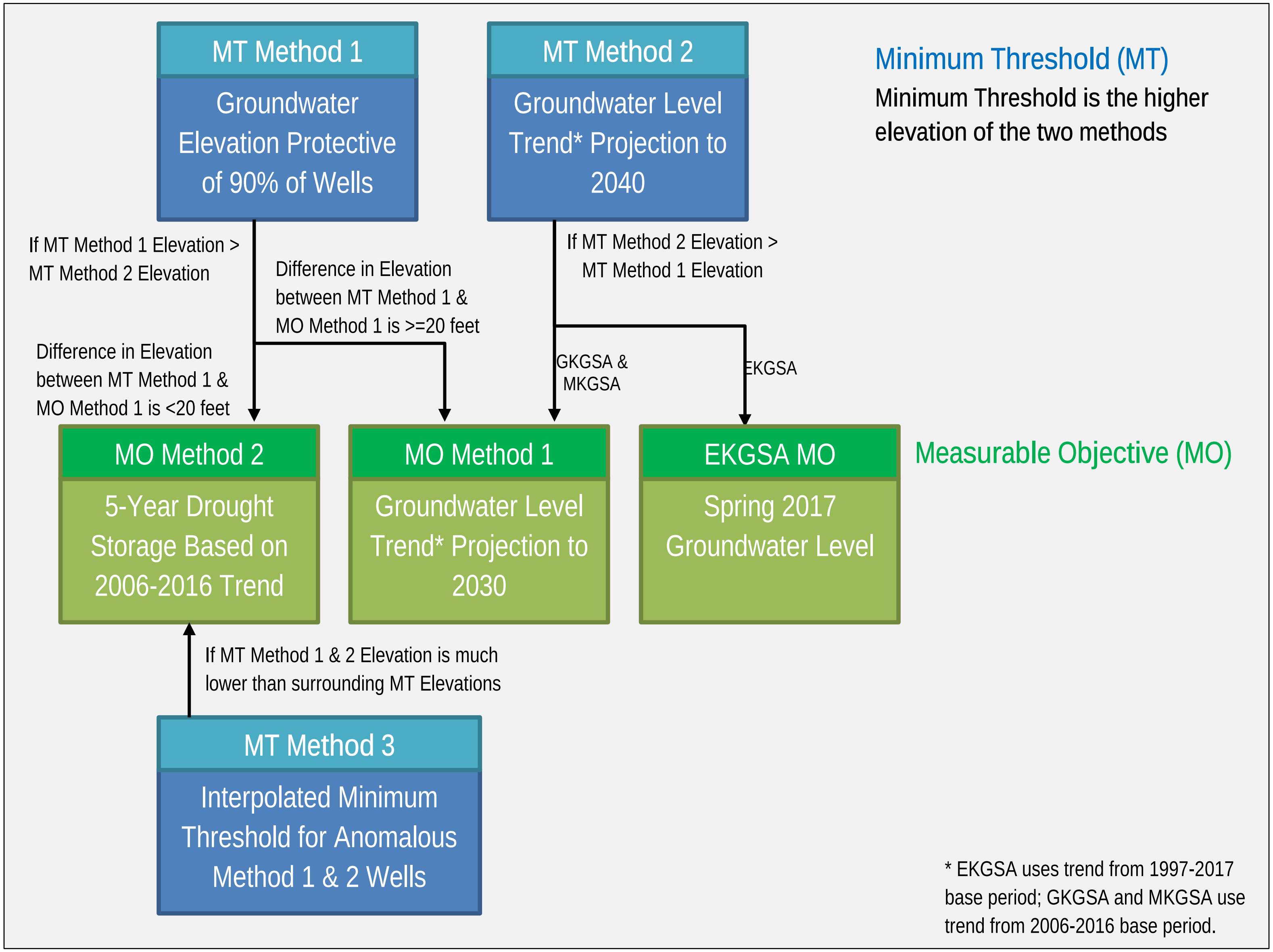


Figure 17. Relationship Between Minimum Threshold and Measurable Objective Methodologies

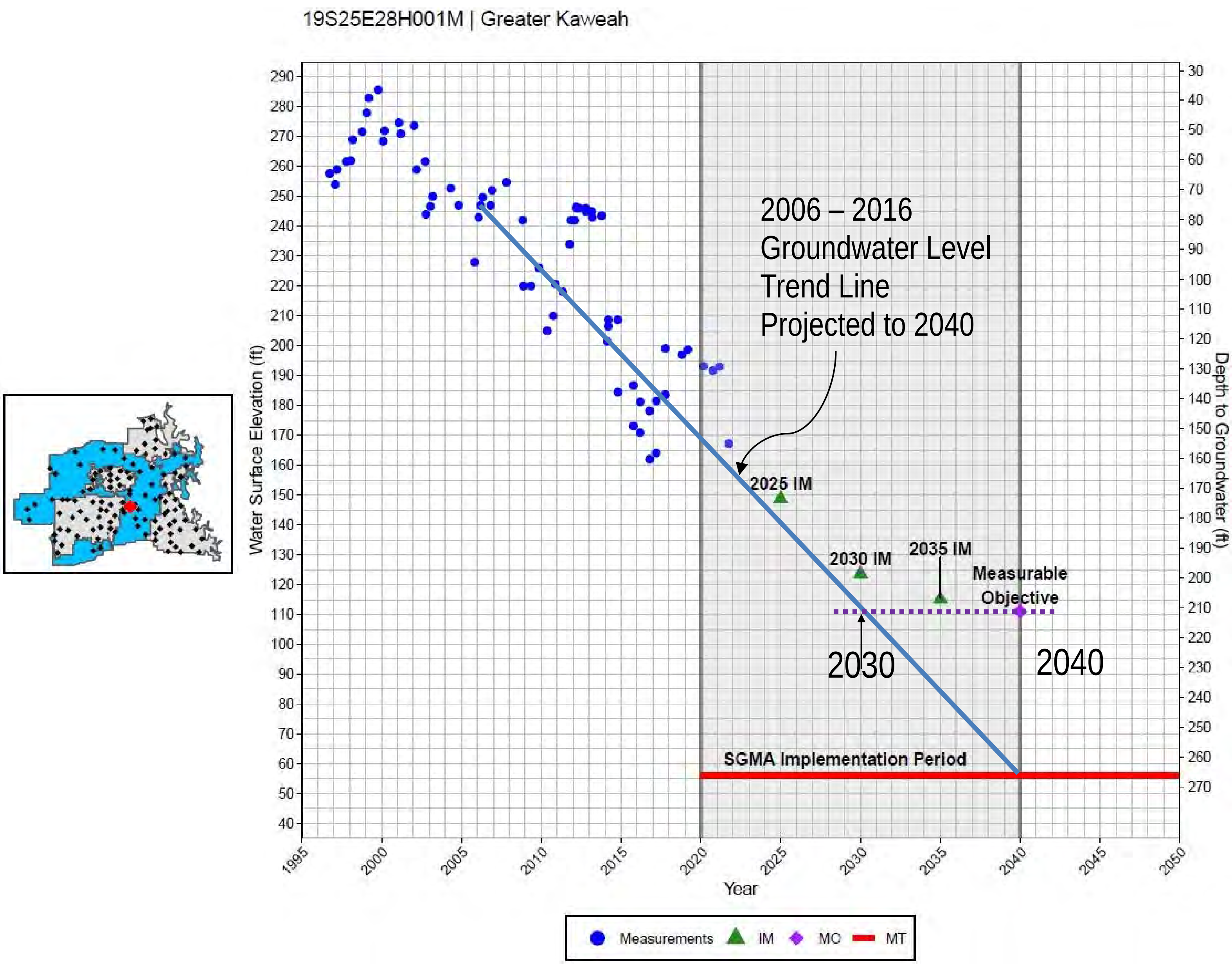


Figure 18. Example Hydrograph Showing Projection of 2006 – 2016 Trend Line

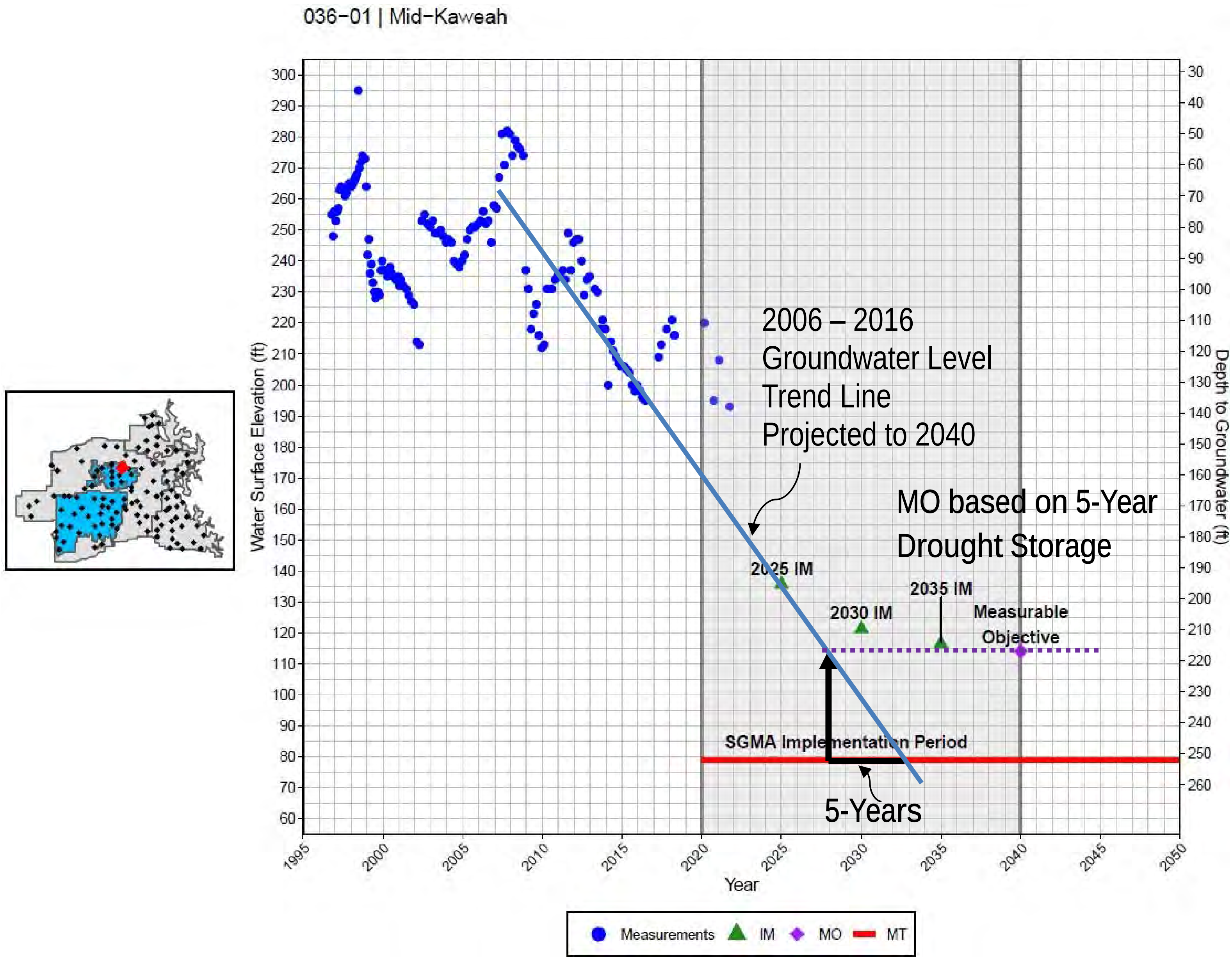


Figure 19. Example Hydrograph Showing Measurable Objective Based on 5-Year Drought Storage

3.2 Interim Milestone Methodology

Interim milestones for all representative monitoring sites take the form of a curve that flattens out toward 2040 when the MO is reached. The curve shape is determined based on implementation of projects and management actions over the next 18 years.

For the EKGSA, interim milestones are proportional to percent of overdraft to be corrected in 5-year intervals through implementation period. The interim milestones leading to groundwater level stabilization are unique to each analysis zone but follow the same incremental mitigation rate for correction of 5%, 25%, 55%, and 100% by 2025, 2030, 2035, and 2040, respectively.

Interim milestones for GKGSA and MKGSA representative monitoring sites are based on incrementally decreasing groundwater level change over time based on the following:

- 2025 interim milestone– extend the 2006-2016 groundwater level trend to 2025
- 2030 interim milestone –elevation at two-thirds of the elevation difference between the 2025 interim milestone and the MO
- 2035 interim milestone - elevation at two-thirds of the elevation difference between the 2030 interim milestone and the MO

The method for setting GKGSA and MKGSA interim milestones is illustrated on Figure 20.

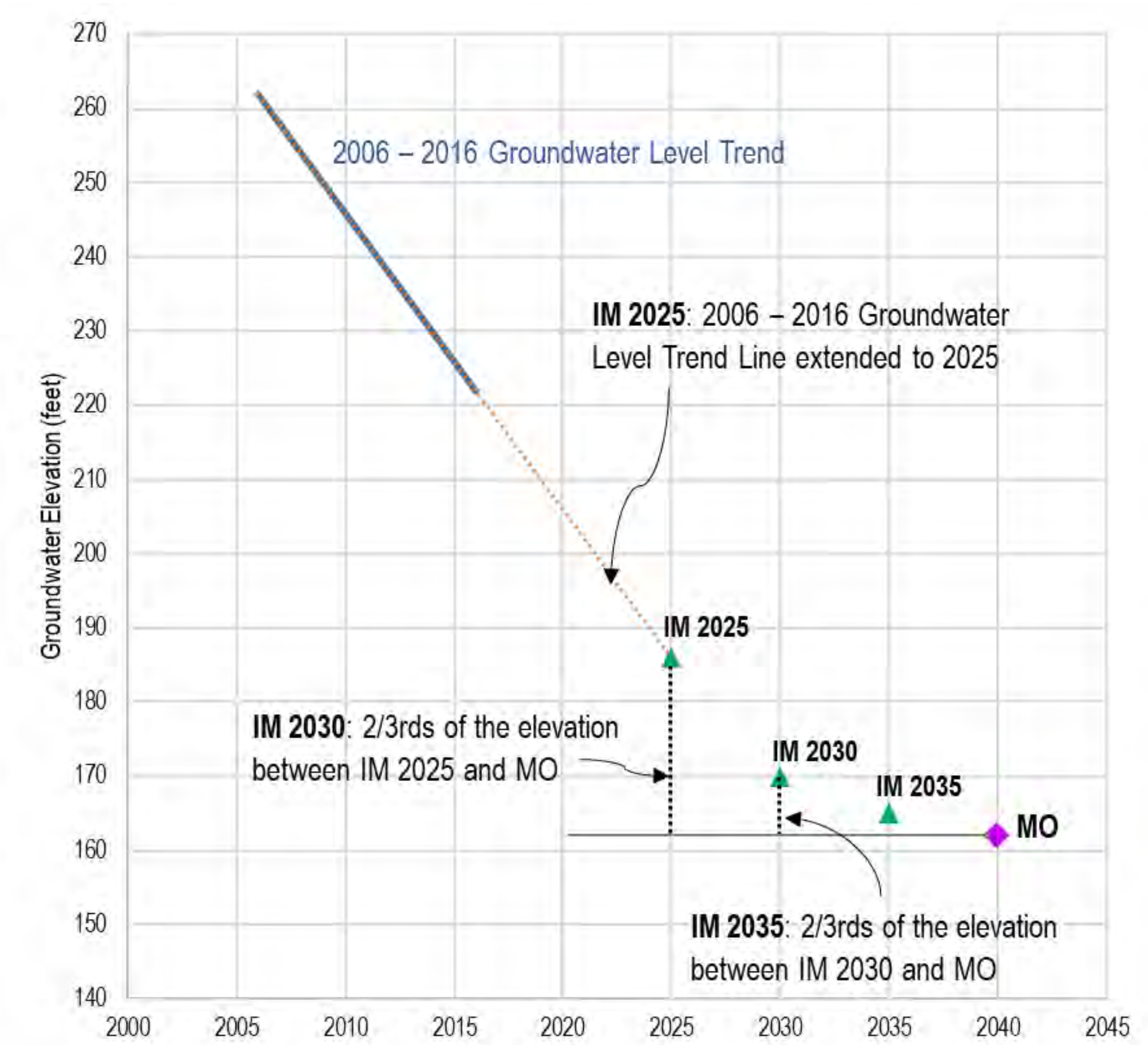


Figure 20. Example of Interim Milestone Method for GKGSA and MKGSA Represenative Monitoring Sites

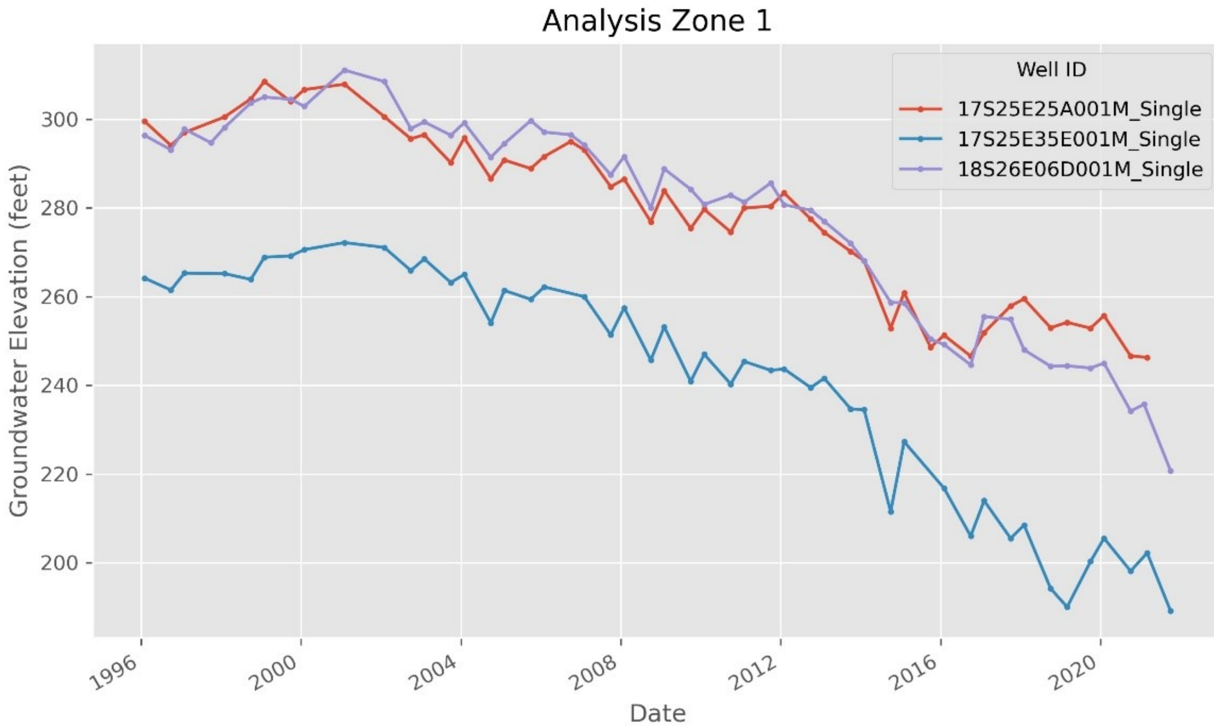
4 REFERENCES

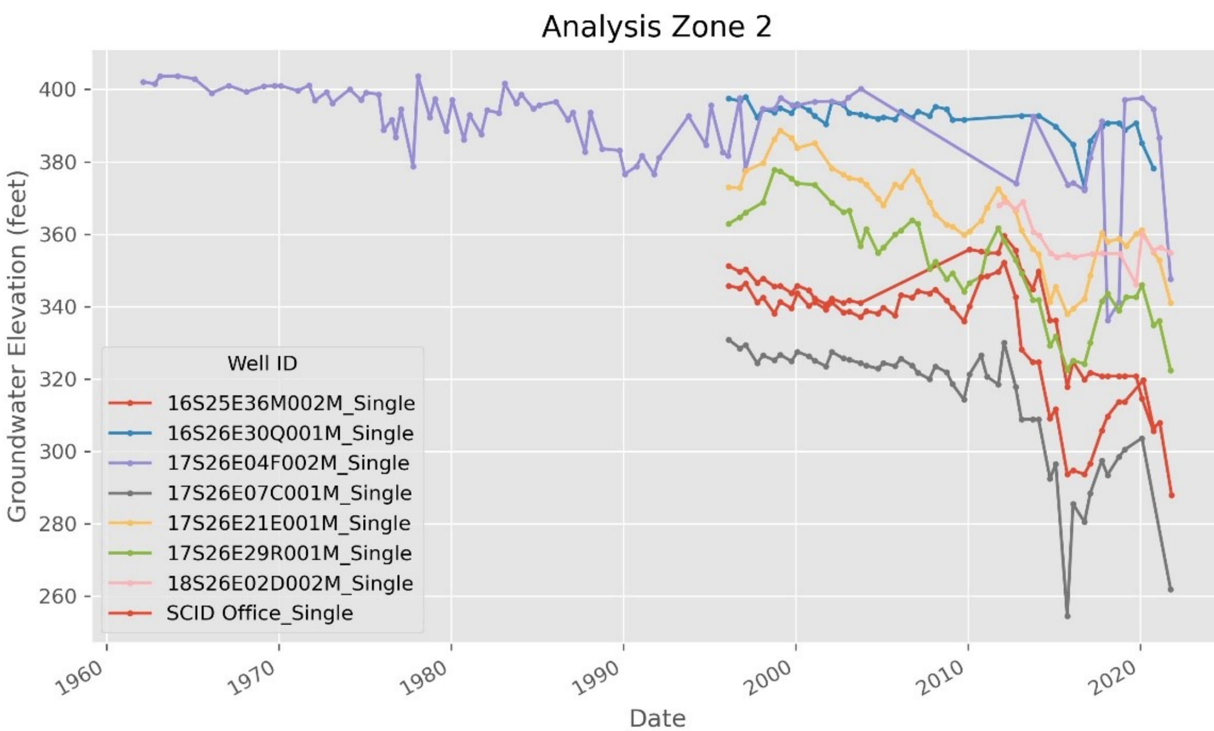
Kang, S., Knight, R., & Goebel, M. (2022). Improved imaging of the large-scale structure of a groundwater system with airborne electromagnetic data. *Water Resources Research*, 58, e2021WR031439. https://doi.org/10.1029/2021WR031439

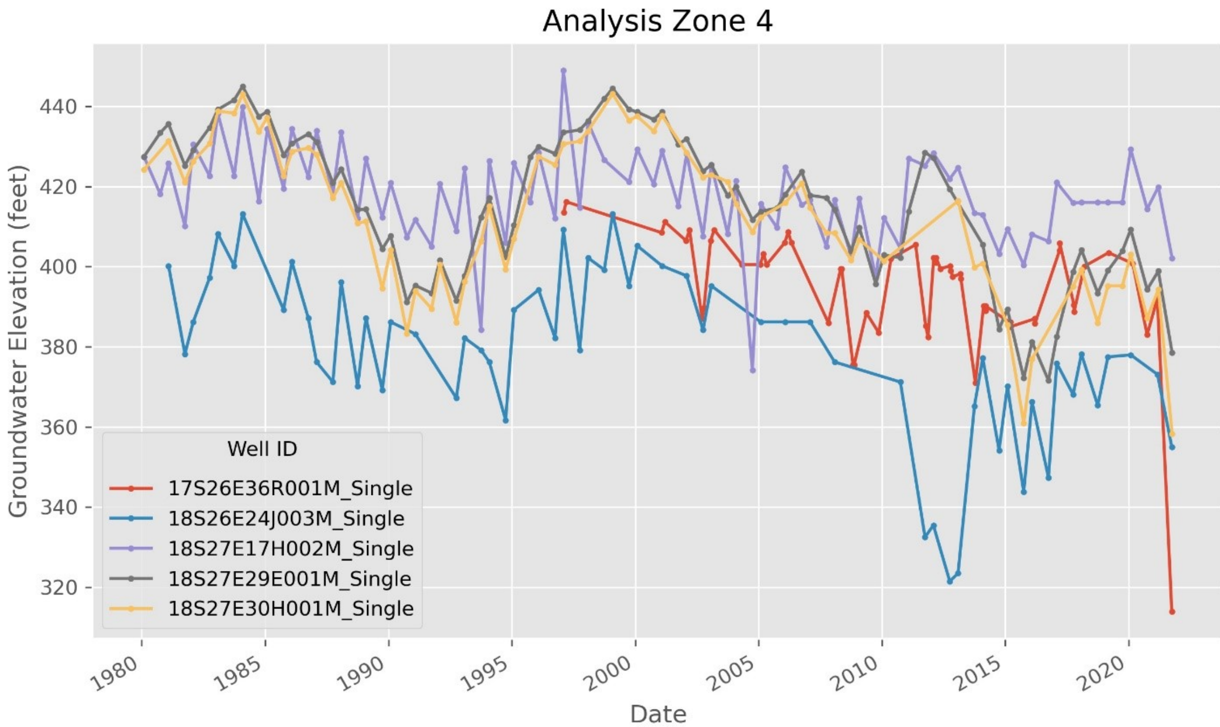
MONTGOMERY
& ASSOCIATES

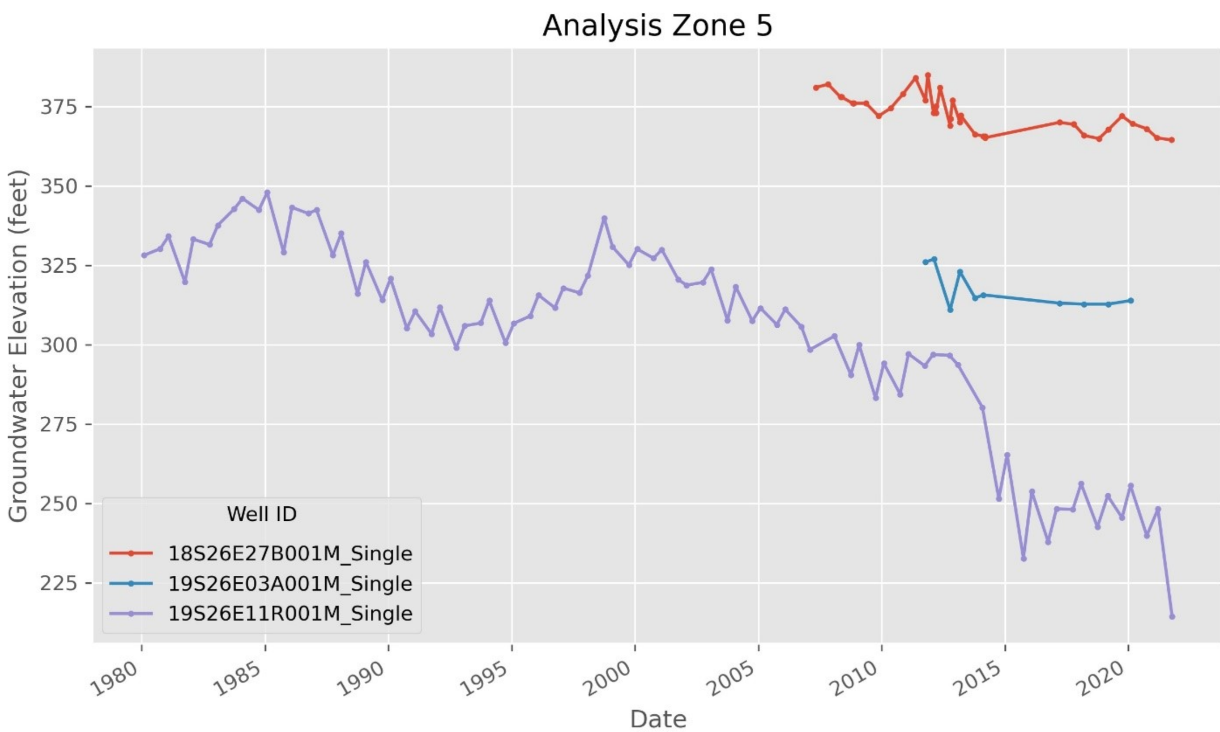
Appendix A

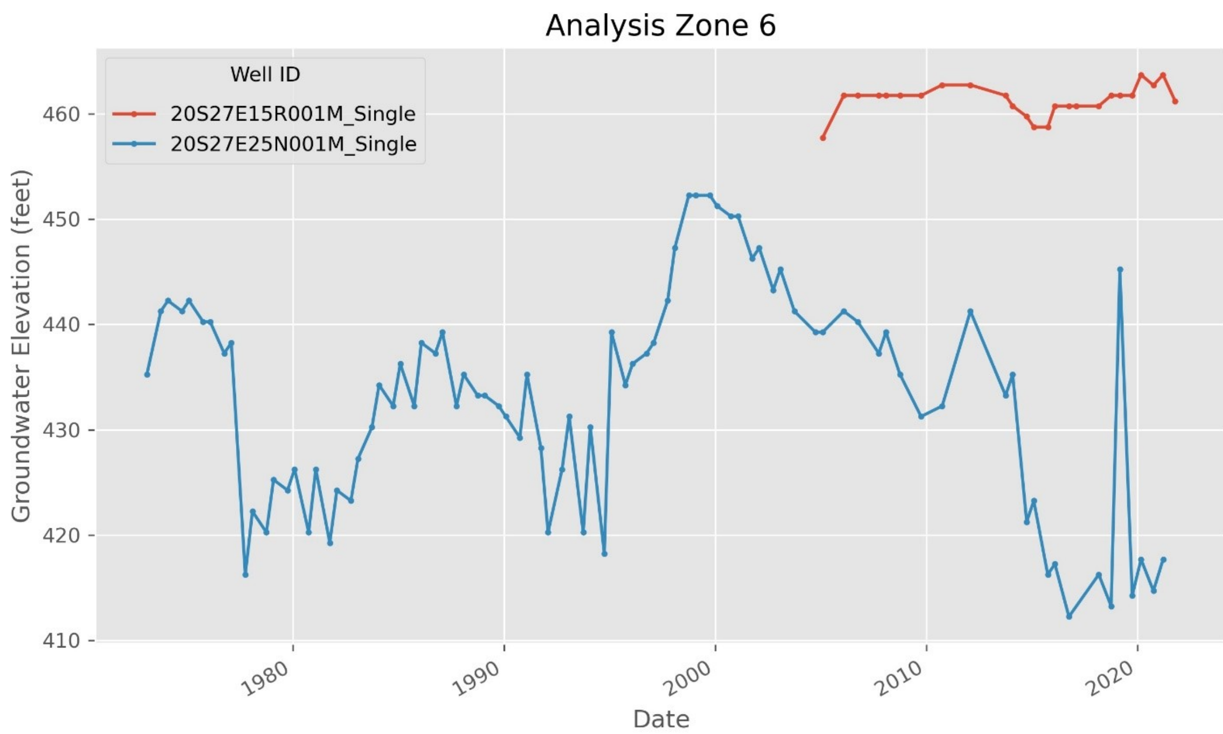
Representative Monitoring Site Hydrographs by Aquifer and Analysis Zone

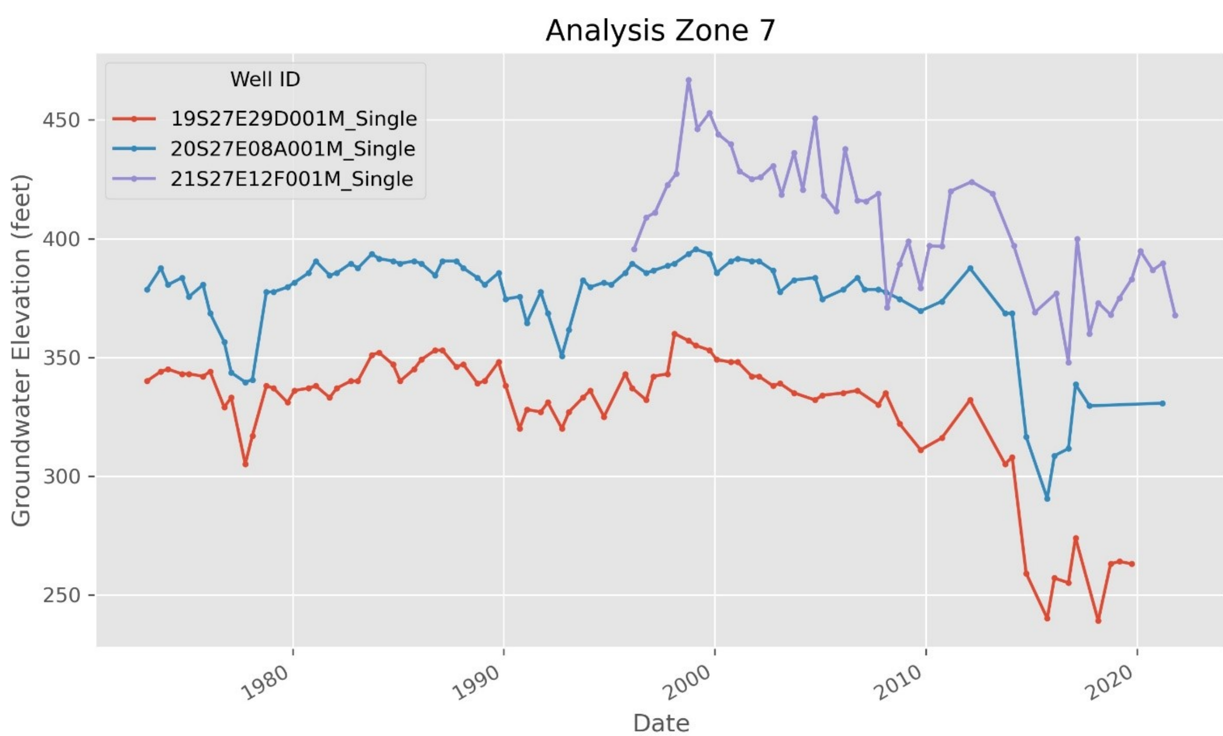

Analysis Zone 1
Well ID
17S25E25A001M_Single
17S25E35E001M_Single
18S26E06D001M_Single
Groundwater Elevation (feet)
300
280
260
240
220
200
1996
2000
2004
2008
2012
2016
2020
Date

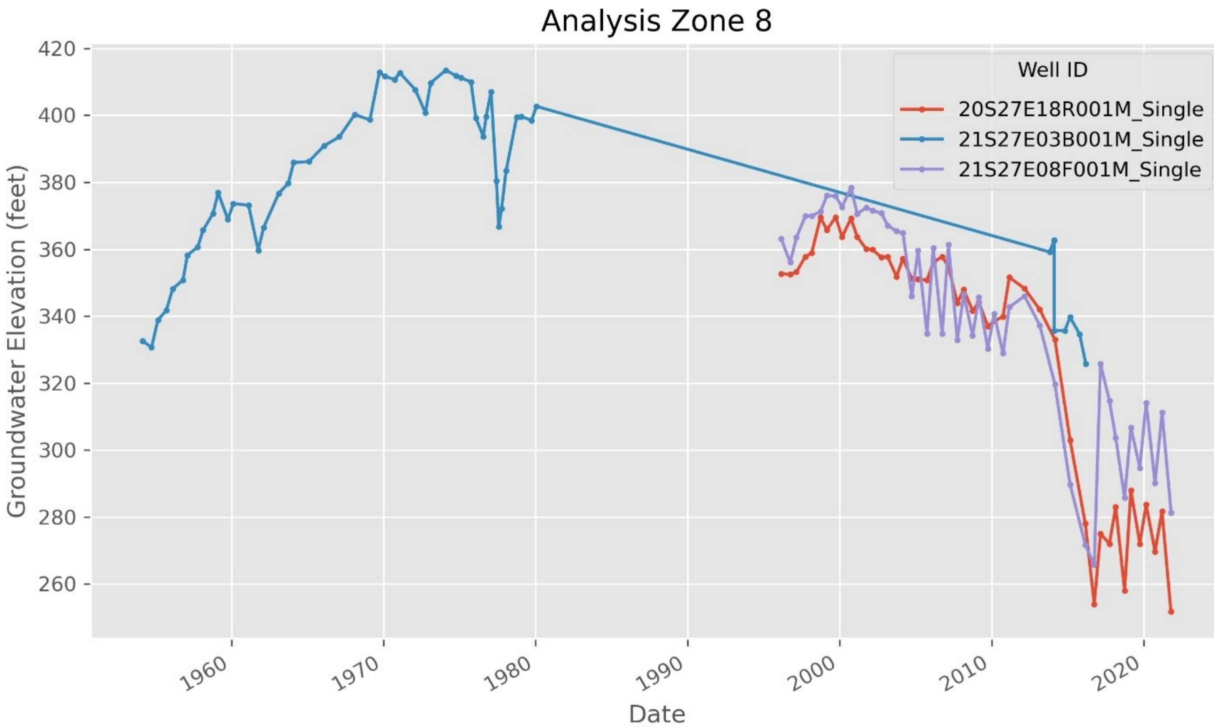

Analysis Zone 2
Well ID
16S25E36M002M_Single
16S26E30Q001M_Single
17S26E04F002M_Single
17S26E07C001M_Single
17S26E21E001M_Single
17S26E29R001M_Single
18S26E02D002M_Single
SCID Office_Single
Groundwater Elevation (feet)
400
380
360
340
320
300
280
260
1960
1970
1980
1990
2000
2010
2020
Date

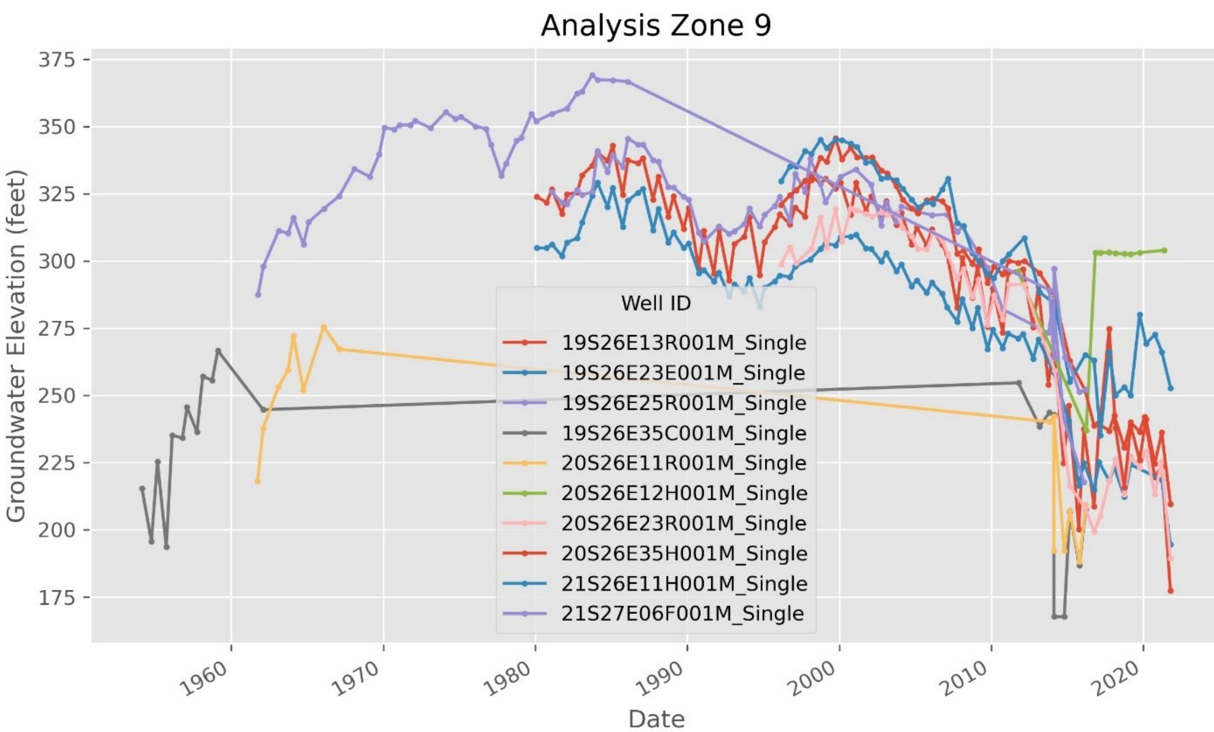

Analysis Zone 4
Groundwater Elevation (feet)
440
420
400
380
360
340
320
Well ID
17S26E36R001M_Single
18S26E24J003M_Single
18S27E17H002M_Single
18S27E29E001M_Single
18S27E30H001M_Single
1980
1985
1990
1995
2000
2005
2010
2015
2020
Date


Analysis Zone 5
Groundwater Elevation (feet)
375
350
325
300
275
250
225
Well ID
18S26E27B001M_Single
19S26E03A001M_Single
19S26E11R001M_Single
1980
1985
1990
1995
2000
2005
2010
2015
2020
Date


Analysis Zone 6
Well ID
20S27E15R001M_Single
20S27E25N001M_Single
Groundwater Elevation (feet)
460
450
440
430
420
410
1980
1990
2000
2010
2020
Date


Analysis Zone 7
Well ID
19S27E29D001M_Single
20S27E08A001M_Single
21S27E12F001M_Single
Groundwater Elevation (feet)
450
400
350
300
250
1980
1990
2000
2010
2020
Date


Analysis Zone 8
Well ID
20S27E18R001M_Single
21S27E03B001M_Single
21S27E08F001M_Single
Groundwater Elevation (feet)
Date
420
400
380
360
340
320
300
280
260
1960
1970
1980
1990
2000
2010
2020


Analysis Zone 9
Well ID
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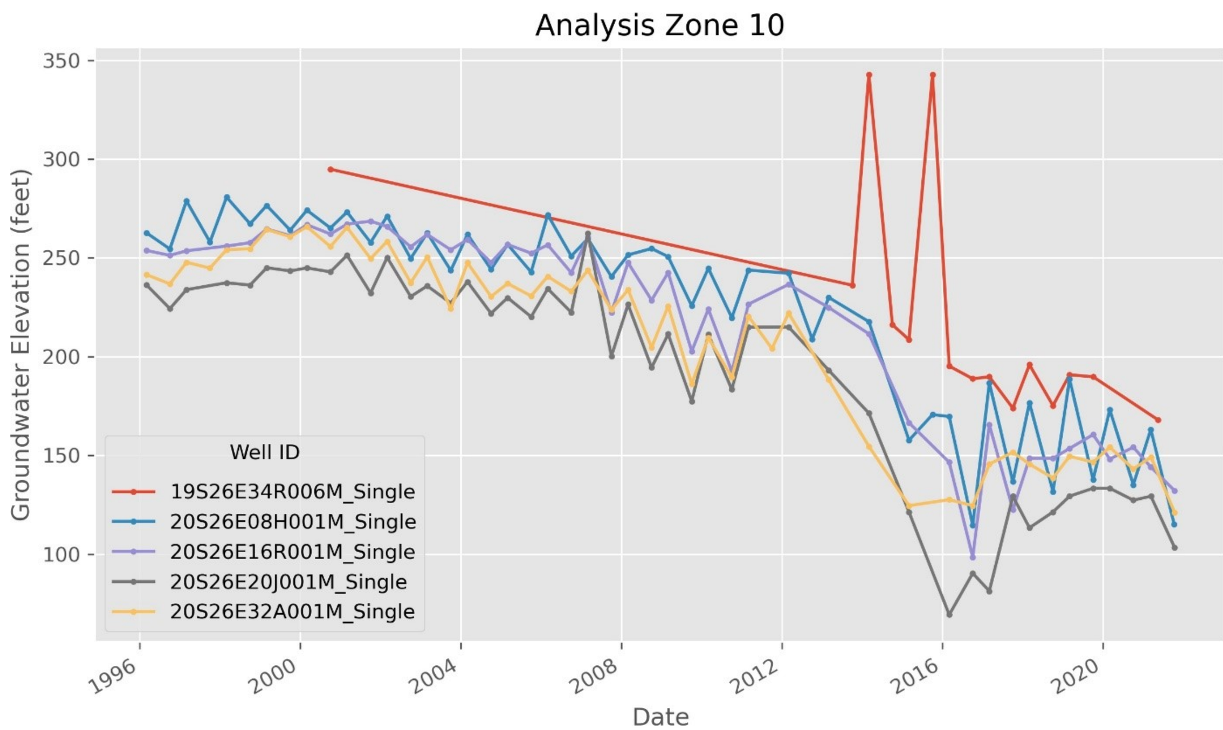
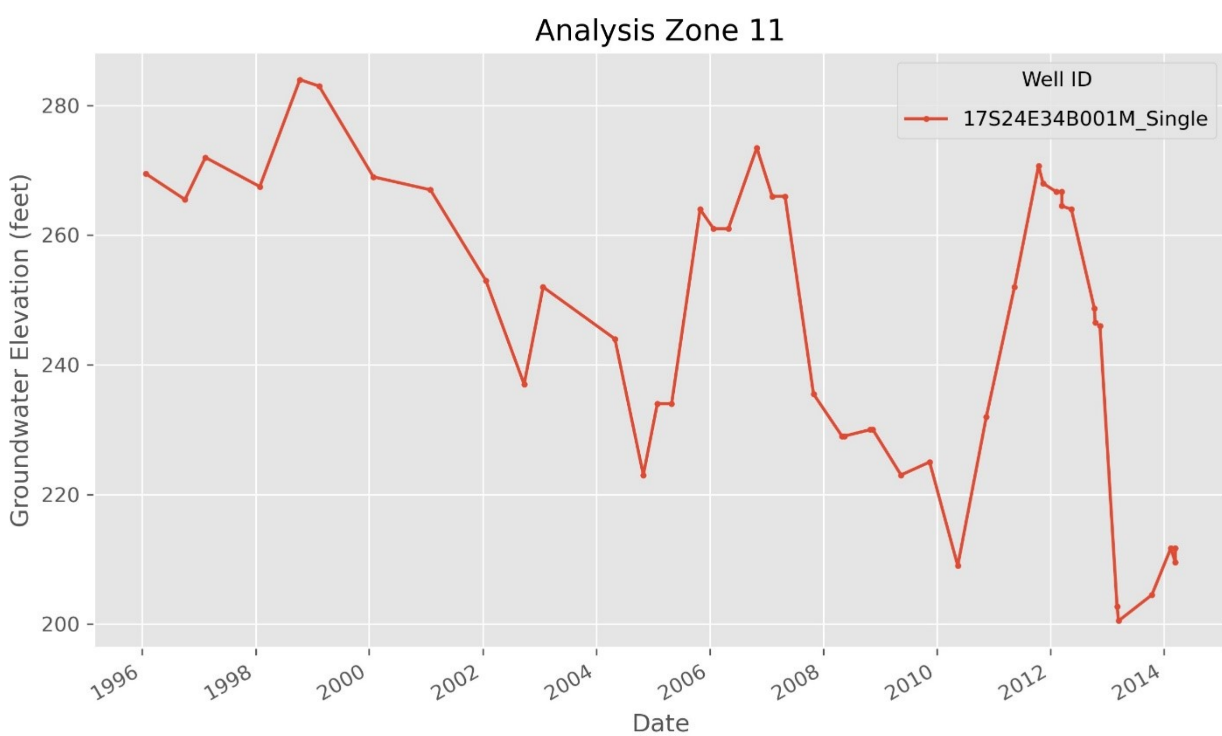
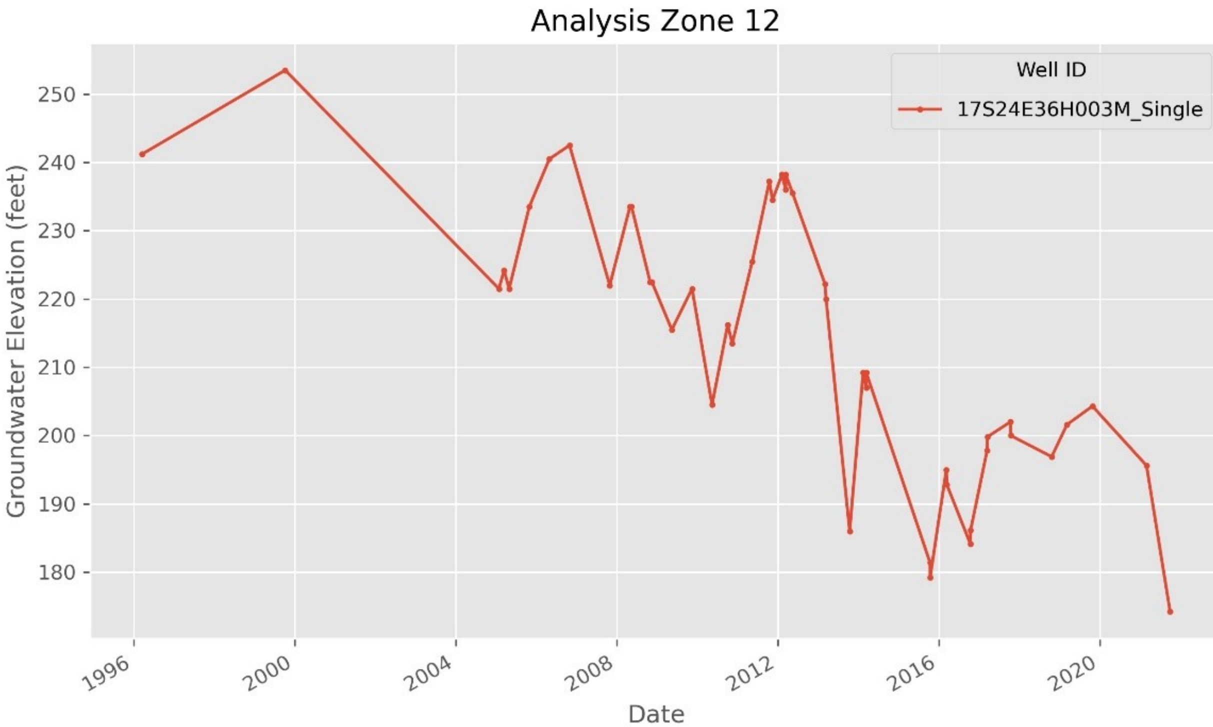
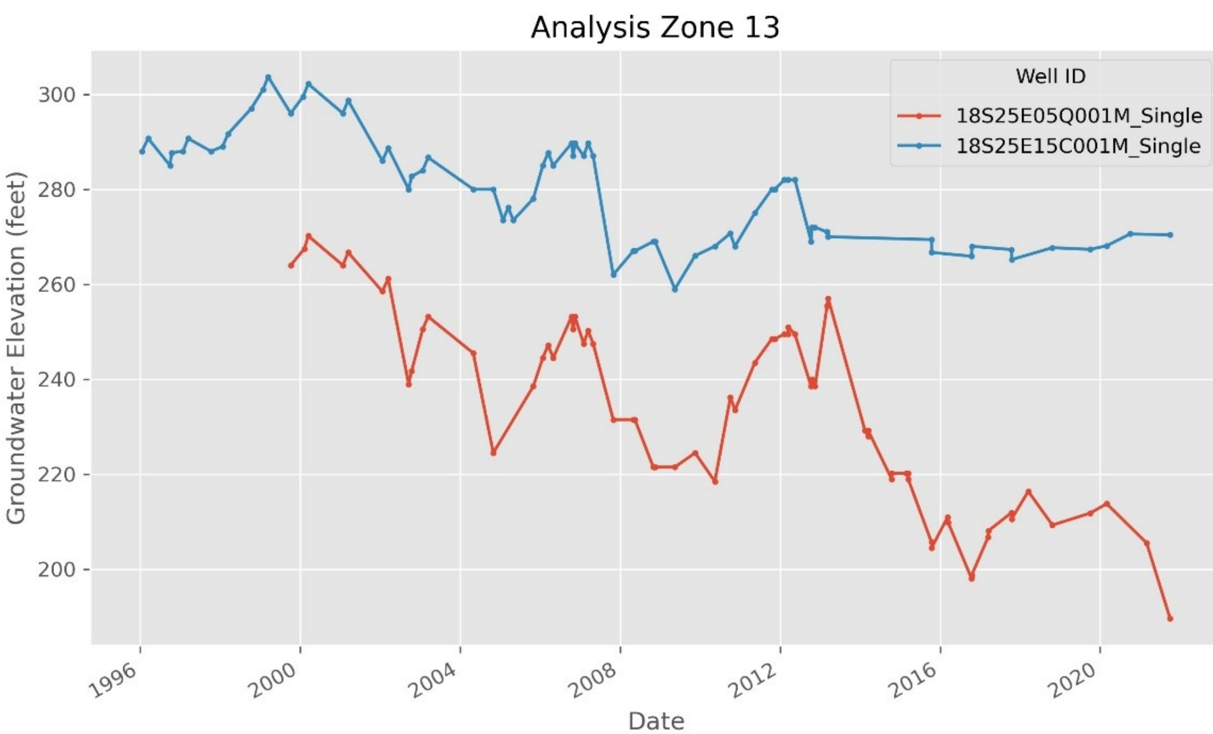
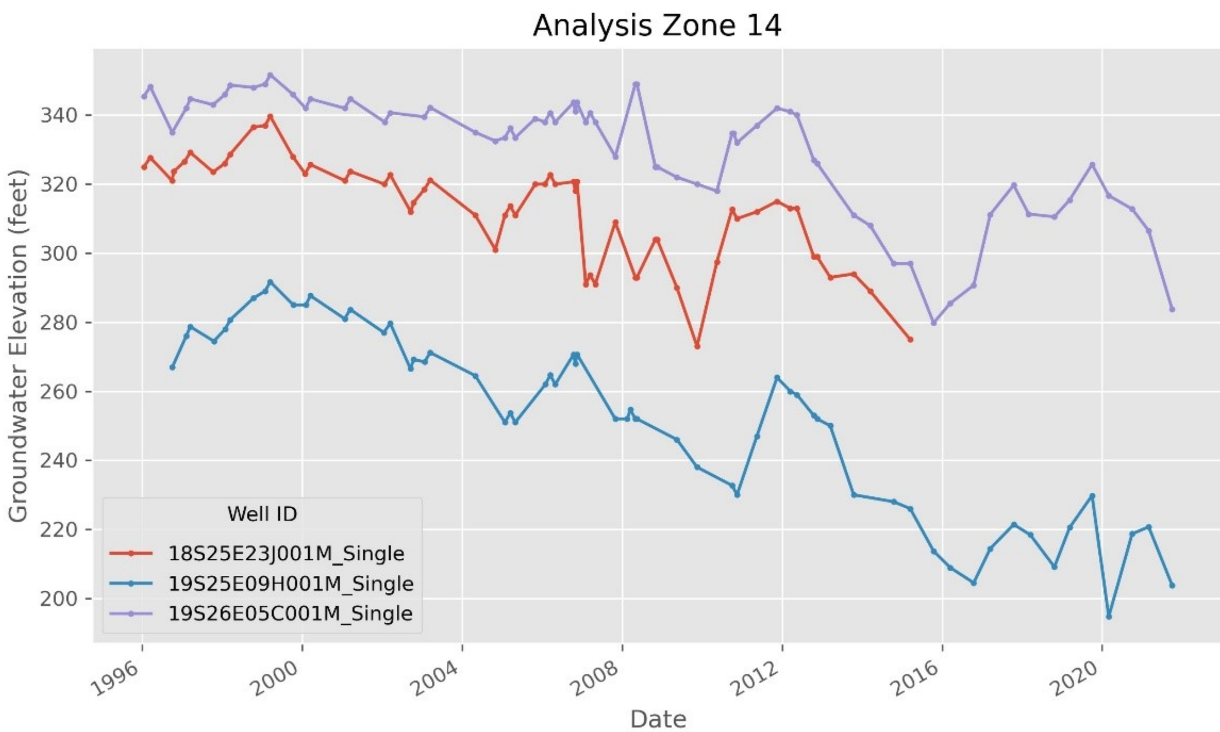
19S26E23E001M_Single
19S26E25R001M_Single
19S26E35C001M_Single
20S26E11R001M_Single
20S26E12H001M_Single
20S26E23R001M_Single
20S26E35H001M_Single
21S26E11H001M_Single
21S27E06F001M_Single
Groundwater Elevation (feet)
Date
375
350
325
300
275
250
225
200
175
1960
1970
1980
1990
2000
2010
2020

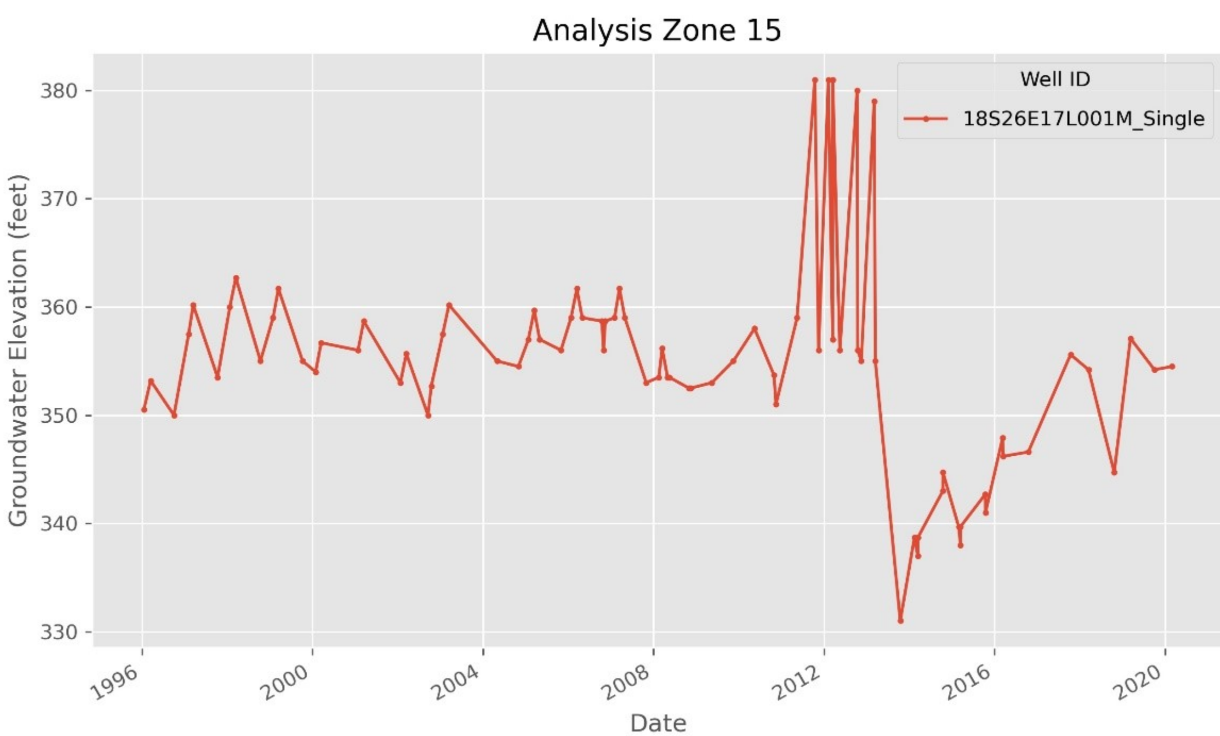

Analysis Zone 10
Groundwater Elevation (feet)
350
300
250
200
150
100
Well ID
19S26E34R006M_Single
20S26E08H001M_Single
20S26E16R001M_Single
20S26E20J001M_Single
20S26E32A001M_Single
1996
2000
2004
2008
2012
2016
2020
Date

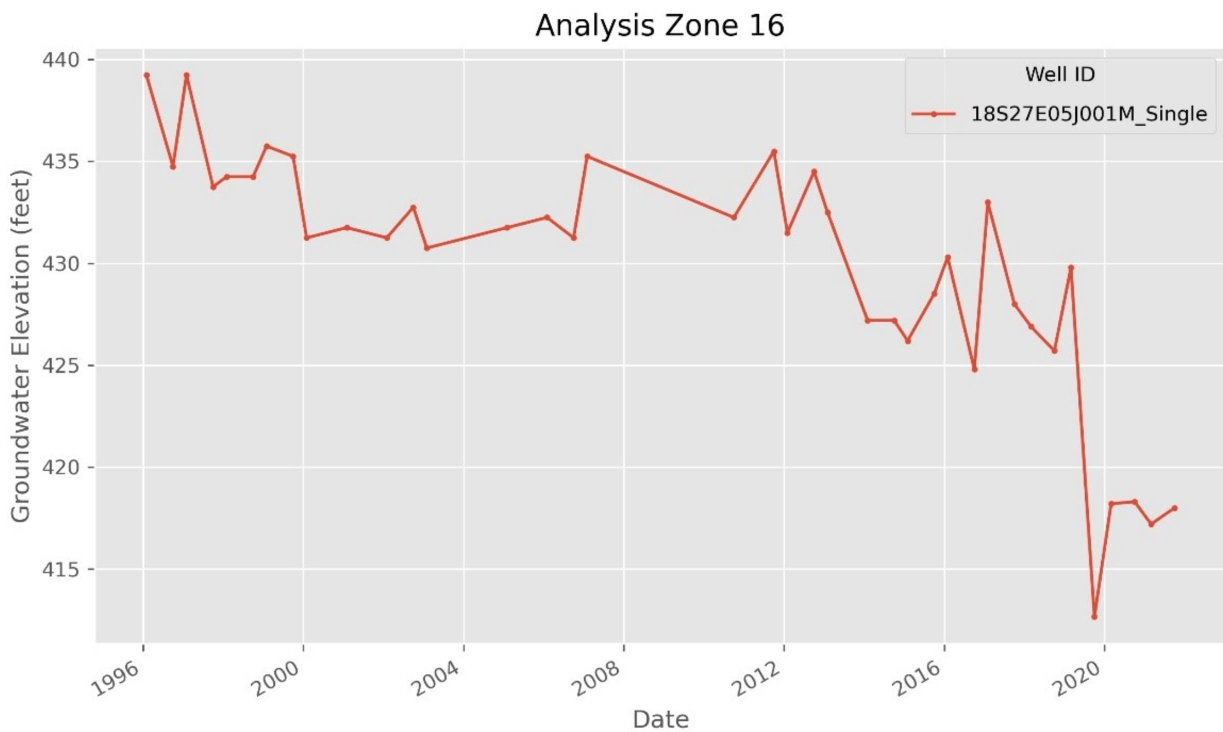

Analysis Zone 11
Groundwater Elevation (feet)
280
260
240
220
200
Well ID
17S24E34B001M_Single
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Date

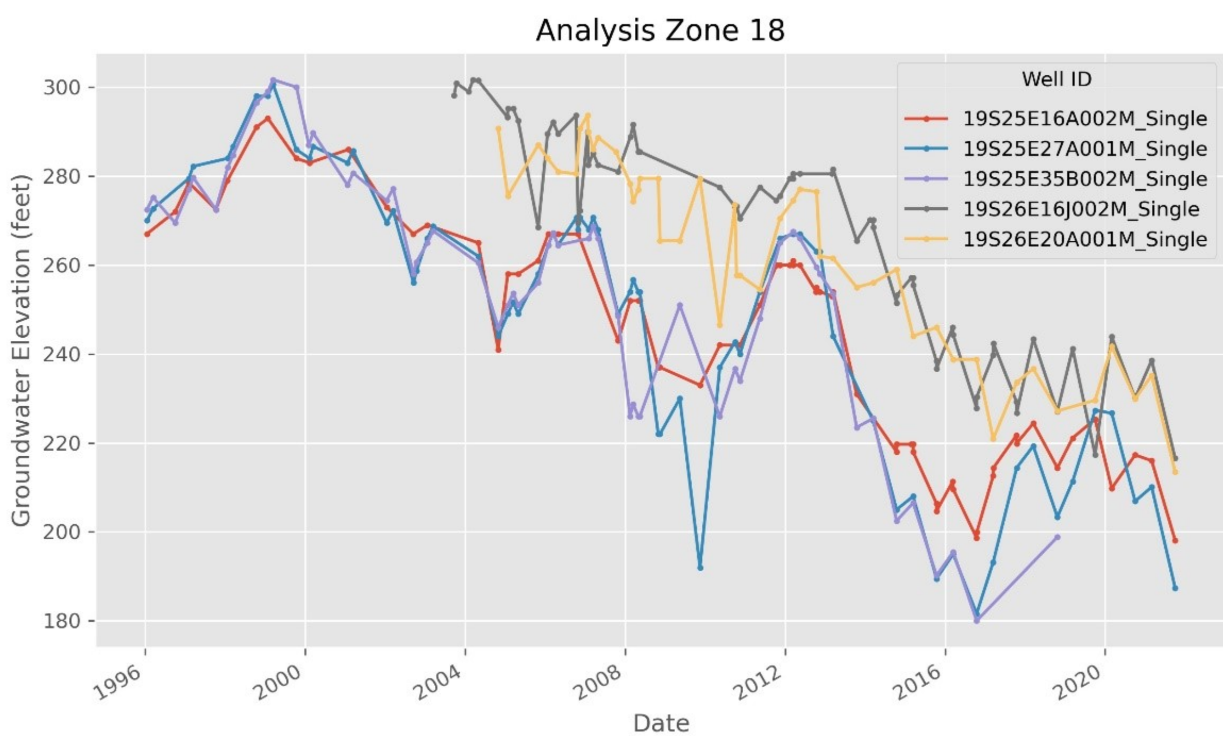

Analysis Zone 12
Well ID
17S24E36H003M_Single
Groundwater Elevation (feet)
250
240
230
220
210
200
190
180
1996
2000
2004
2008
2012
2016
2020
Date

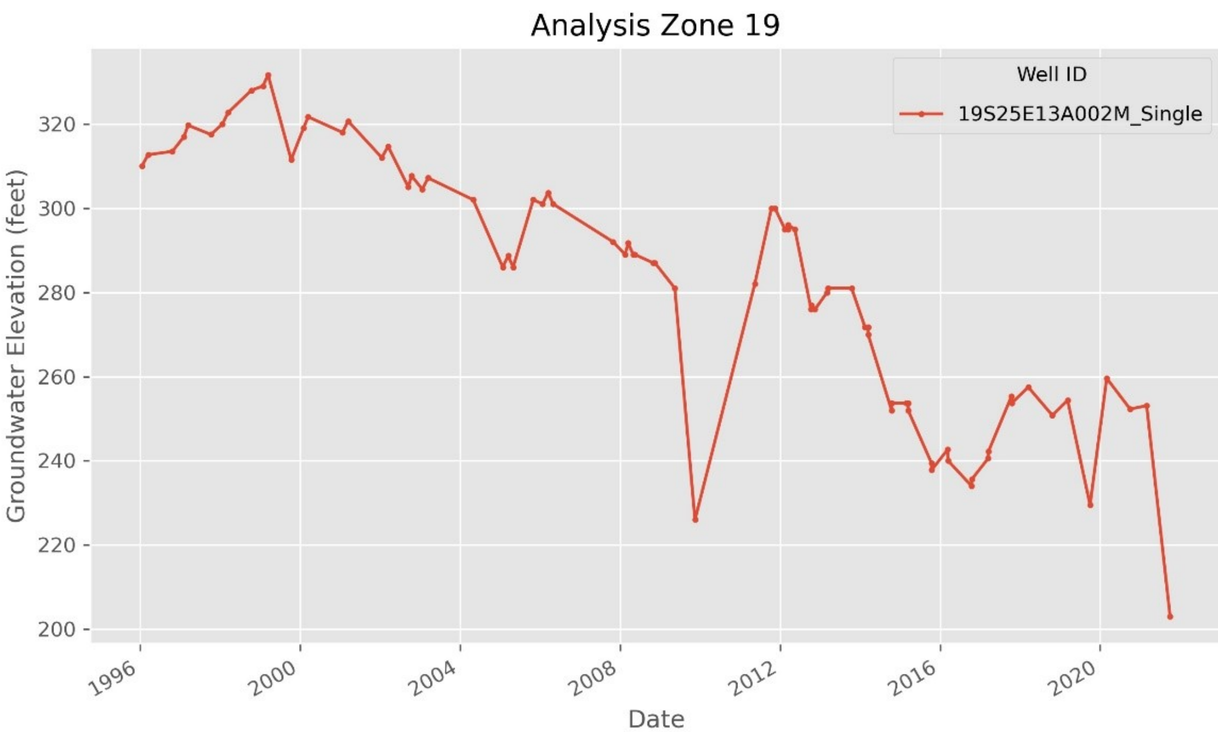

Analysis Zone 13
Well ID
18S25E05Q001M_Single
18S25E15C001M_Single
Groundwater Elevation (feet)
300
280
260
240
220
200
1996
2000
2004
2008
2012
2016
2020
Date

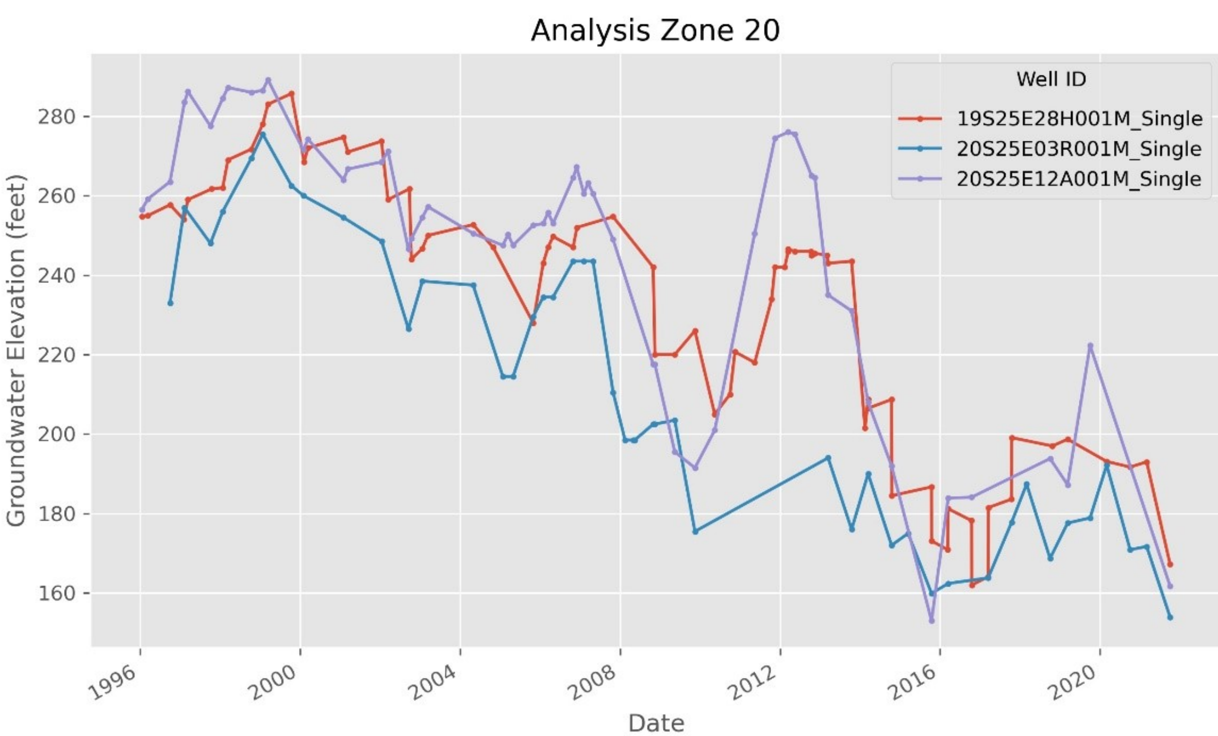

Analysis Zone 14
Groundwater Elevation (feet)
340
320
300
280
260
240
220
200
Well ID
18S25E23J001M_Single
19S25E09H001M_Single
19S26E05C001M_Single
1996
2000
2004
2008
2012
2016
2020
Date

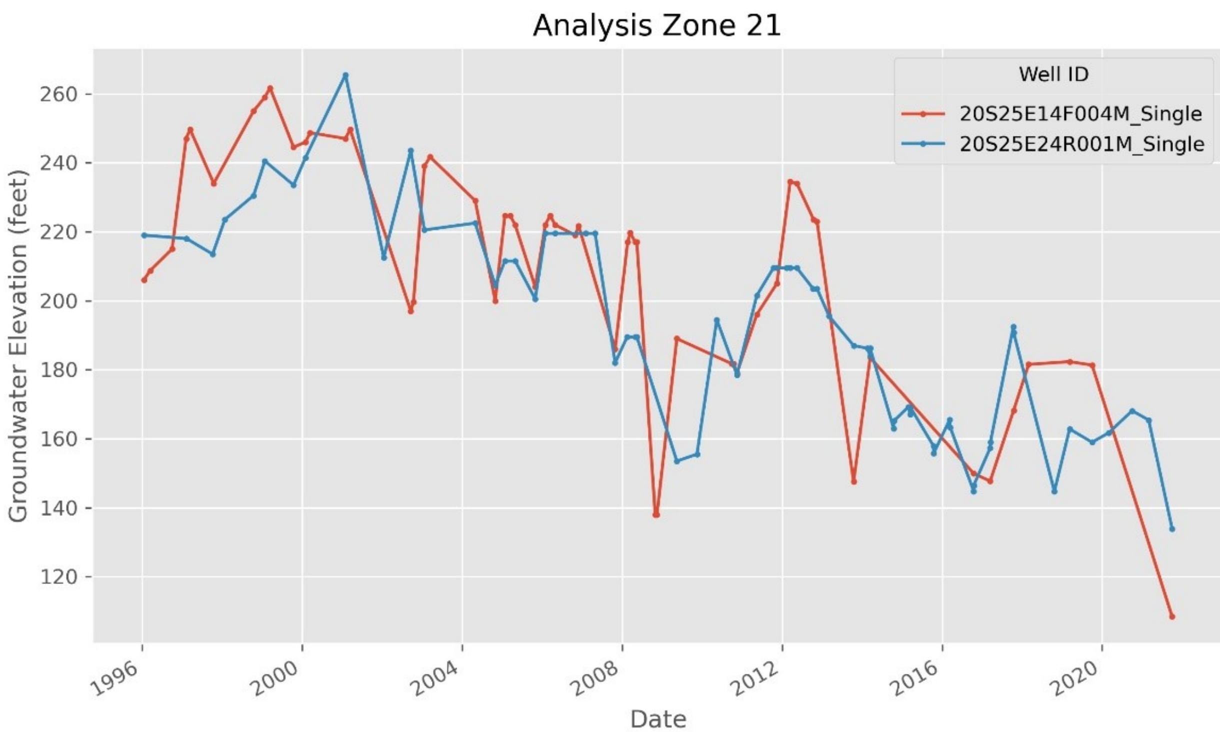

Analysis Zone 15
Groundwater Elevation (feet)
380
370
360
350
340
330
Well ID
18S26E17L001M_Single
1996
2000
2004
2008
2012
2016
2020
Date

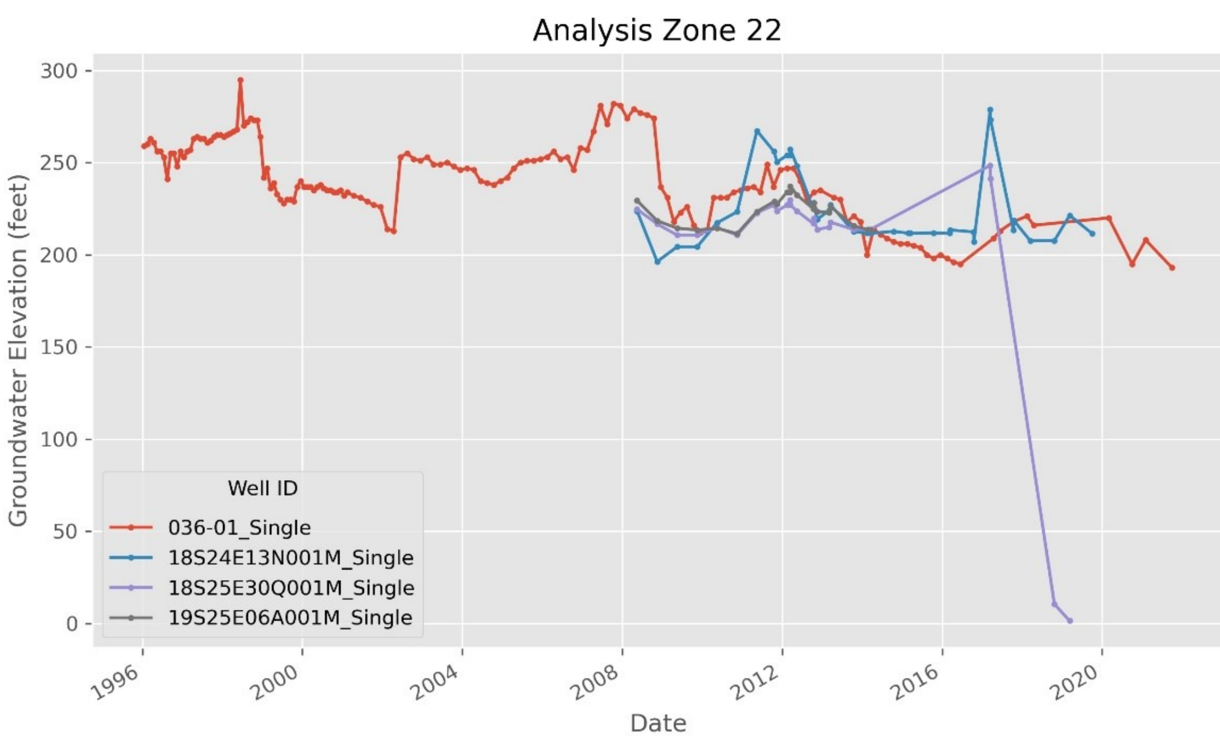

Analysis Zone 16
Well ID
18S27E05J001M_Single
Groundwater Elevation (feet)
440
435
430
425
420
415
1996
2000
2004
2008
2012
2016
2020
Date

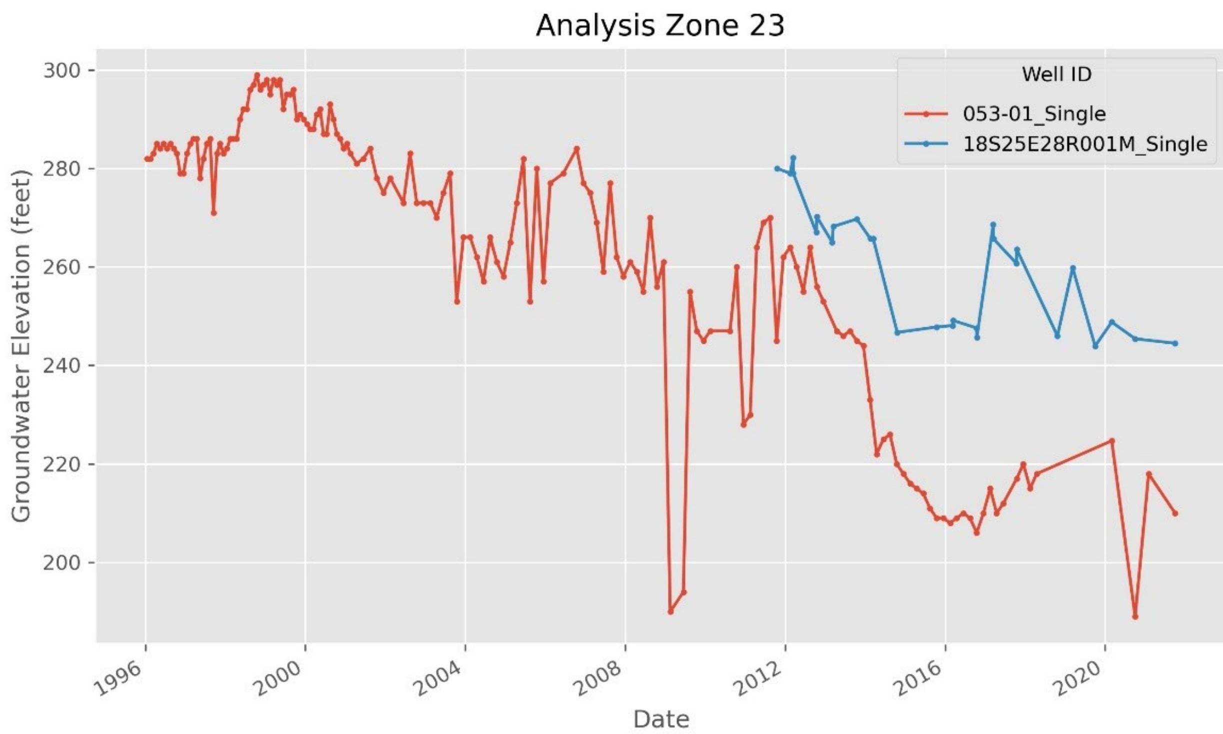

Analysis Zone 18
Well ID
19S25E16A002M_Single
19S25E27A001M_Single
19S25E35B002M_Single
19S26E16J002M_Single
19S26E20A001M_Single
Groundwater Elevation (feet)
300
280
260
240
220
200
180
1996
2000
2004
2008
2012
2016
2020
Date

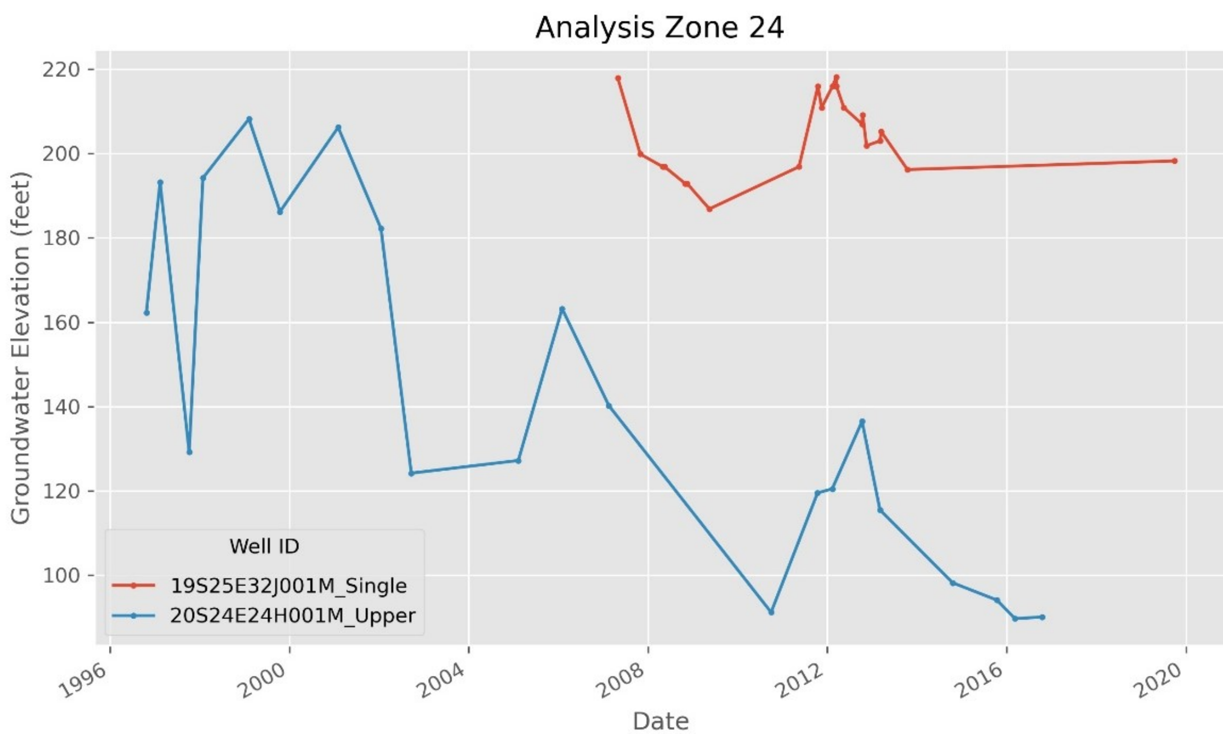

Analysis Zone 19
Well ID
19S25E13A002M_Single
Groundwater Elevation (feet)
200
220
240
260
280
300
320
1996
2000
2004
2008
2012
2016
2020
Date

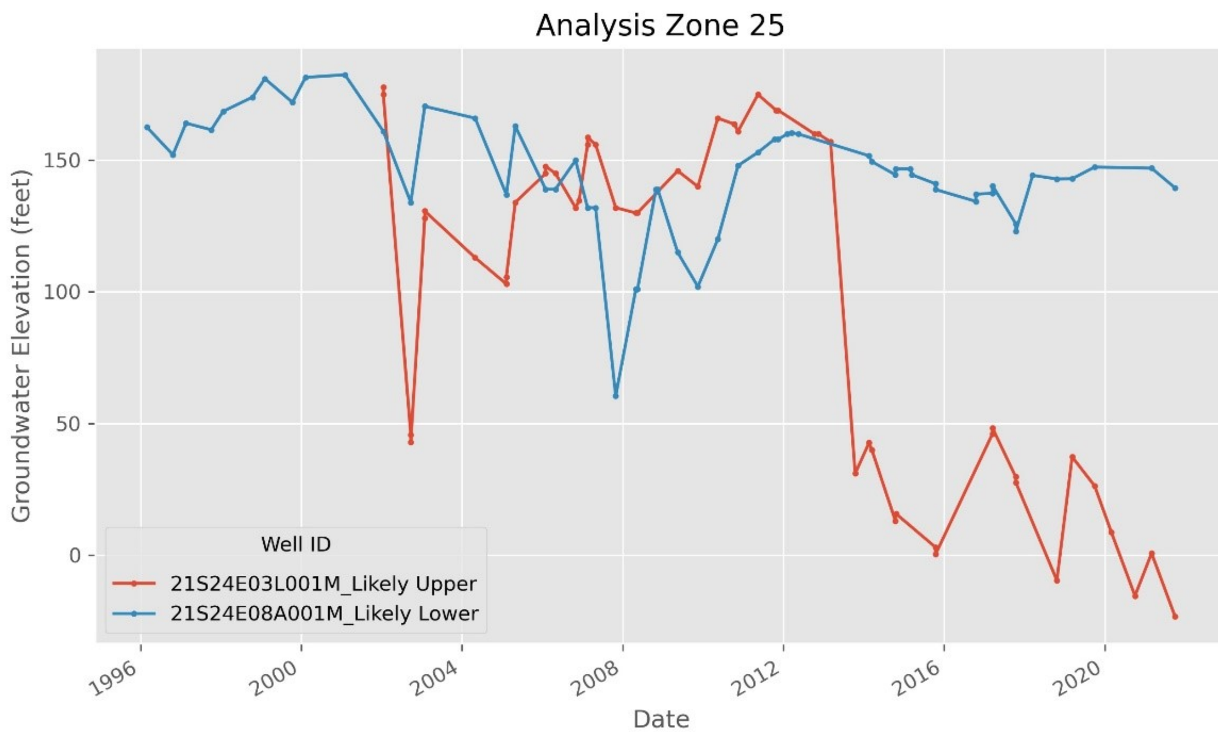

Analysis Zone 20
Well ID
19S25E28H001M_Single
20S25E03R001M_Single
20S25E12A001M_Single
Groundwater Elevation (feet)
160
180
200
220
240
260
280
1996
2000
2004
2008
2012
2016
2020
Date


Analysis Zone 21
Well ID
20S25E14F004M_Single
20S25E24R001M_Single
Groundwater Elevation (feet)
260
240
220
200
180
160
140
120
1996
2000
2004
2008
2012
2016
2020
Date


Analysis Zone 22
Well ID
036-01_Single
18S24E13N001M_Single
18S25E30Q001M_Single
19S25E06A001M_Single
Groundwater Elevation (feet)
300
250
200
150
100
50
0
1996
2000
2004
2008
2012
2016
2020
Date


Analysis Zone 23
Well ID
053-01_Single
18S25E28R001M_Single
Groundwater Elevation (feet)
300
280
260
240
220
200
1996
2000
2004
2008
2012
2016
2020
Date


Analysis Zone 24
Well ID
19S25E32J001M_Single
20S24E24H001M_Upper
Groundwater Elevation (feet)
220
200
180
160
140
120
100
1996
2000
2004
2008
2012
2016
2020
Date


Analysis Zone 25
Groundwater Elevation (feet)
Date
Well ID
21S24E03L001M_Likely Upper
21S24E08A001M_Likely Lower
150
100
50
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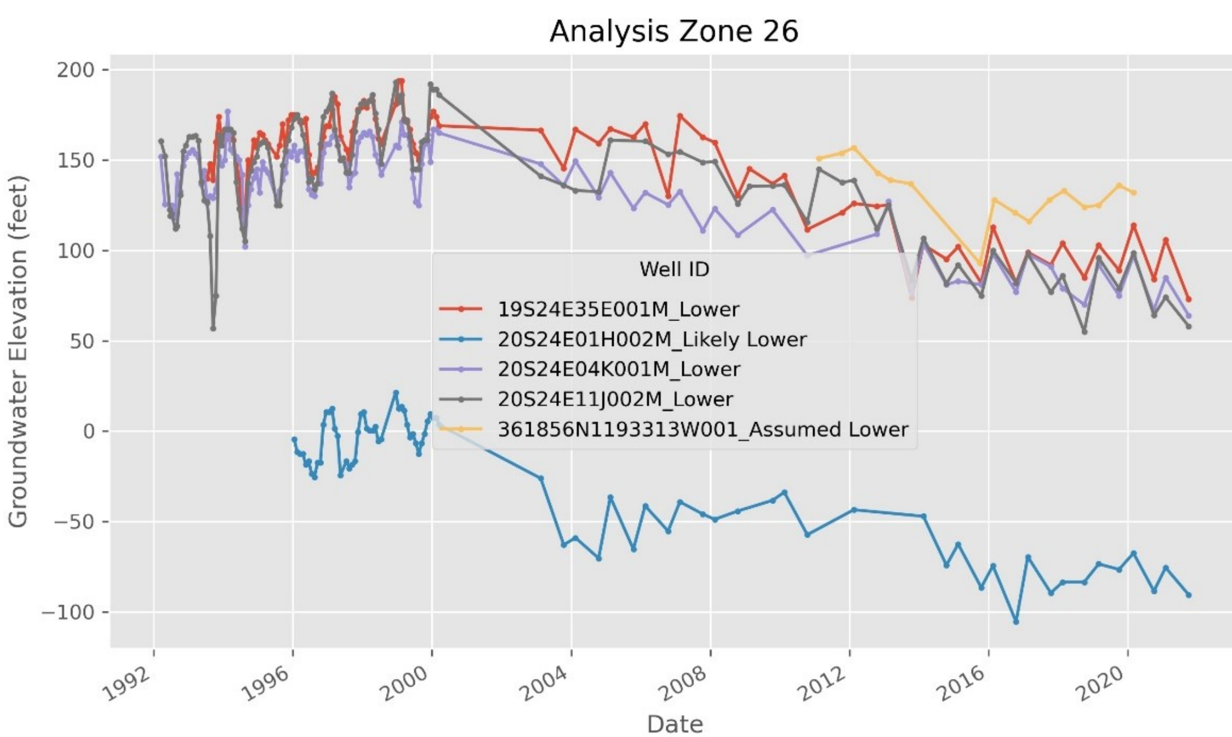
1996
2000
2004
2008
2012
2016
2020


Analysis Zone 26
Groundwater Elevation (feet)
Date
Well ID
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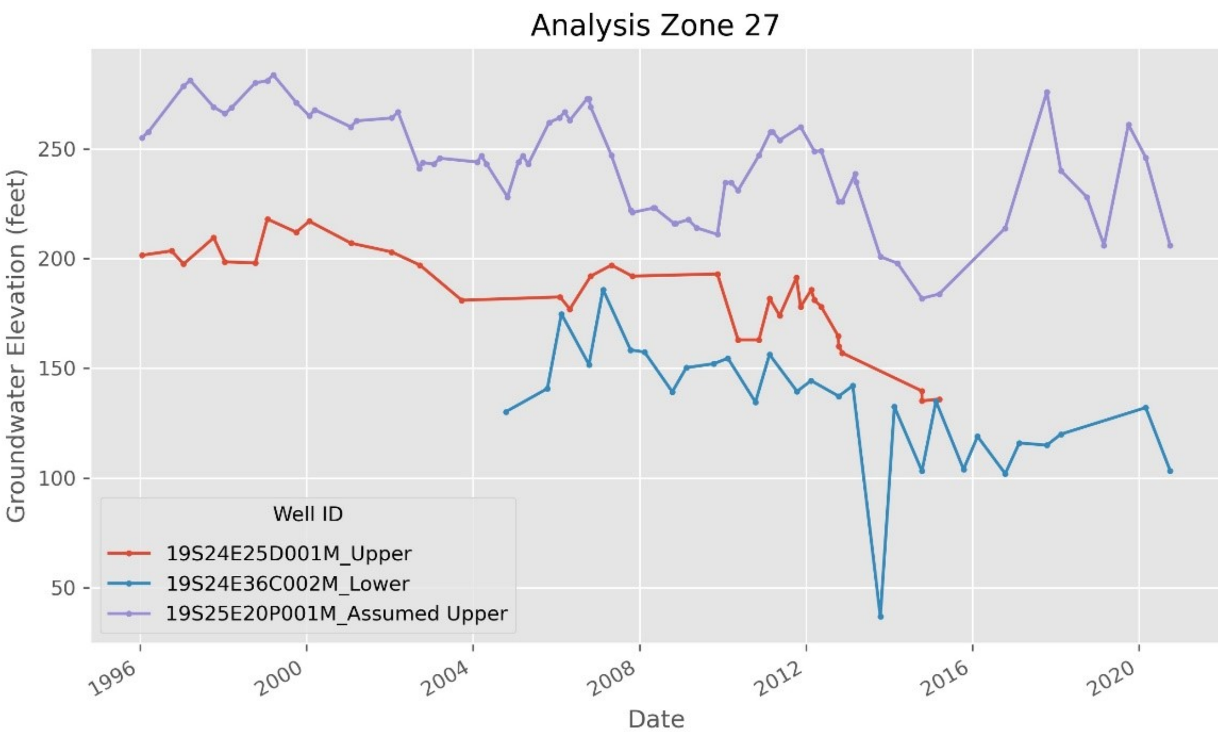
20S24E01H002M_Likely Lower
20S24E04K001M_Lower
20S24E11J002M_Lower
361856N1193313W001_Assumed Lower
200
150
100
50
0
−50
−100
1992
1996
2000
2004
2008
2012
2016
2020


Analysis Zone 27
Groundwater Elevation (feet)
Date
Well ID
19S24E25D001M_Upper
19S24E36C002M_Lower
19S25E20P001M_Assumed Upper
250
200
150
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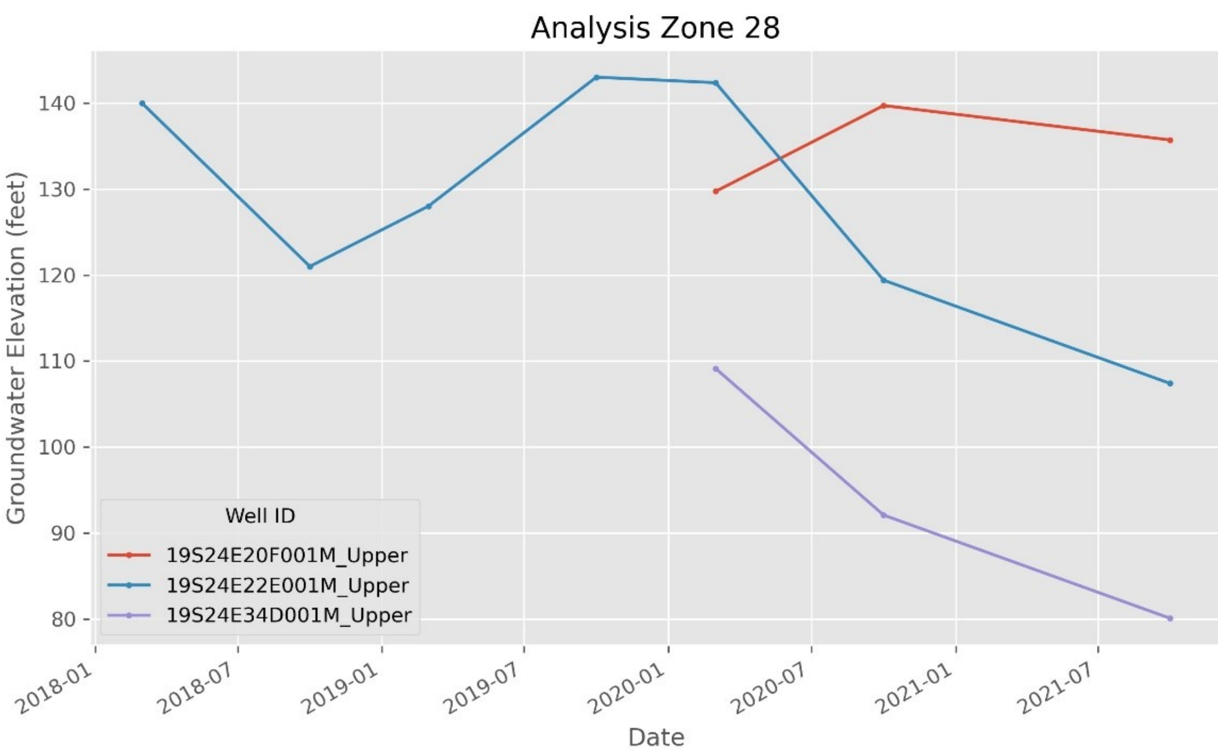
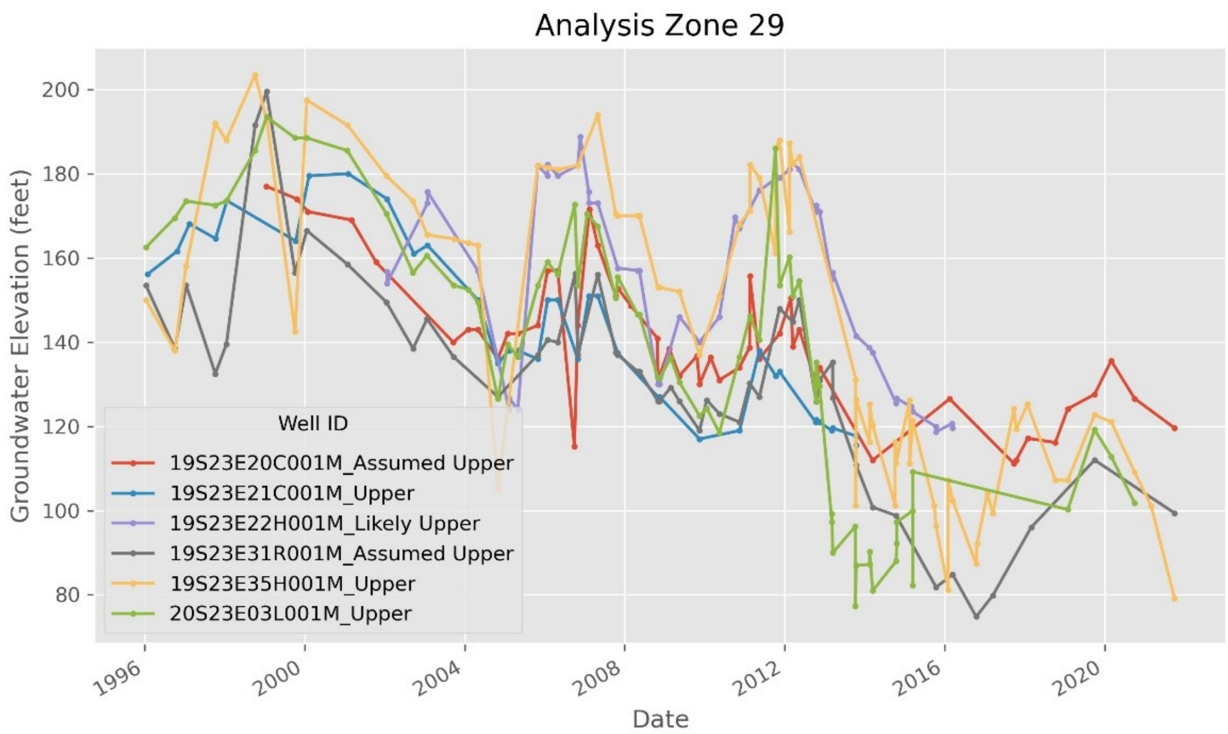
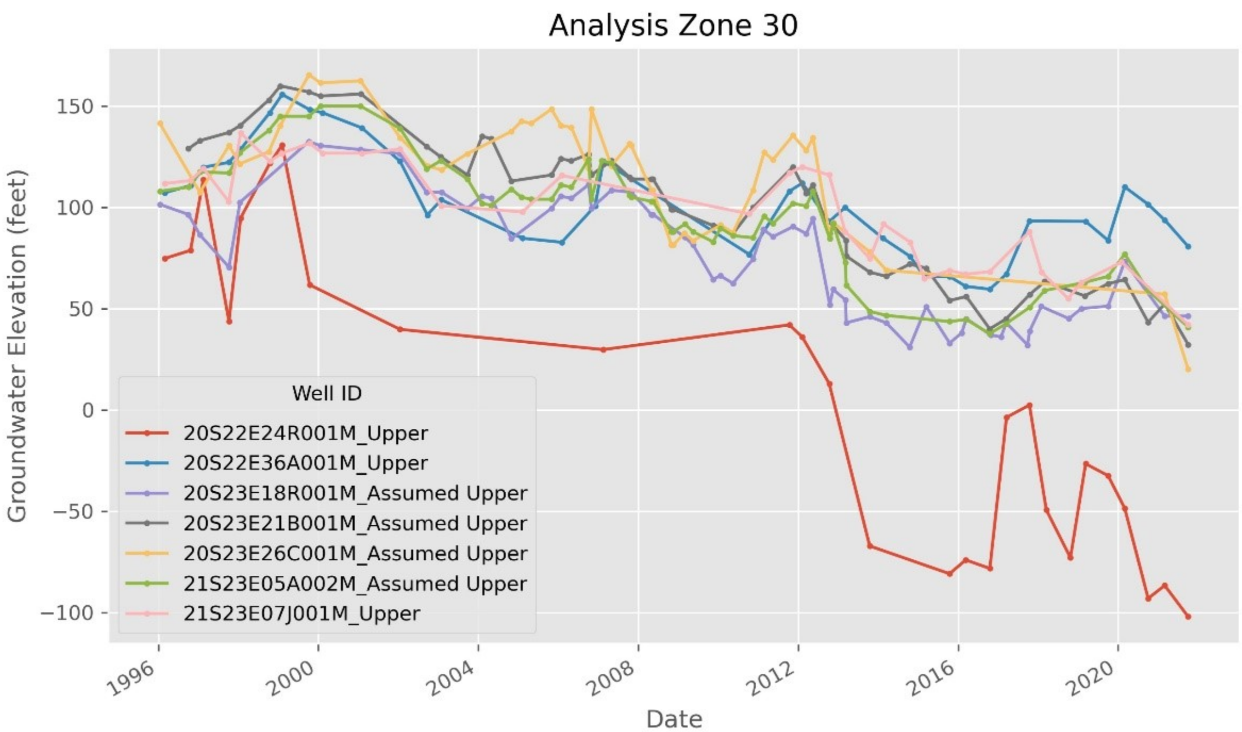
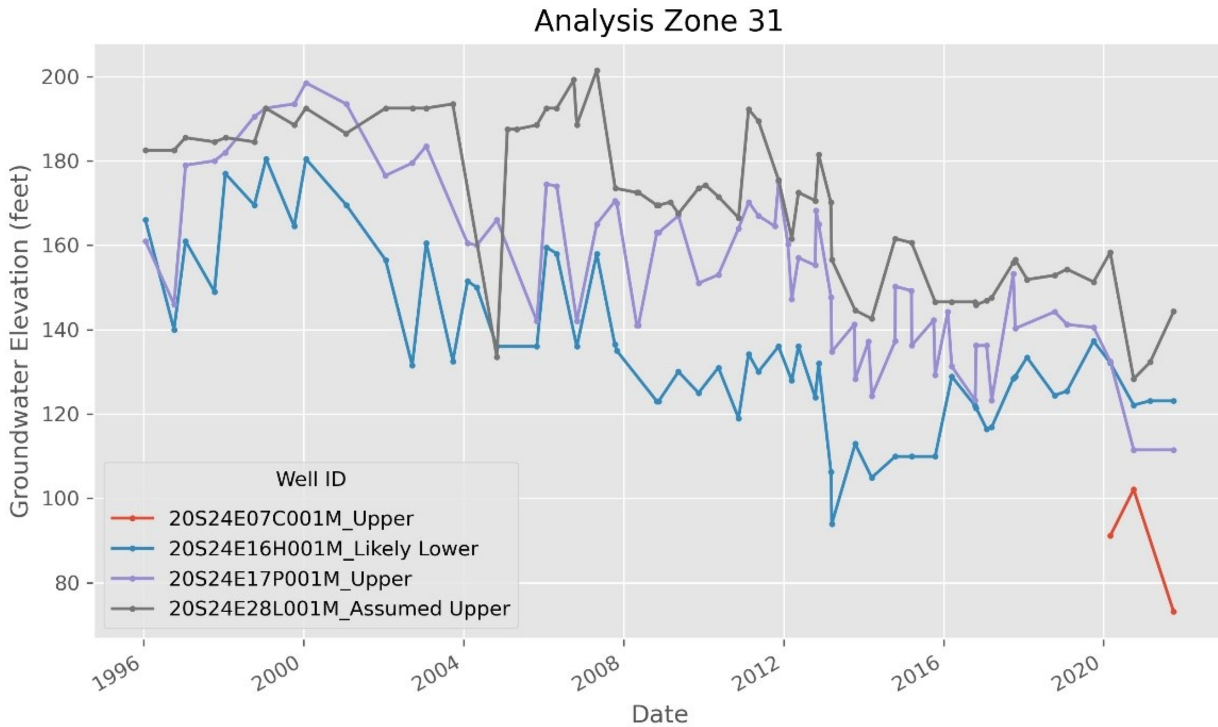
1996
2000
2004
2008
2012
2016
2020


Analysis Zone 28
Groundwater Elevation (feet)
Date
Well ID
19S24E20F001M_Upper
19S24E22E001M_Upper
19S24E34D001M_Upper
140
130
120
110
100
90
80
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07


Analysis Zone 29
Groundwater Elevation (feet)
200
180
160
140
120
100
80
Well ID
19S23E20C001M_Assumed Upper
19S23E21C001M_Upper
19S23E22H001M_Likely Upper
19S23E31R001M_Assumed Upper
19S23E35H001M_Upper
20S23E03L001M_Upper
1996
2000
2004
2008
2012
2016
2020
Date


Analysis Zone 30
Groundwater Elevation (feet)
150
100
50
0
−50
−100
Well ID
20S22E24R001M_Upper
20S22E36A001M_Upper
20S23E18R001M_Assumed Upper
20S23E21B001M_Assumed Upper
20S23E26C001M_Assumed Upper
21S23E05A002M_Assumed Upper
21S23E07J001M_Upper
1996
2000
2004
2008
2012
2016
2020
Date


Analysis Zone 31
Groundwater Elevation (feet)
Date
Well ID
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20S24E16H001M_Likely Lower
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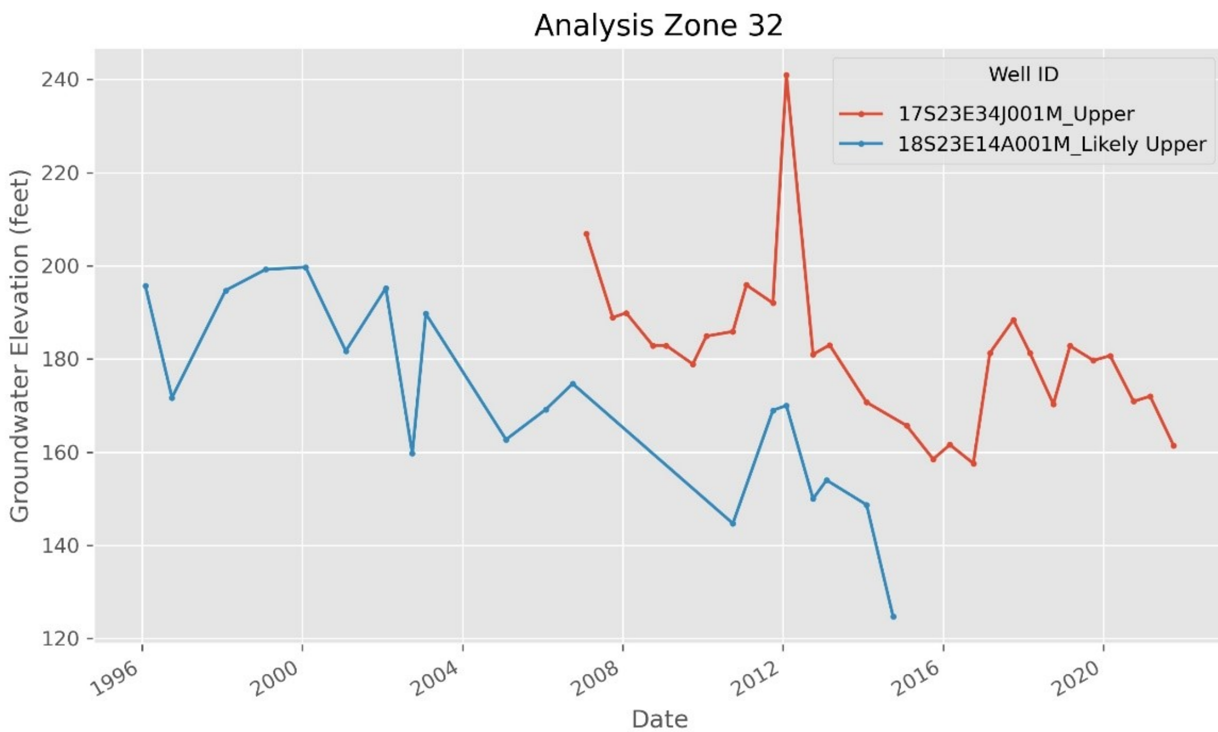
20S24E28L001M_Assumed Upper


Analysis Zone 32
Groundwater Elevation (feet)
Date
Well ID
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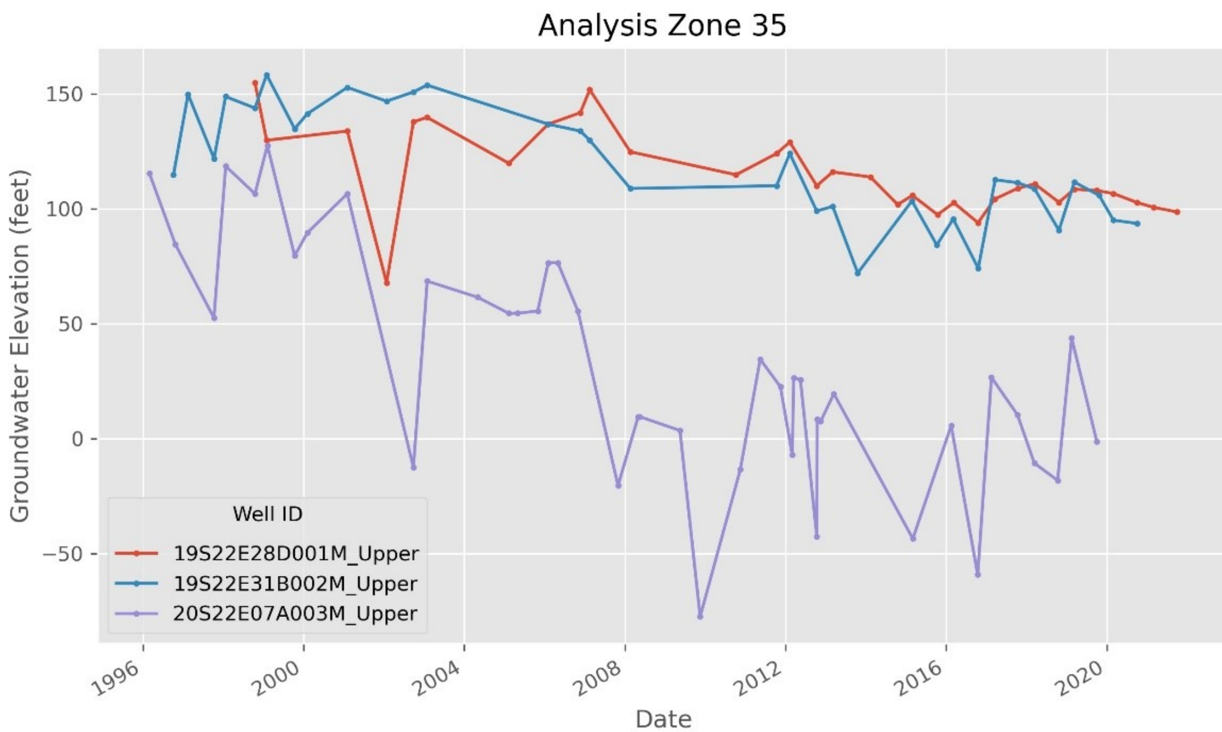
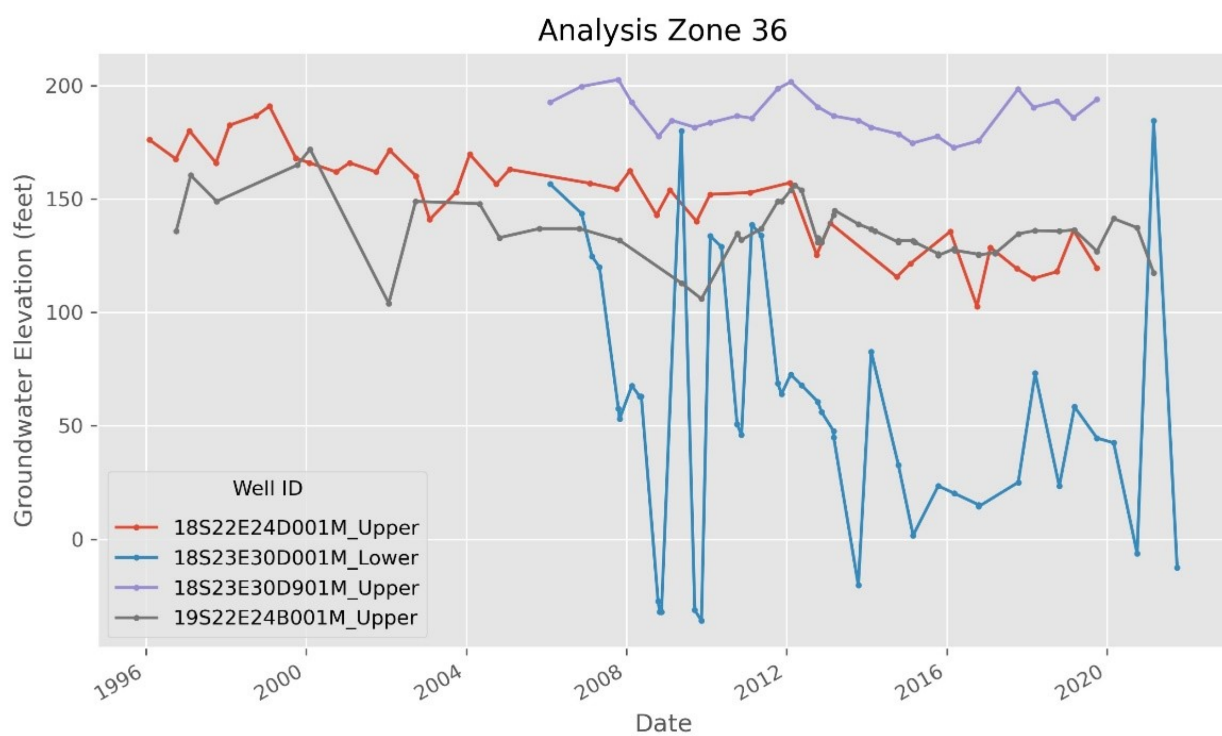
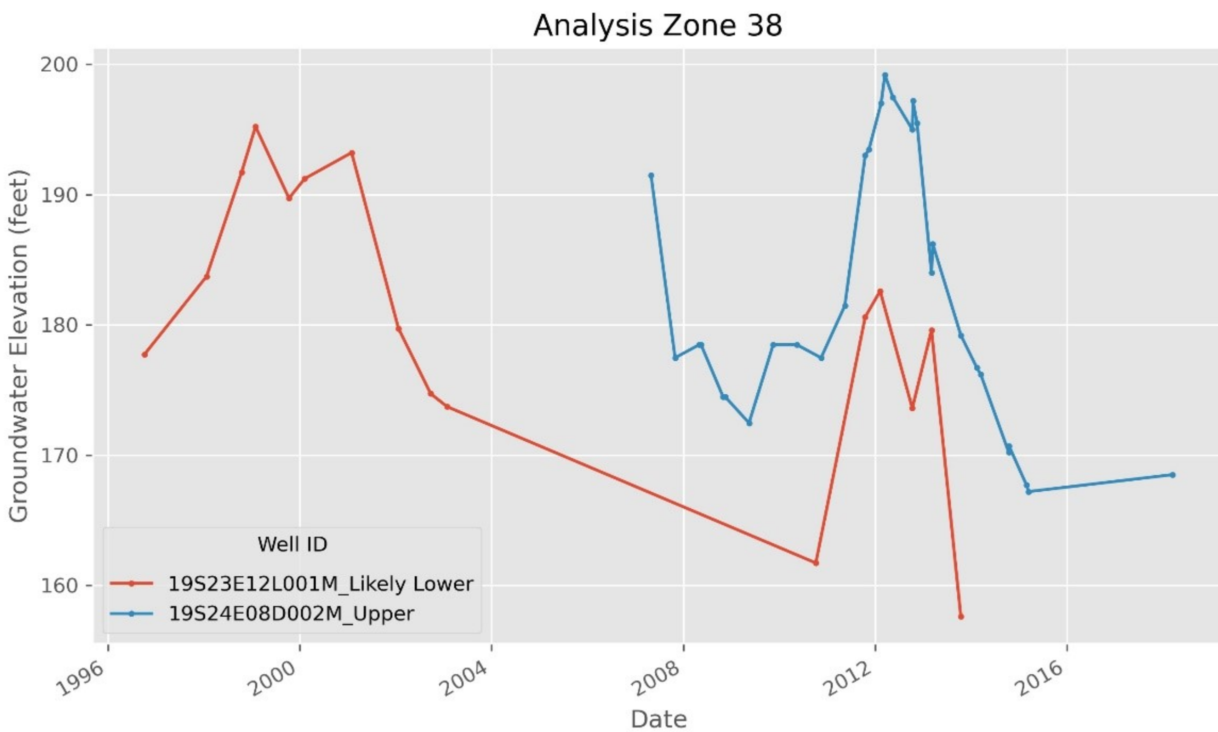
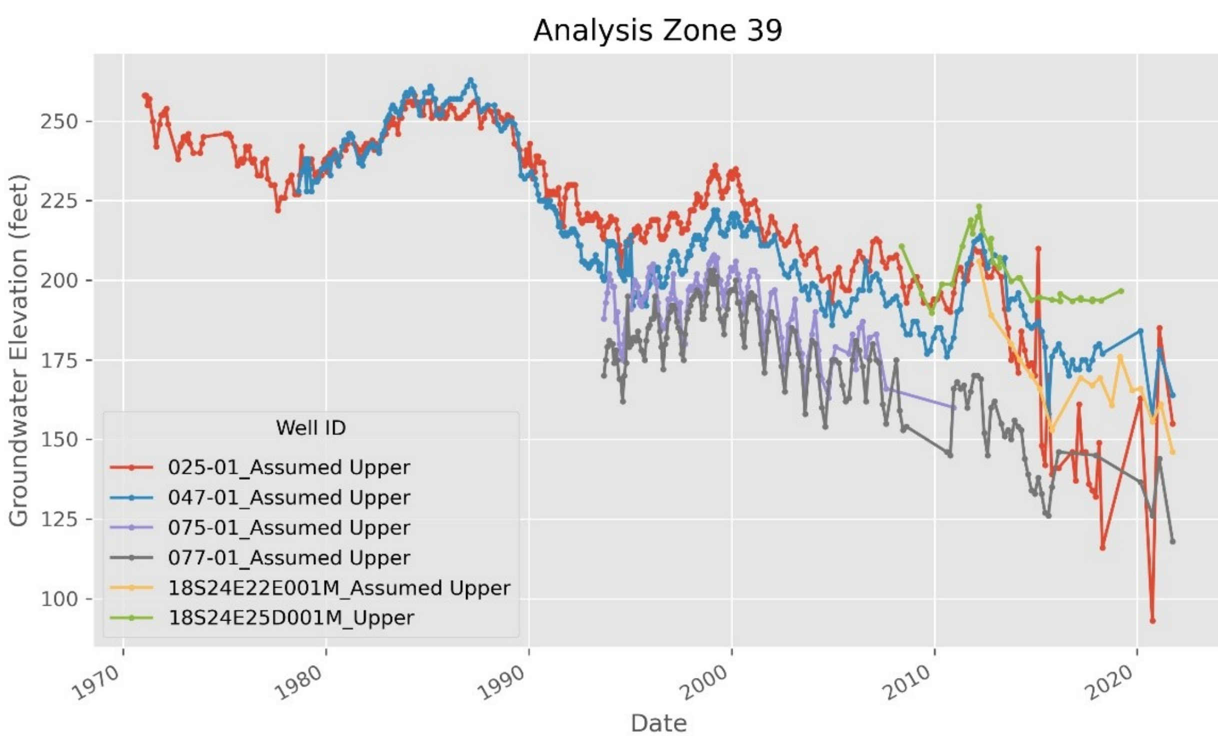
18S23E14A001M_Likely Upper


Analysis Zone 35
Groundwater Elevation (feet)
Date
Well ID
19S22E28D001M_Upper
19S22E31B002M_Upper
20S22E07A003M_Upper
150
100
50
0
−50
1996
2000
2004
2008
2012
2016
2020


Analysis Zone 36
Groundwater Elevation (feet)
Date
Well ID
18S22E24D001M_Upper
18S23E30D001M_Lower
18S23E30D901M_Upper
19S22E24B001M_Upper
200
150
100
50
0
1996
2000
2004
2008
2012
2016
2020

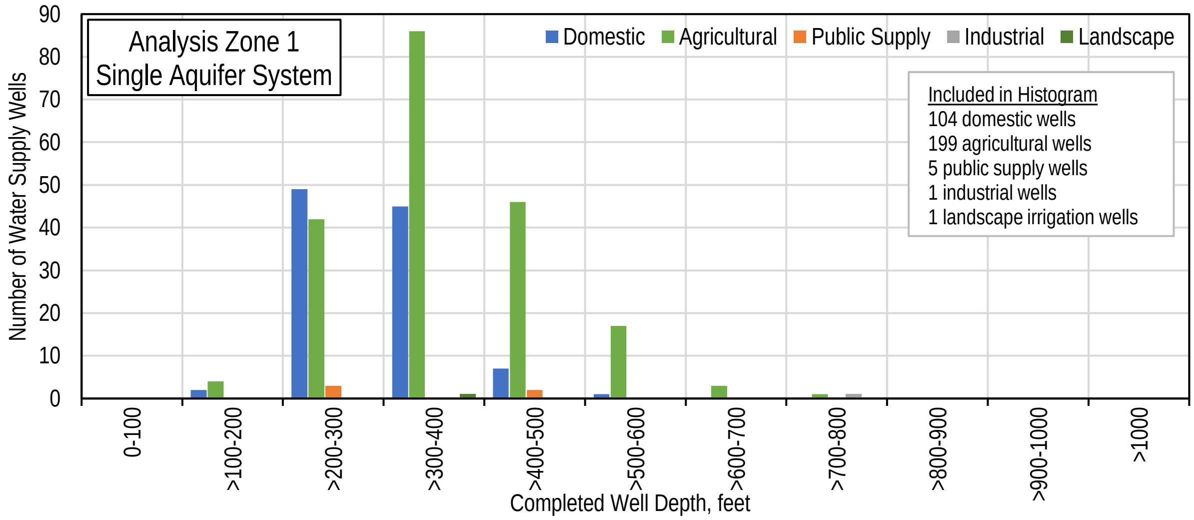

Analysis Zone 38
Groundwater Elevation (feet)
200
190
180
170
160
Well ID
19S23E12L001M_Likely Lower
19S24E08D002M_Upper
1996
2000
2004
2008
2012
2016
Date

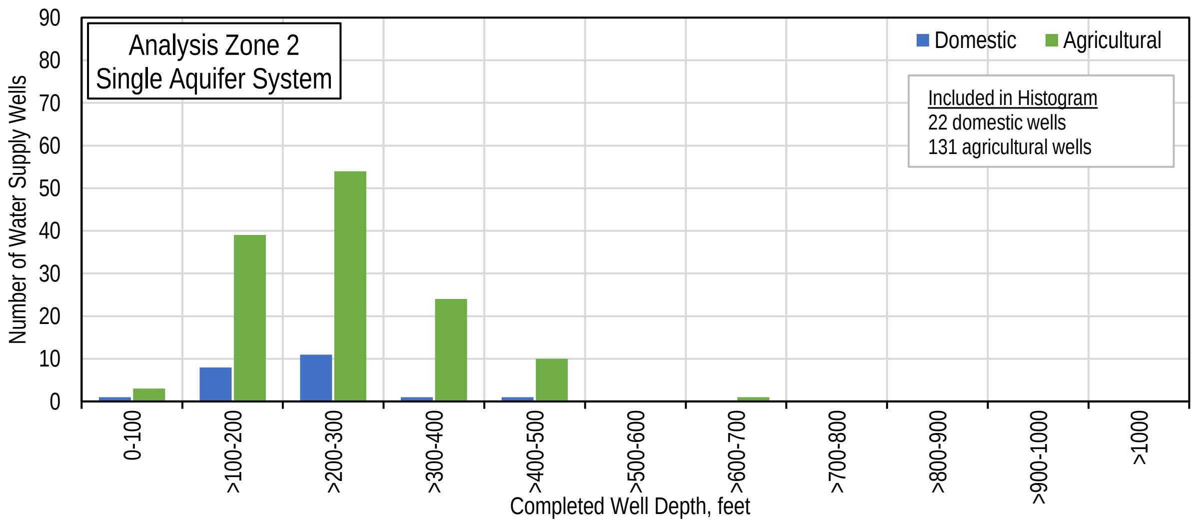

Analysis Zone 39
Groundwater Elevation (feet)
250
225
200
175
150
125
100
Well ID
025-01_Assumed Upper
047-01_Assumed Upper
075-01_Assumed Upper
077-01_Assumed Upper
18S24E22E001M_Assumed Upper
18S24E25D001M_Upper
1970
1980
1990
2000
2010
2020
Date

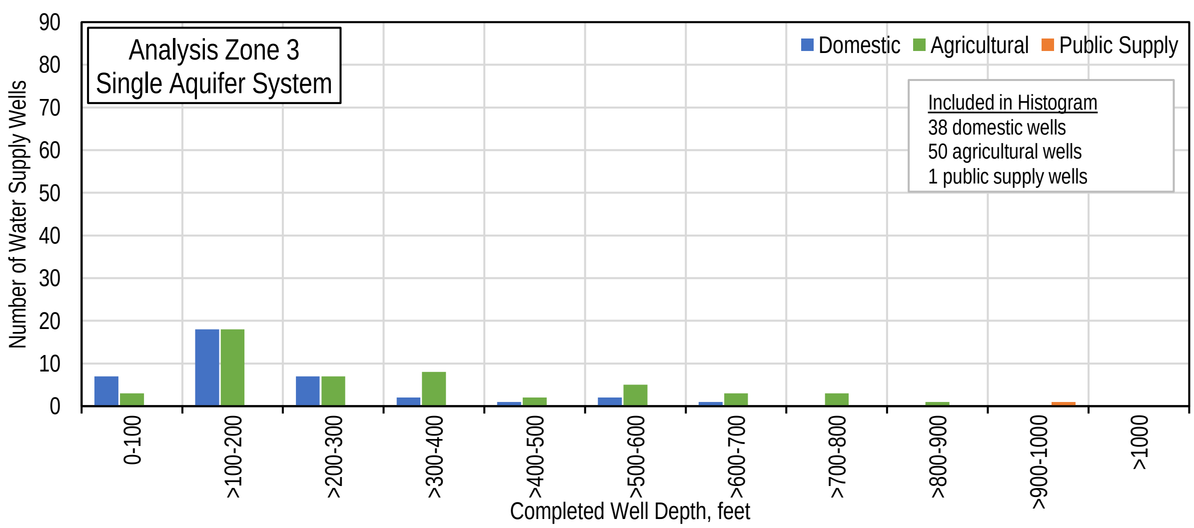
MONTGOMERY & ASSOCIATES

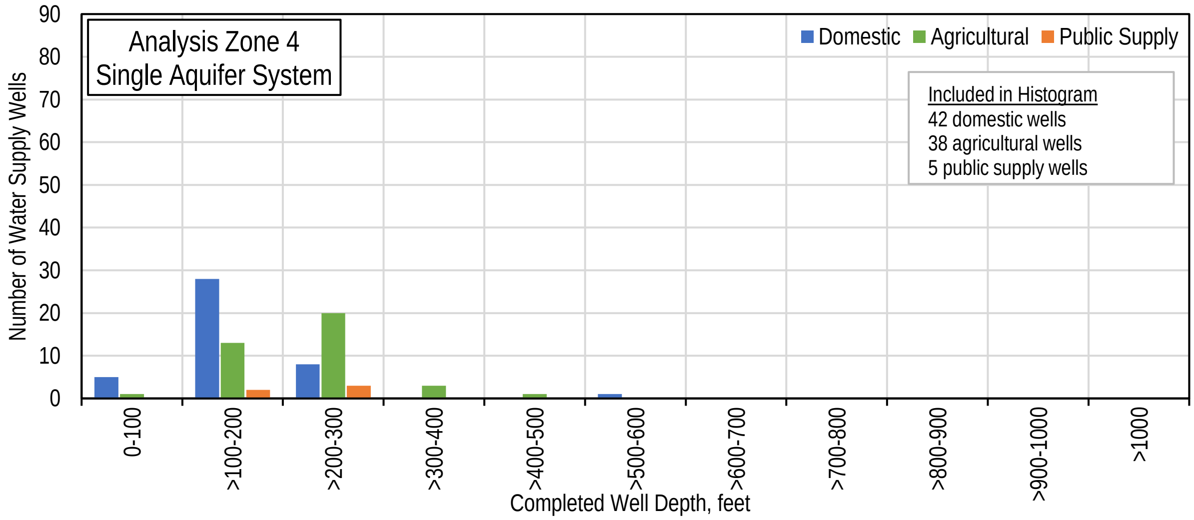
Appendix B

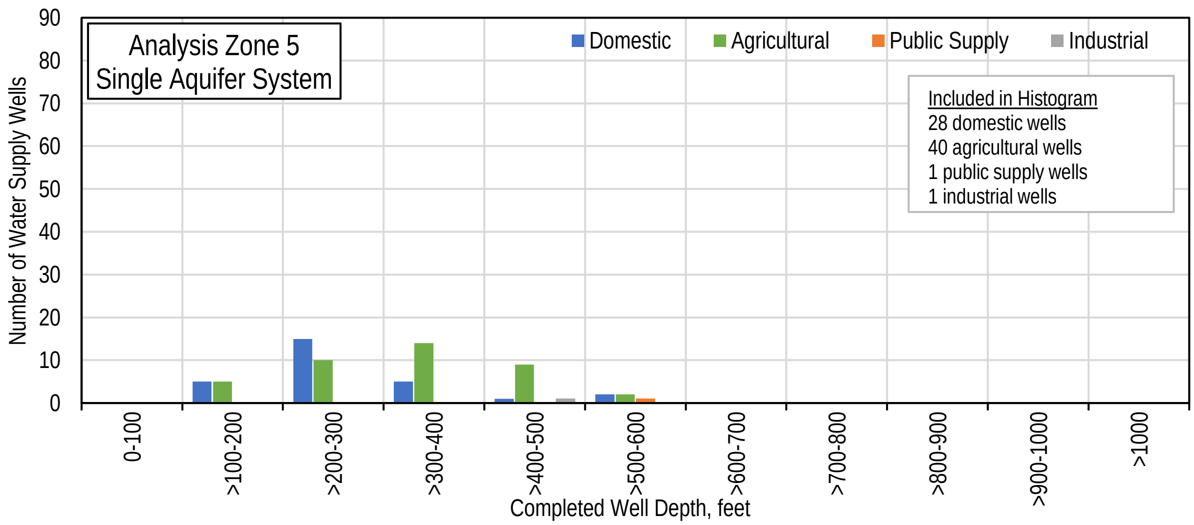
Completed Well Depth Histograms by Analysis Zone

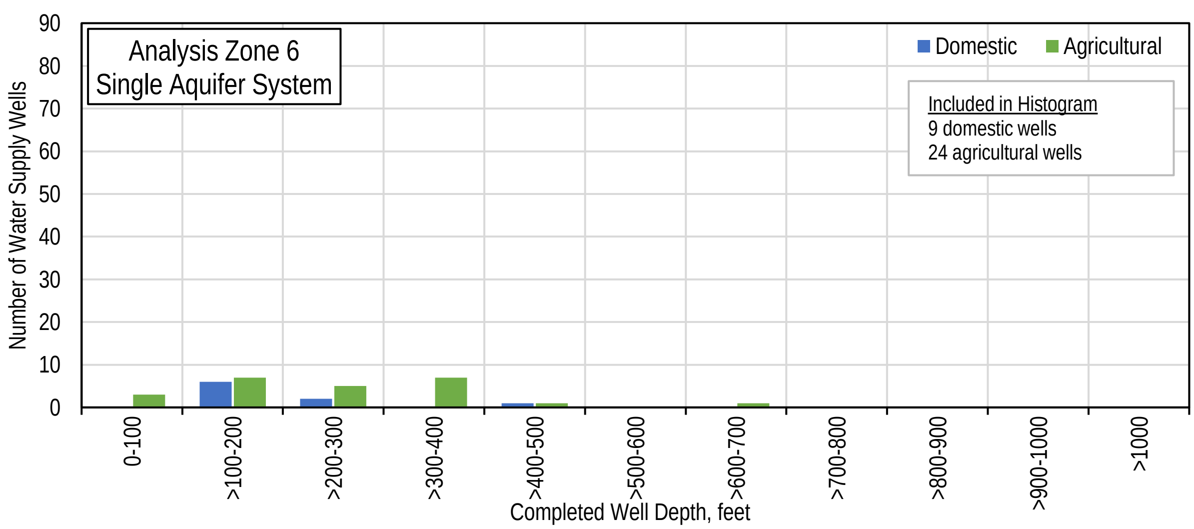

Analysis Zone 1
Single Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Landscape
Included in Histogram
104 domestic wells
199 agricultural wells
5 public supply wells
1 industrial wells
1 landscape irrigation wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

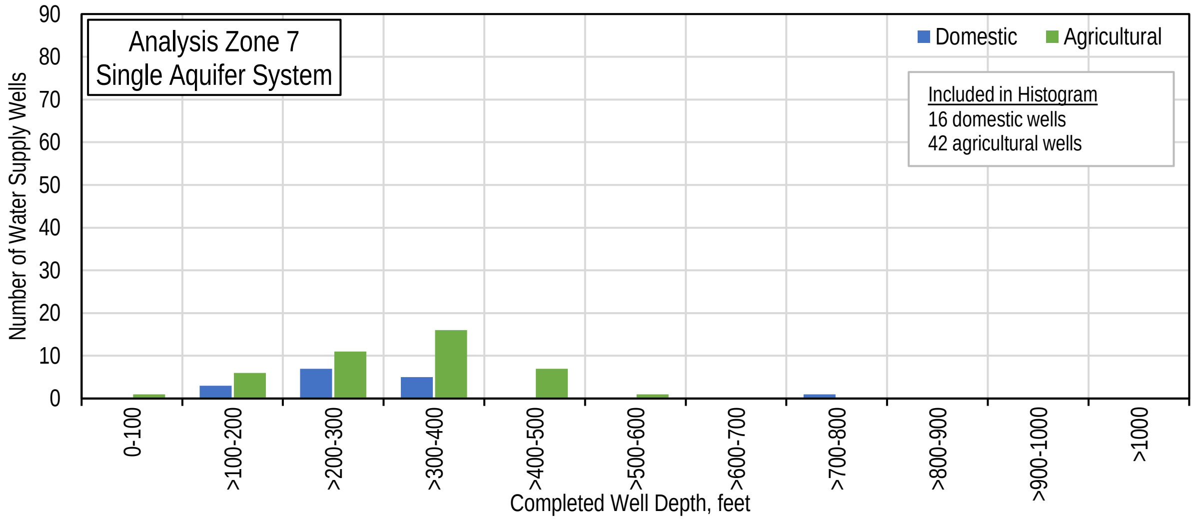

Analysis Zone 2
Single Aquifer System
Domestic
Agricultural
Included in Histogram
22 domestic wells
131 agricultural wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

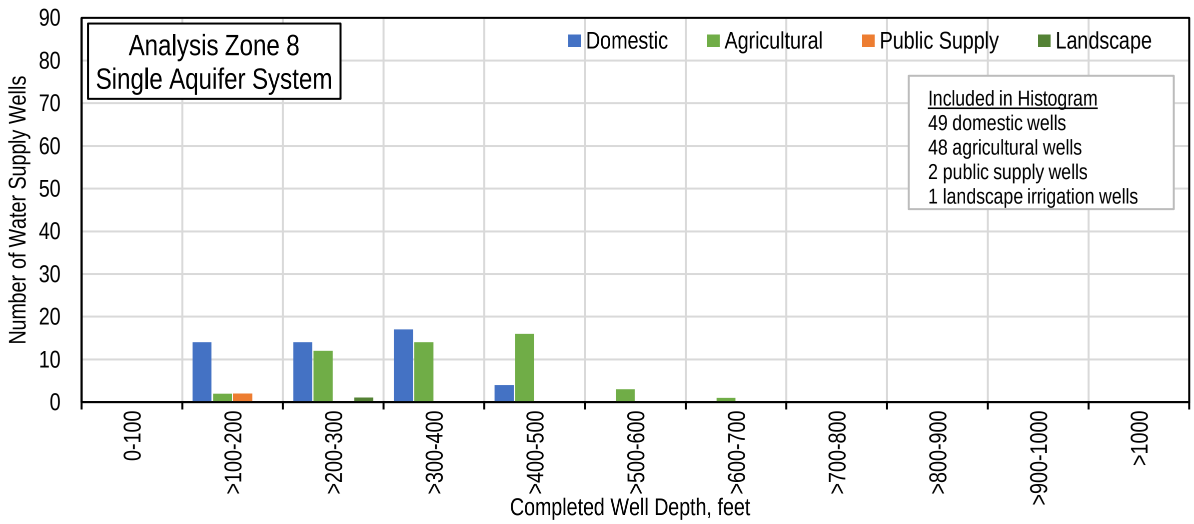

Analysis Zone 3
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
38 domestic wells
50 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

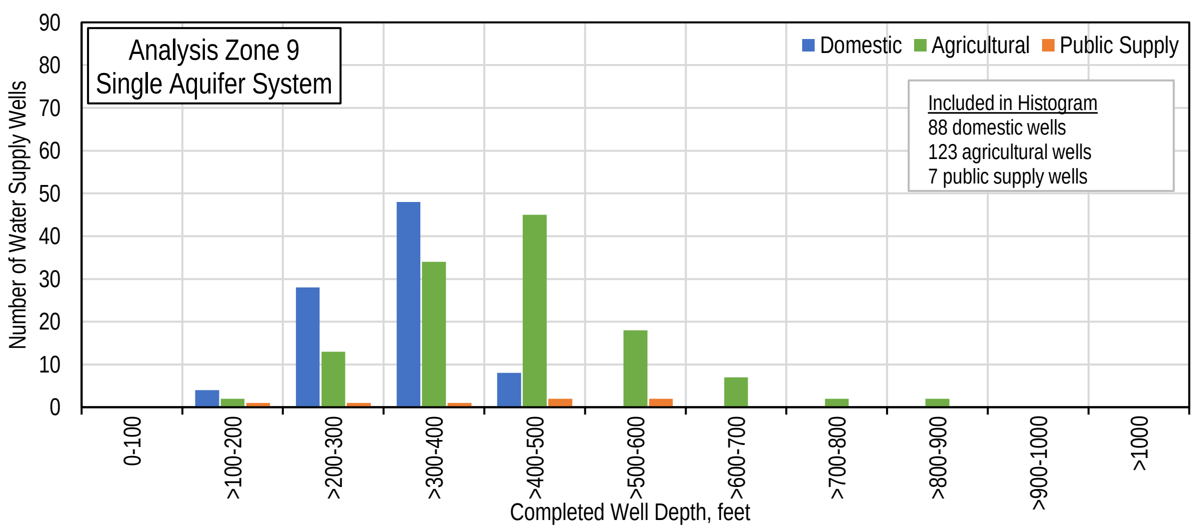

Analysis Zone 4
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
42 domestic wells
38 agricultural wells
5 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

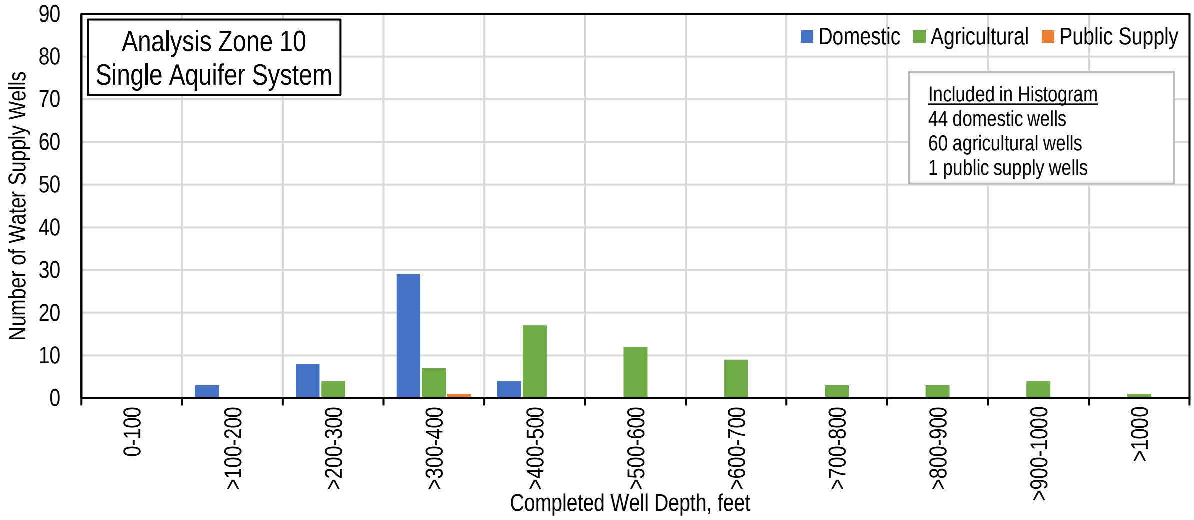

Analysis Zone 5
Single Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
28 domestic wells
40 agricultural wells
1 public supply wells
1 industrial wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

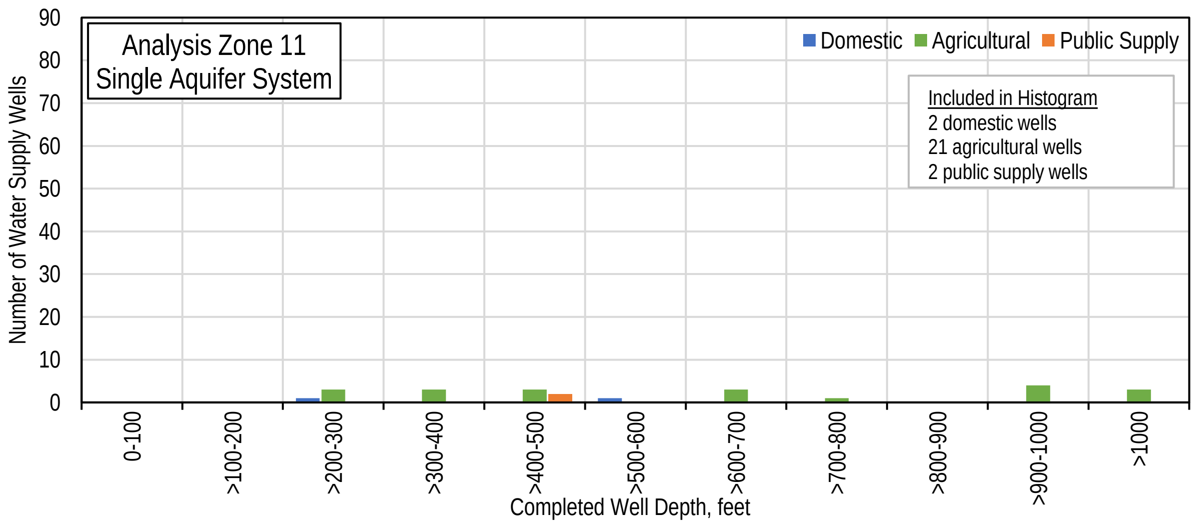

Analysis Zone 6
Single Aquifer System
Domestic
Agricultural
Included in Histogram
9 domestic wells
24 agricultural wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

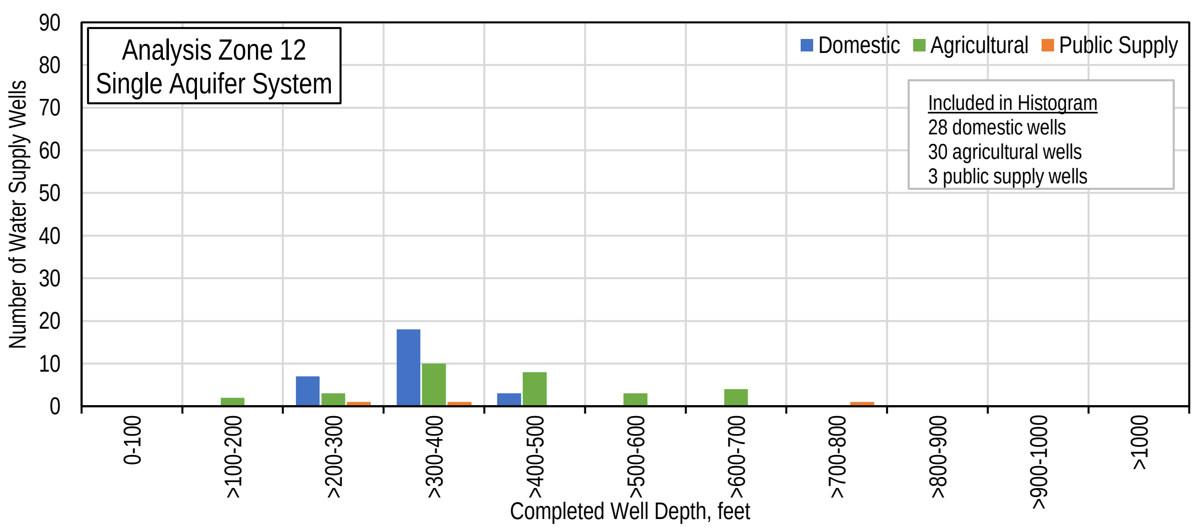

Analysis Zone 7
Single Aquifer System
Domestic
Agricultural
Included in Histogram
16 domestic wells
42 agricultural wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

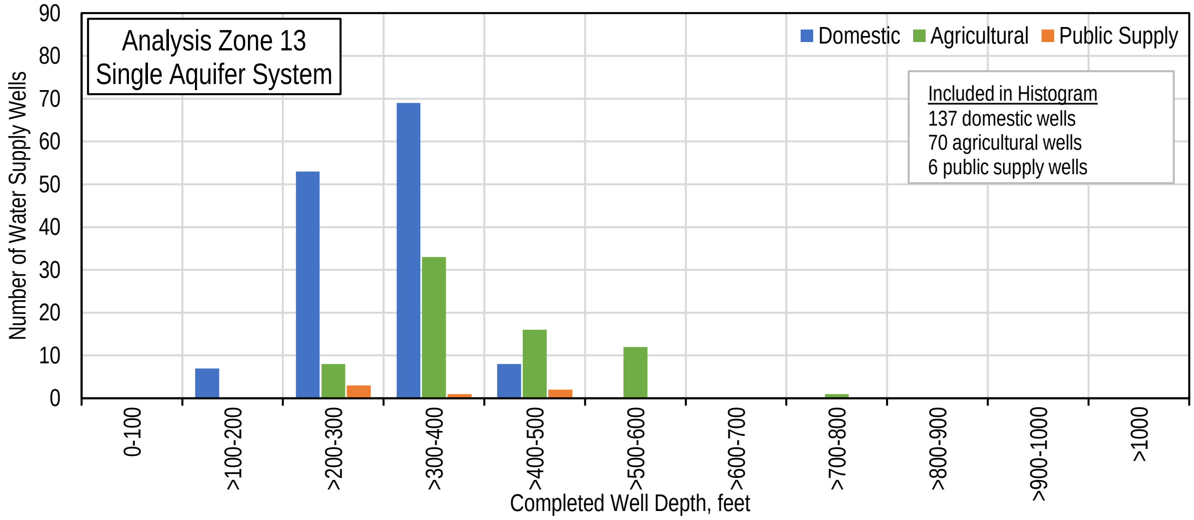

Analysis Zone 8
Single Aquifer System
Domestic
Agricultural
Public Supply
Landscape
Included in Histogram
49 domestic wells
48 agricultural wells
2 public supply wells
1 landscape irrigation wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

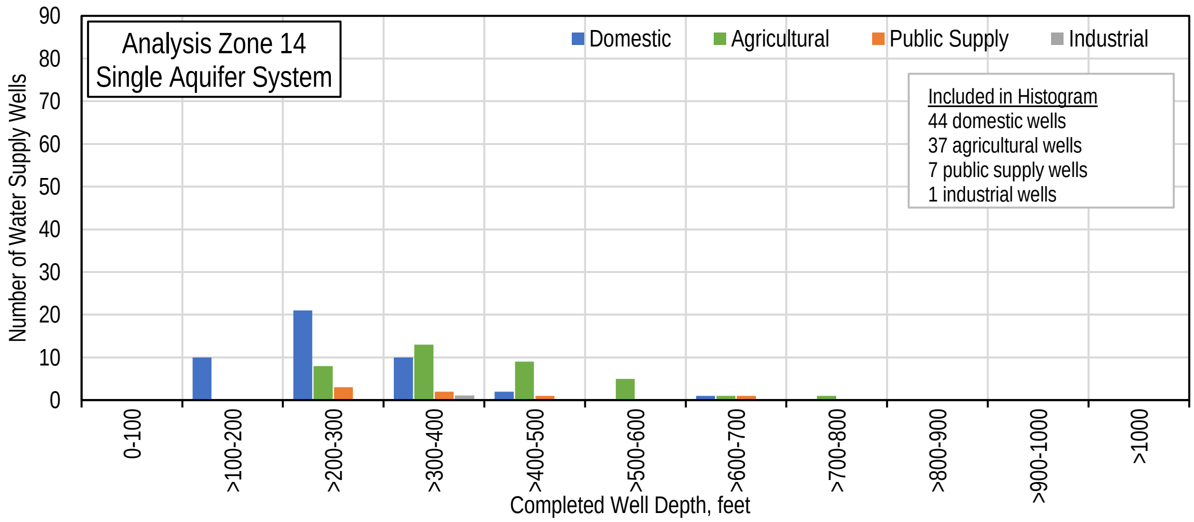

Analysis Zone 9
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
88 domestic wells
123 agricultural wells
7 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

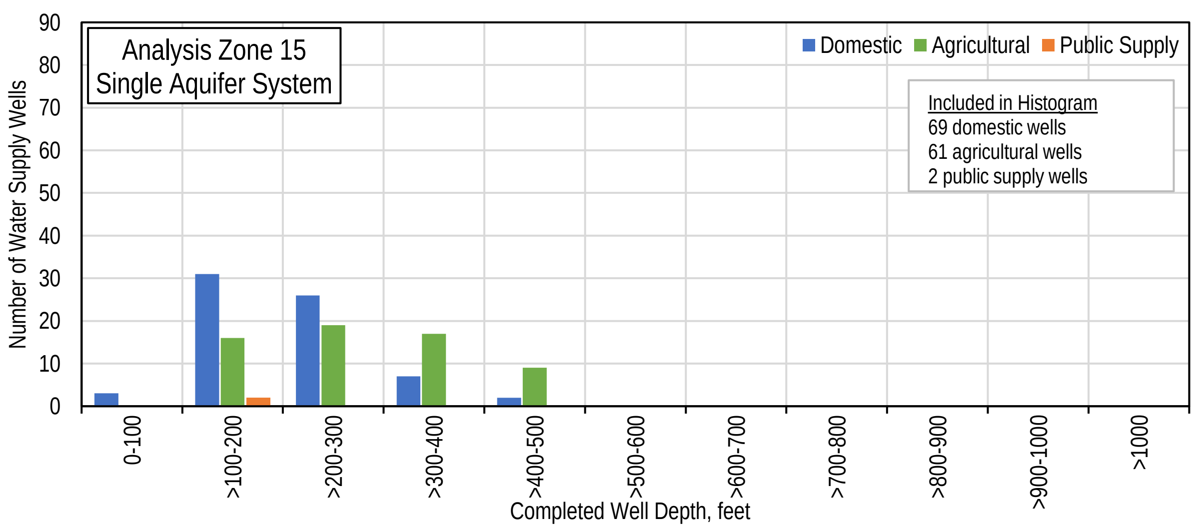

Analysis Zone 10
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
44 domestic wells
60 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

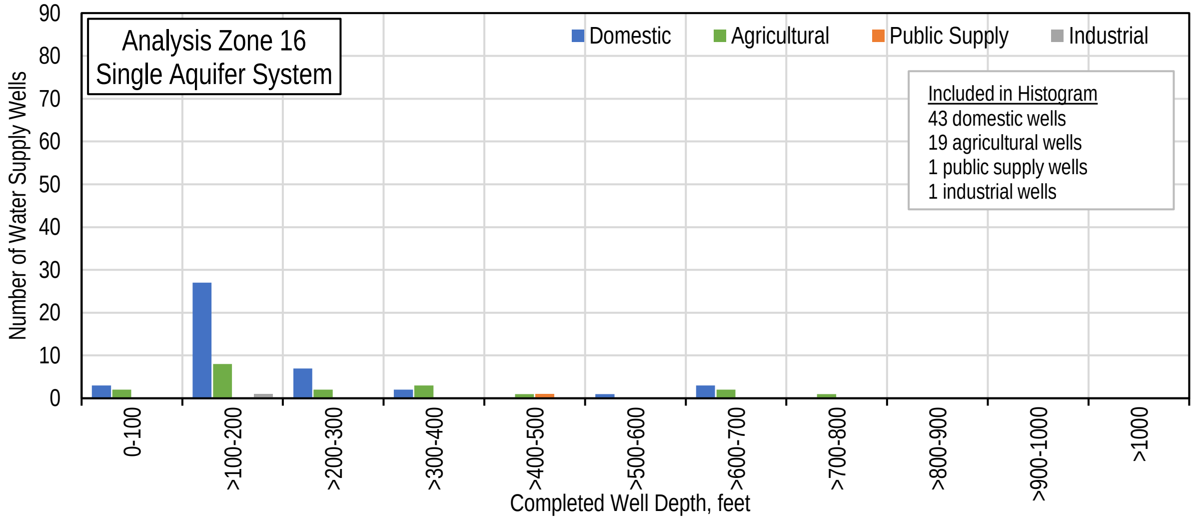

Analysis Zone 11
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
2 domestic wells
21 agricultural wells
2 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

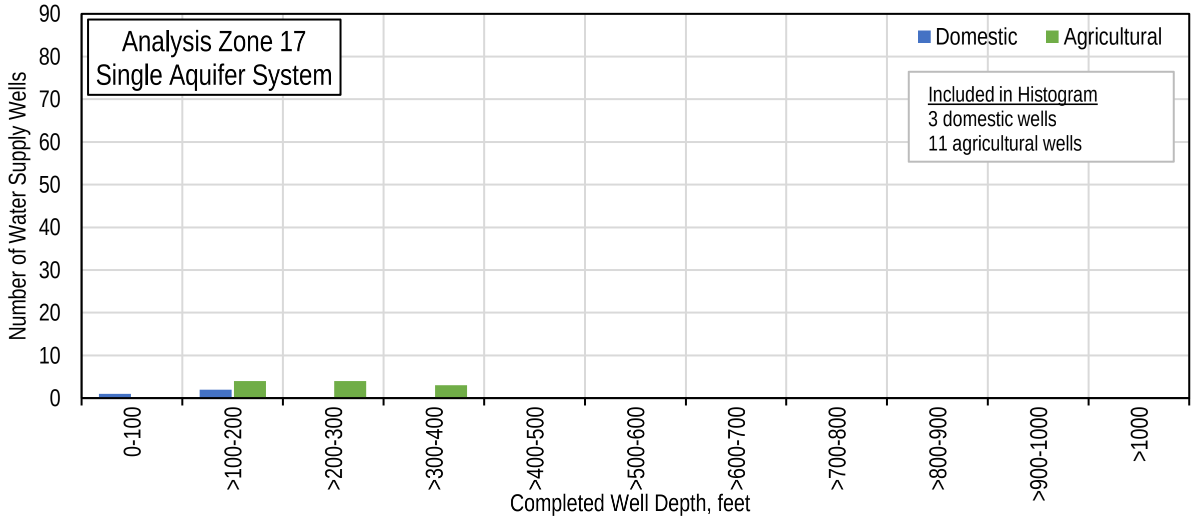

Analysis Zone 12
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
28 domestic wells
30 agricultural wells
3 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

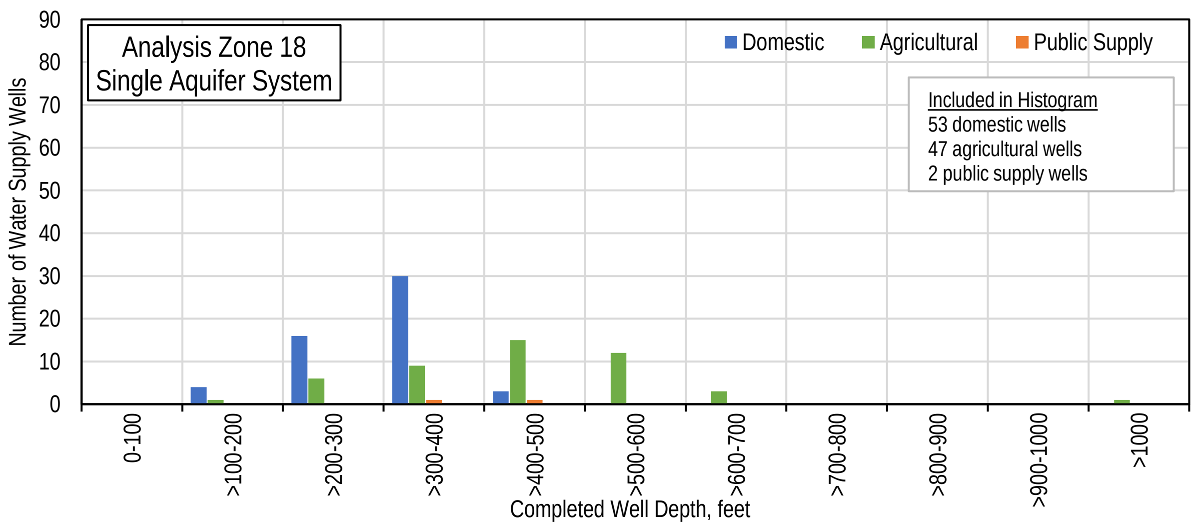

Analysis Zone 13
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
137 domestic wells
70 agricultural wells
6 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

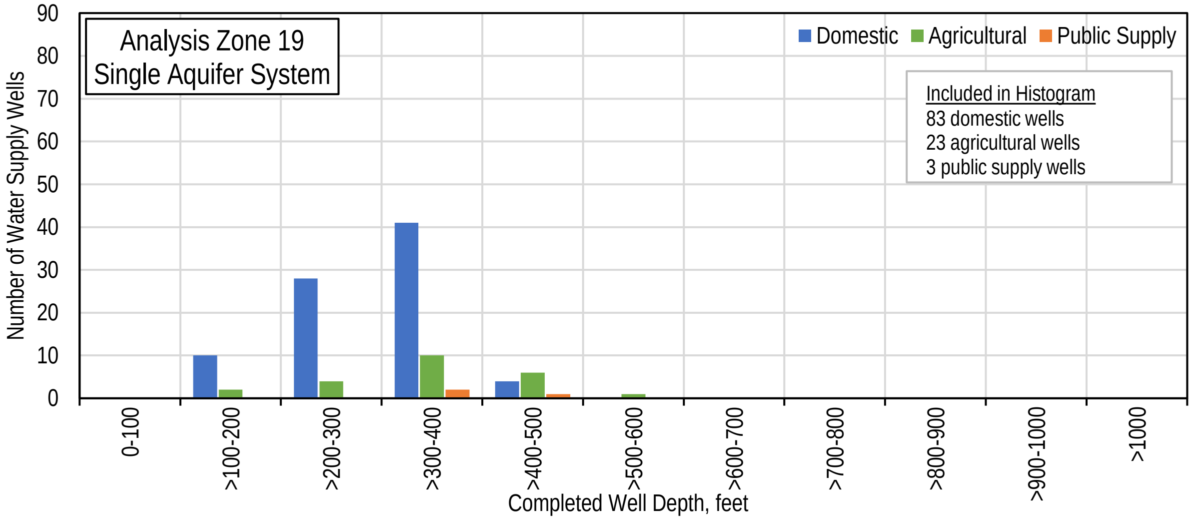

Analysis Zone 14
Single Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
44 domestic wells
37 agricultural wells
7 public supply wells
1 industrial wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

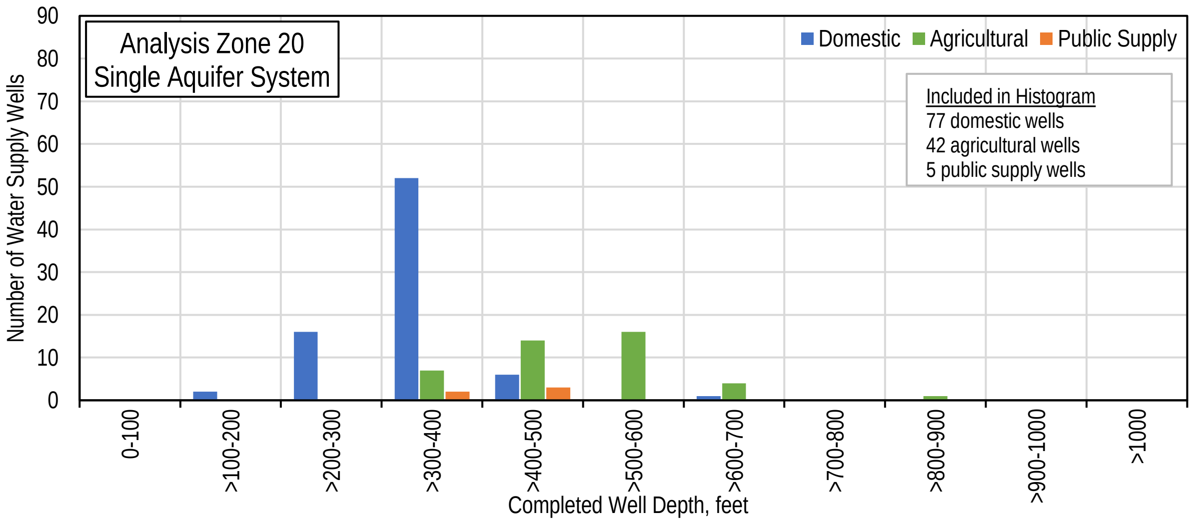

Analysis Zone 15
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
69 domestic wells
61 agricultural wells
2 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

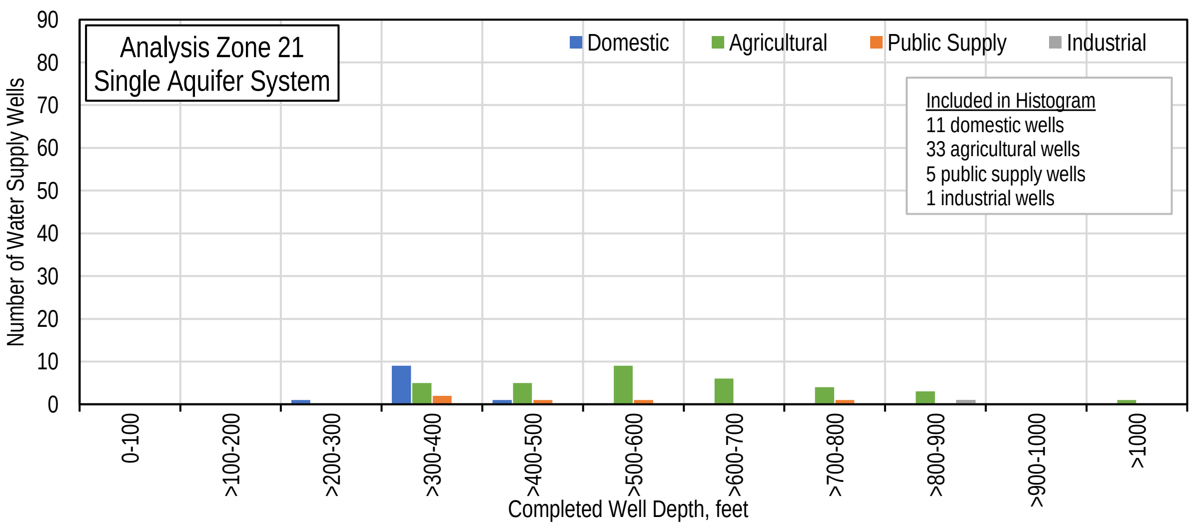

Analysis Zone 16
Single Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
43 domestic wells
19 agricultural wells
1 public supply wells
1 industrial wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

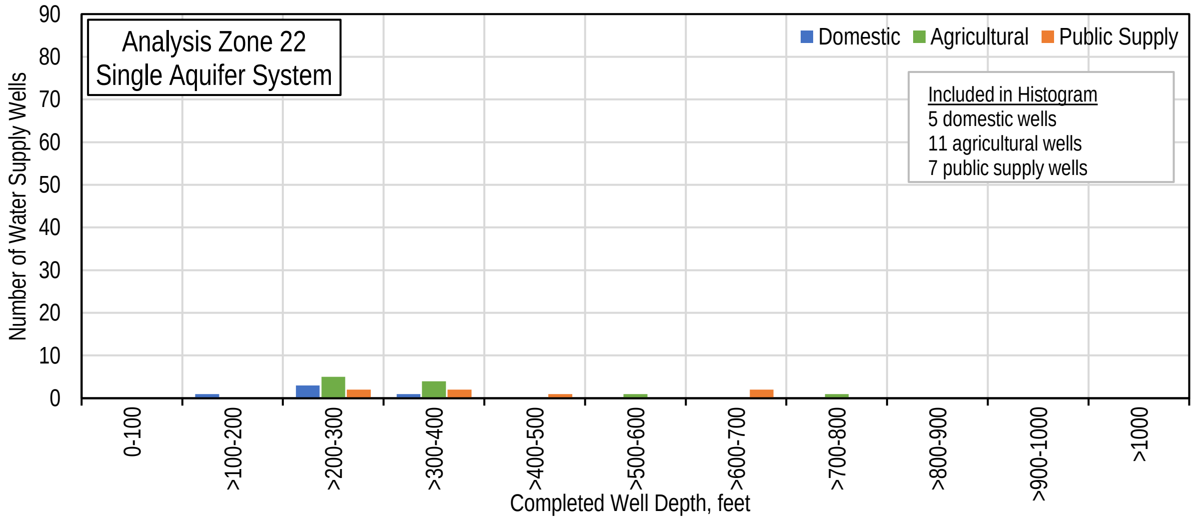

Analysis Zone 17
Single Aquifer System
Domestic
Agricultural
Included in Histogram
3 domestic wells
11 agricultural wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

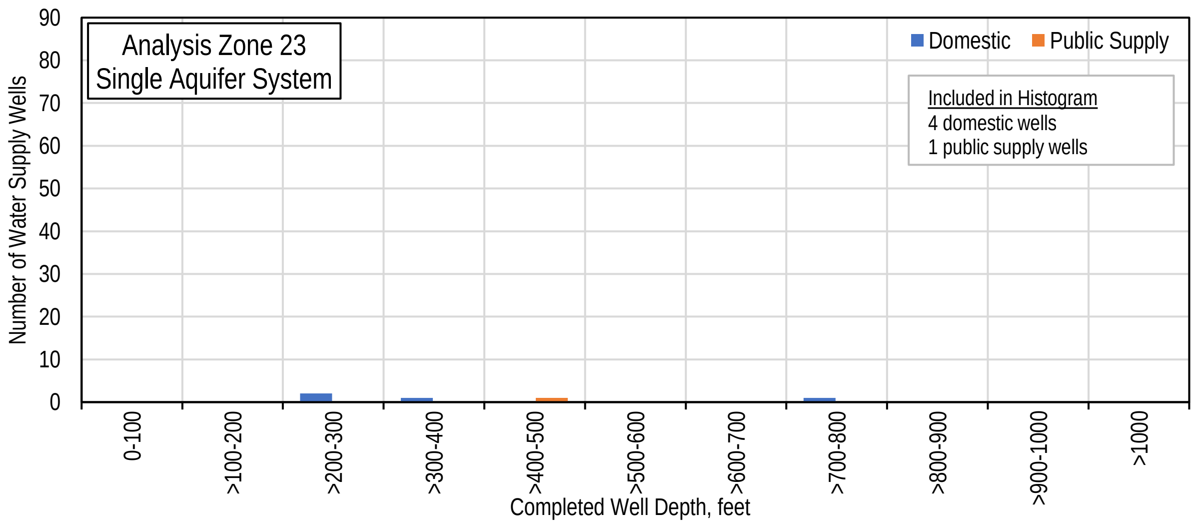

Analysis Zone 18
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
53 domestic wells
47 agricultural wells
2 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

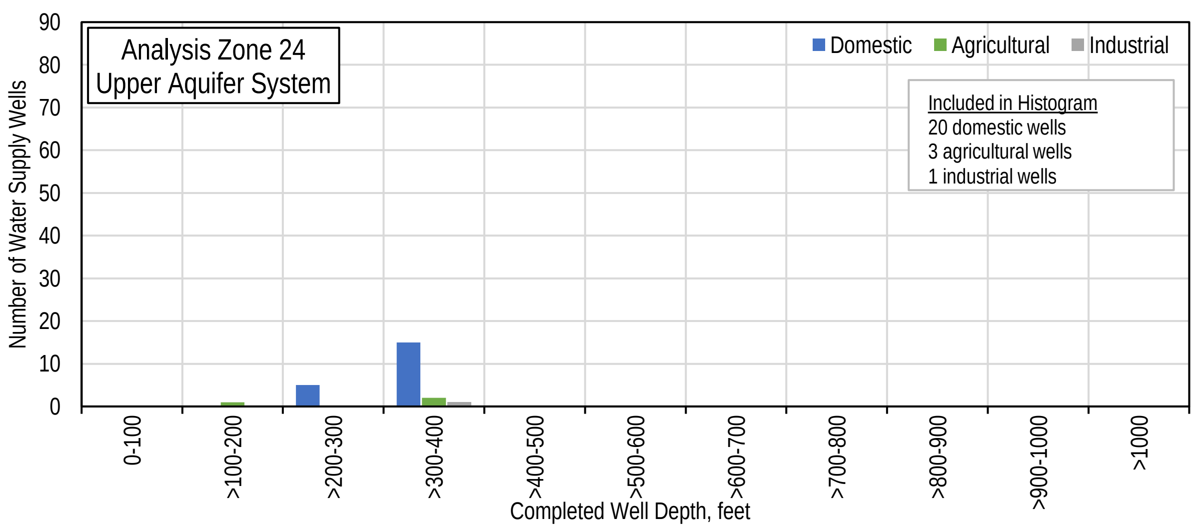

Analysis Zone 19
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
83 domestic wells
23 agricultural wells
3 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

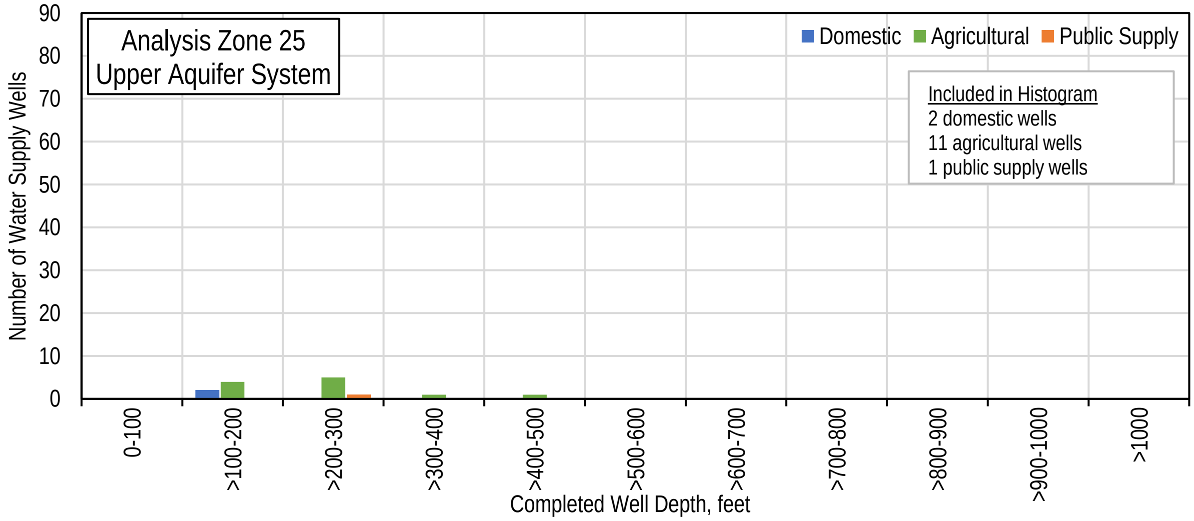

Analysis Zone 20
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
77 domestic wells
42 agricultural wells
5 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

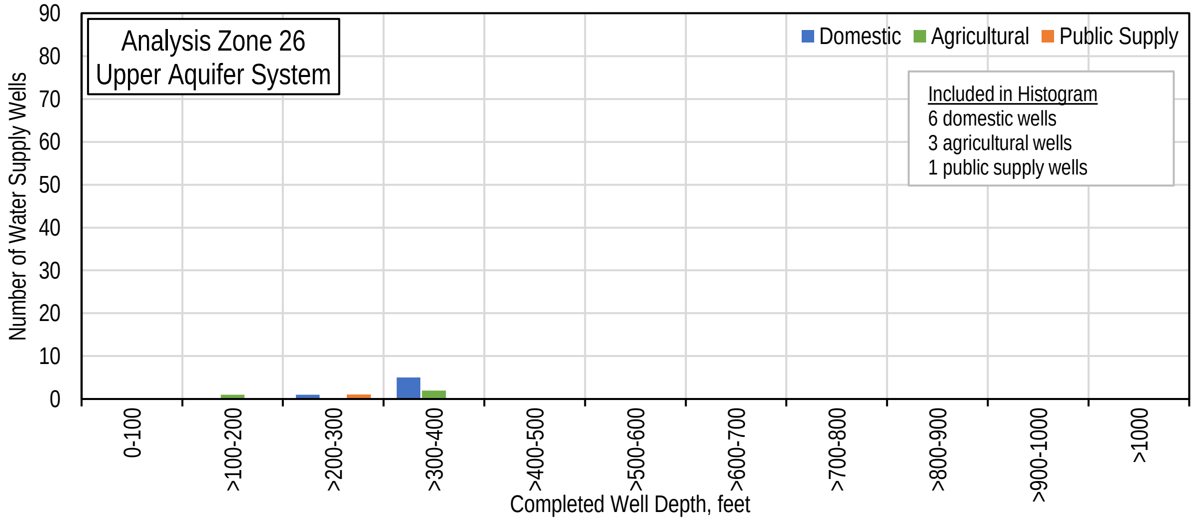

Analysis Zone 21
Single Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
11 domestic wells
33 agricultural wells
5 public supply wells
1 industrial wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

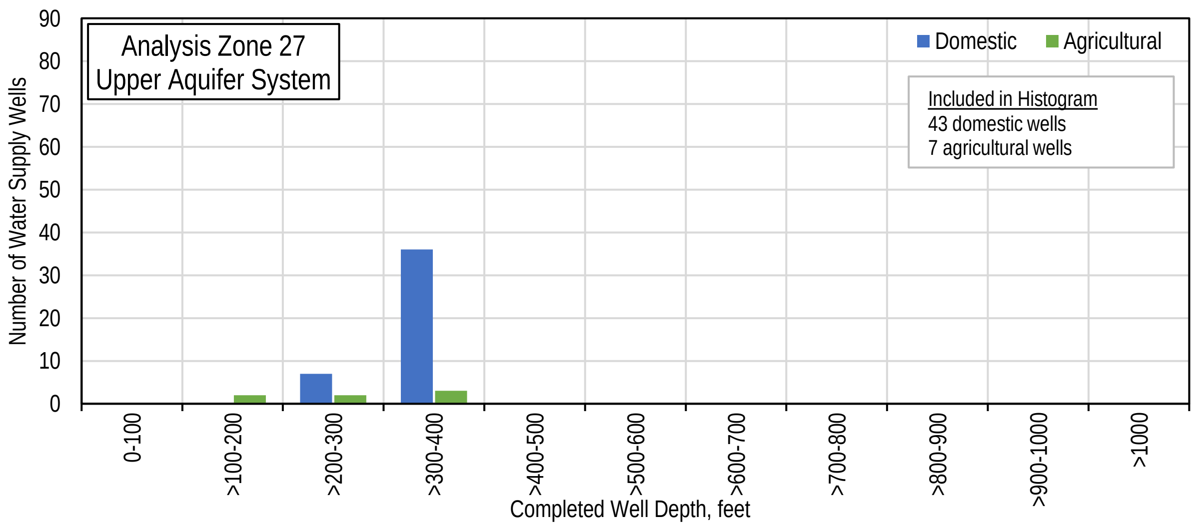

Analysis Zone 22
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
5 domestic wells
11 agricultural wells
7 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

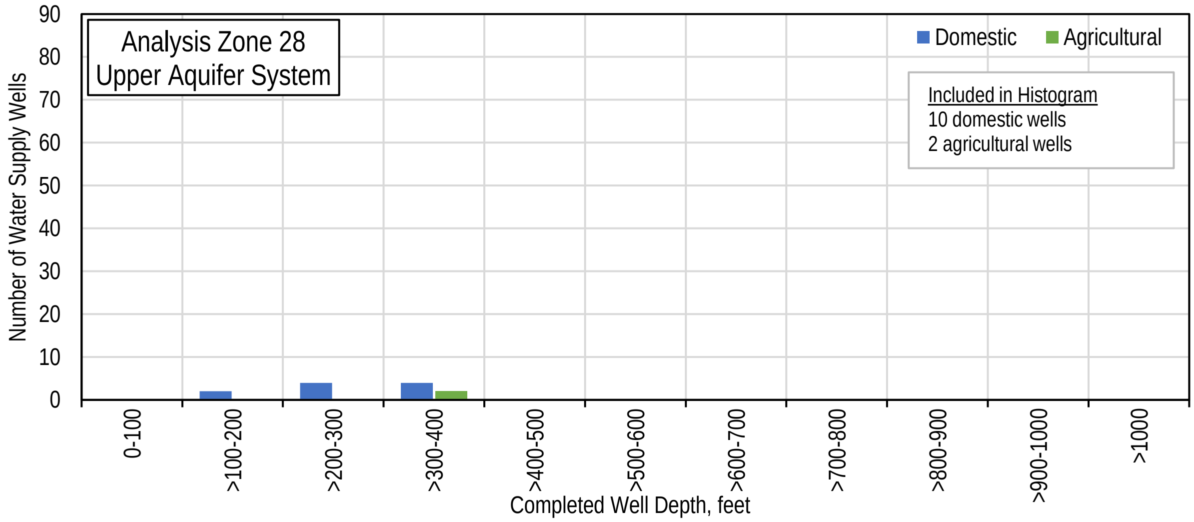

Analysis Zone 23
Single Aquifer System
Domestic
Public Supply
Included in Histogram
4 domestic wells
1 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

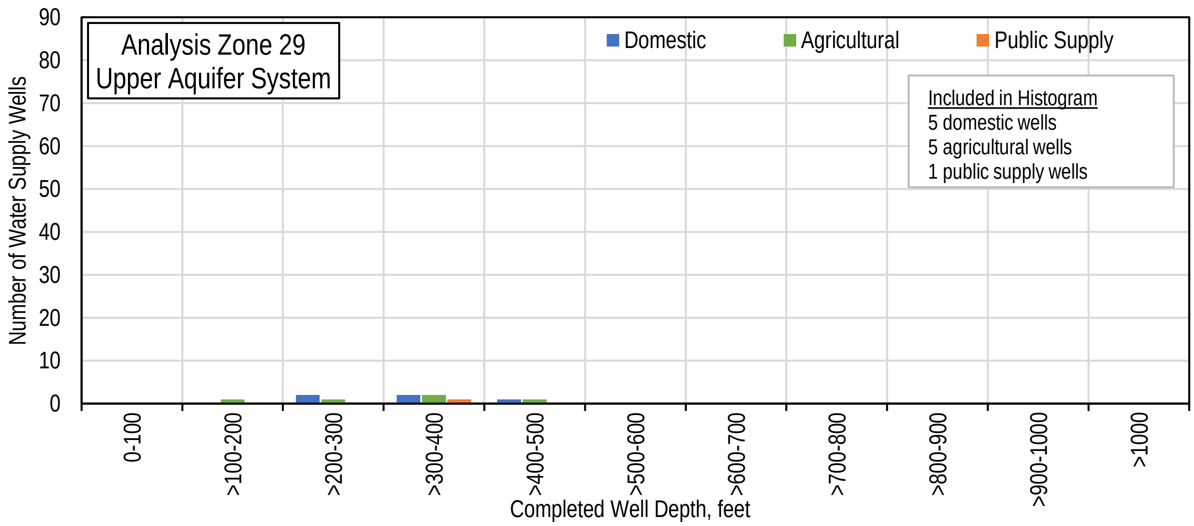

Analysis Zone 24
Upper Aquifer System
Domestic
Agricultural
Industrial
Included in Histogram
20 domestic wells
3 agricultural wells
1 industrial wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

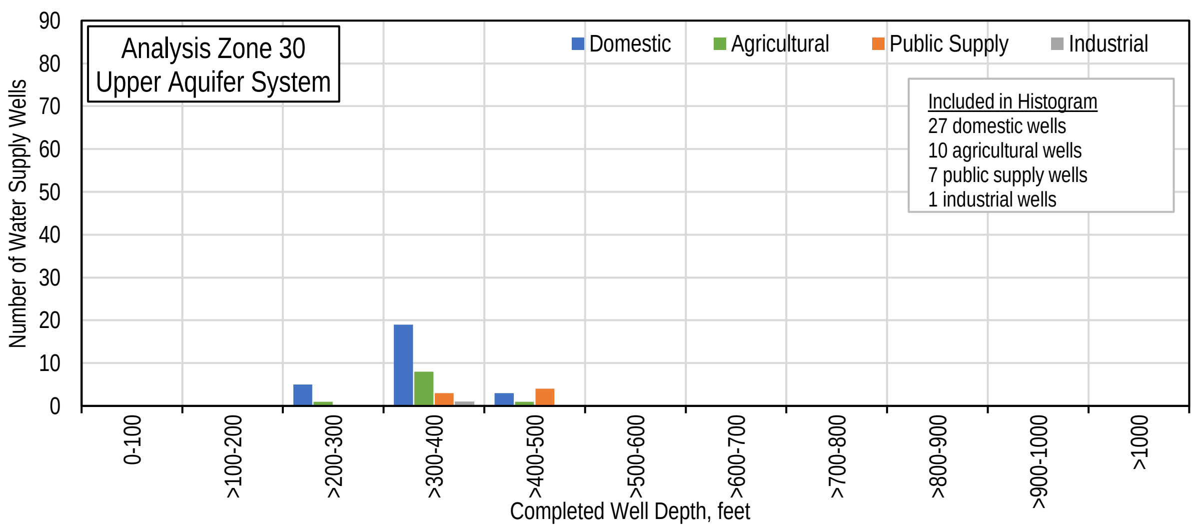

Analysis Zone 25
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
2 domestic wells
11 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

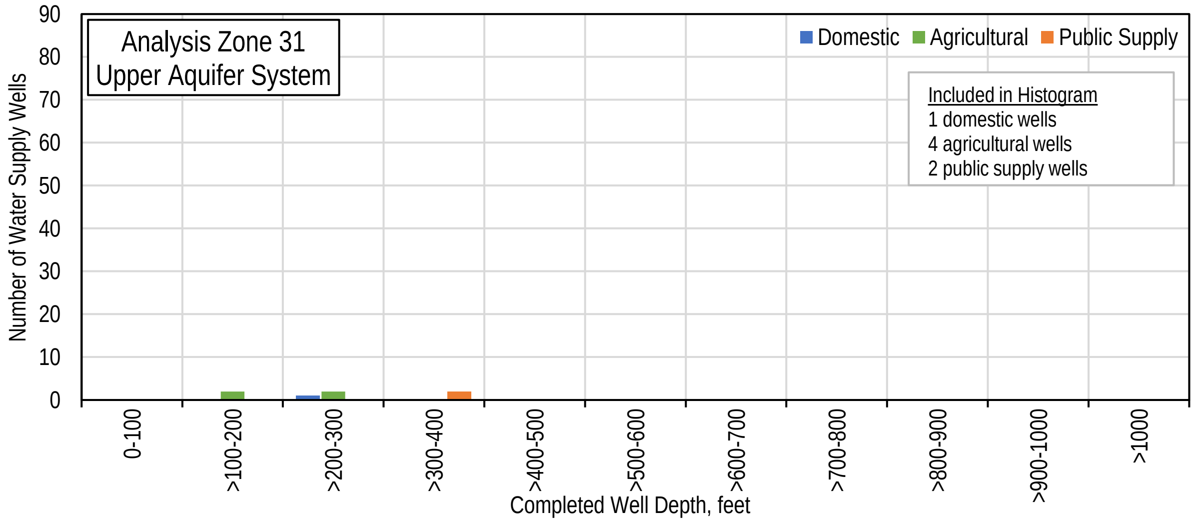

Analysis Zone 26
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
6 domestic wells
3 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

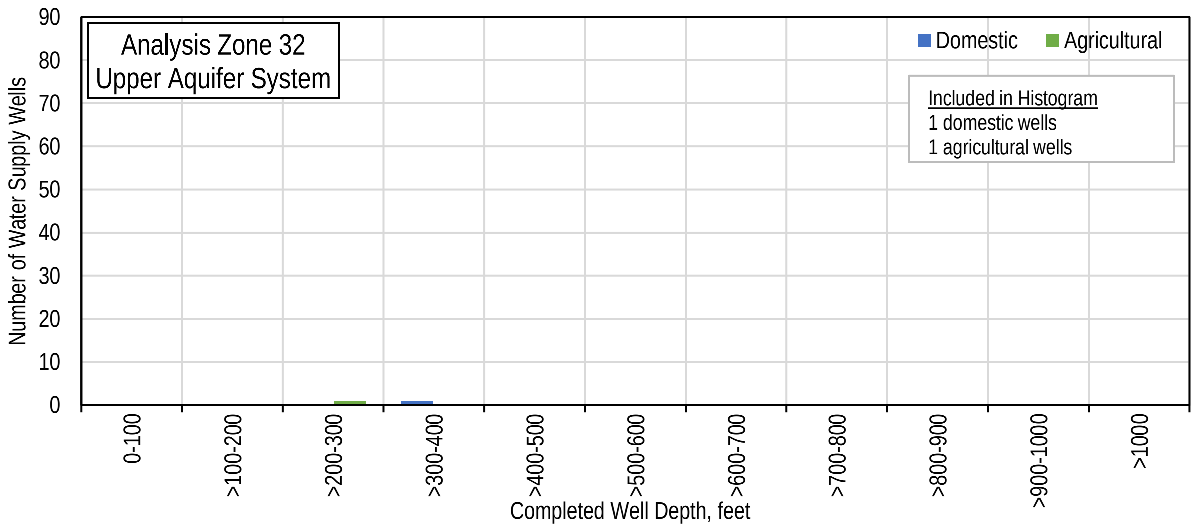

Analysis Zone 27
Upper Aquifer System
Domestic
Agricultural
Included in Histogram
43 domestic wells
7 agricultural wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

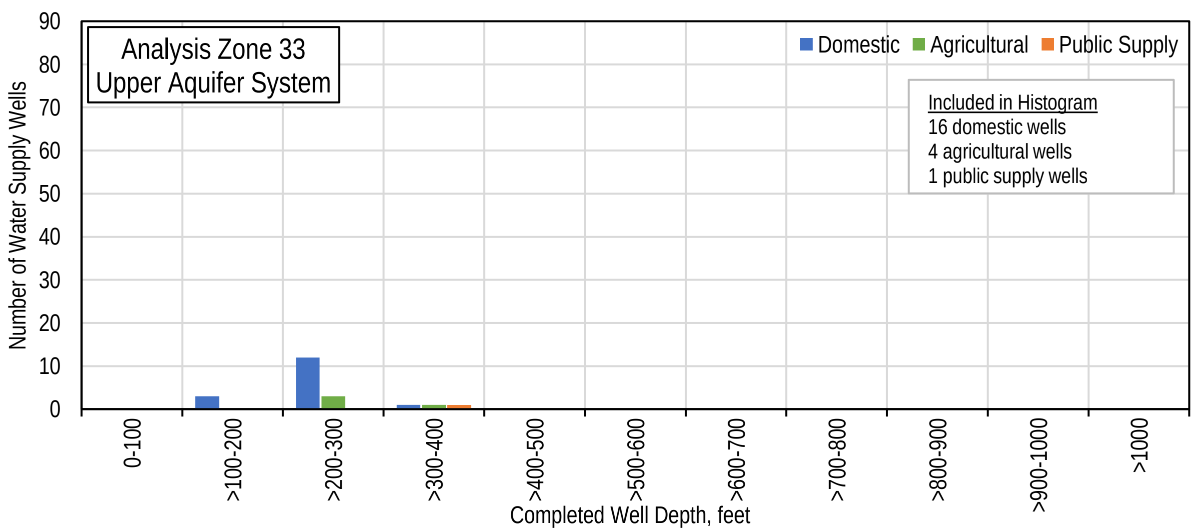

Analysis Zone 28
Upper Aquifer System
Domestic
Agricultural
Included in Histogram
10 domestic wells
2 agricultural wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

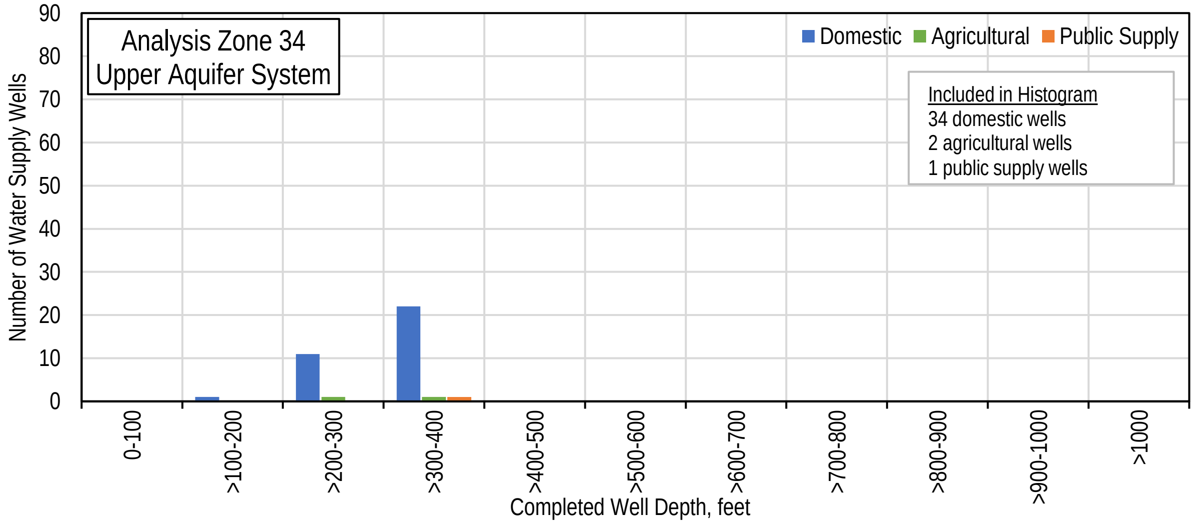

Analysis Zone 29
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
5 domestic wells
5 agricultural wells
1 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet

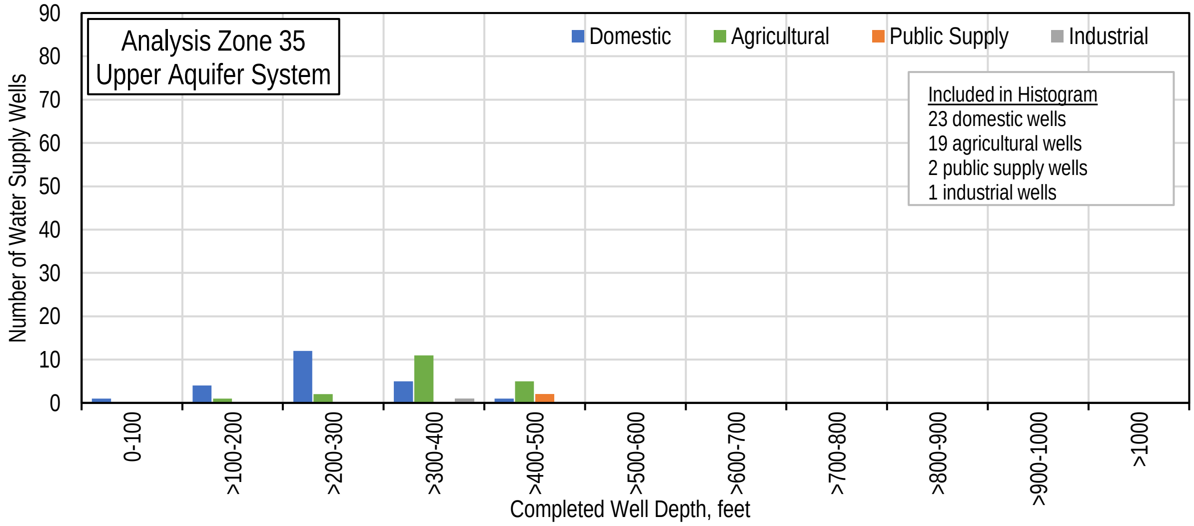

Analysis Zone 30
Upper Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
27 domestic wells
10 agricultural wells
7 public supply wells
1 industrial wells
Number of Water Supply Wells
Completed Well Depth, feet

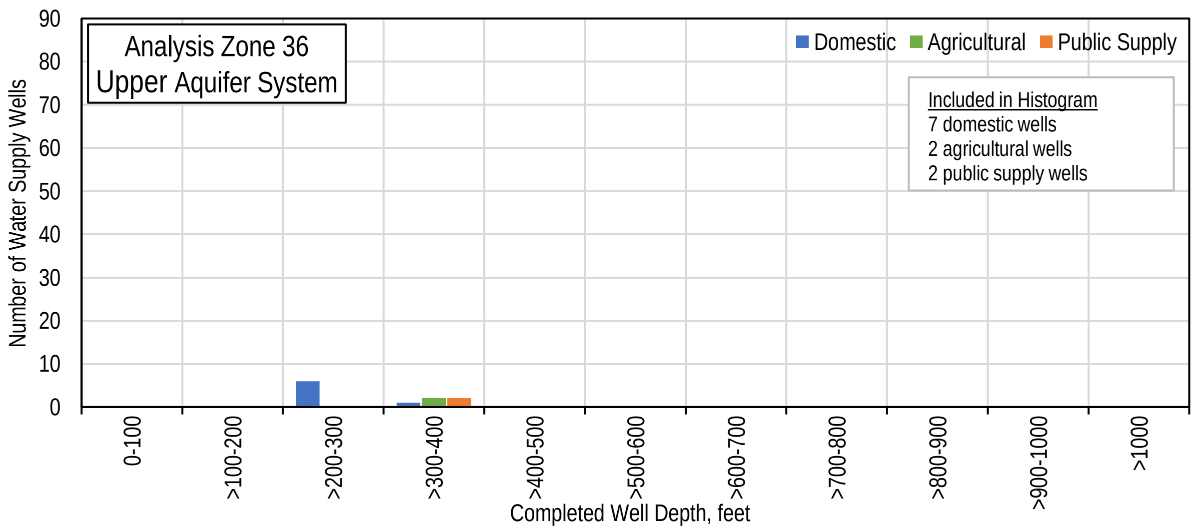

Analysis Zone 31
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
1 domestic wells
4 agricultural wells
2 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

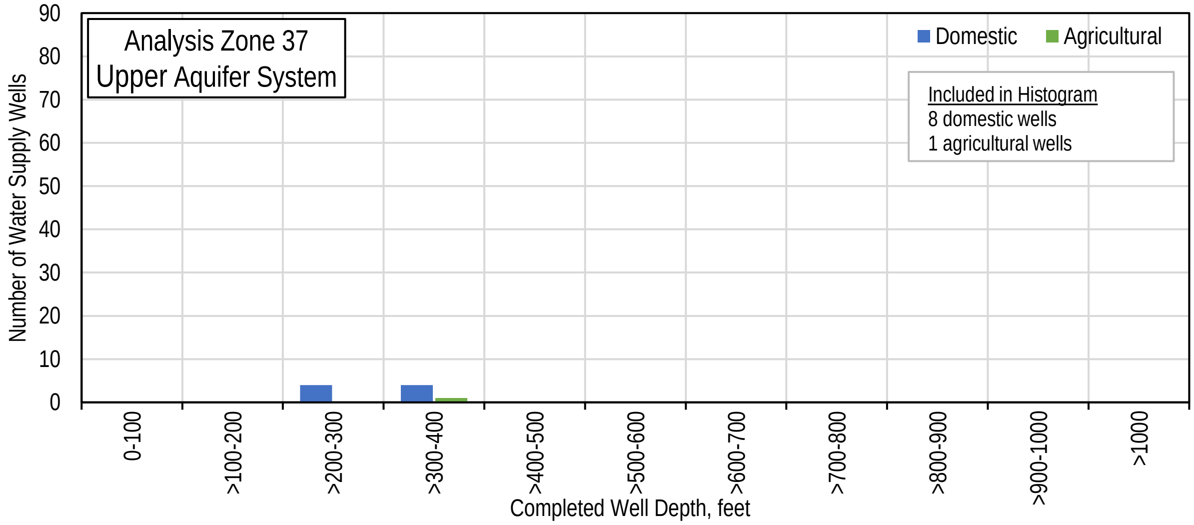

Analysis Zone 32
Upper Aquifer System
Domestic
Agricultural
Included in Histogram
1 domestic wells
1 agricultural wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

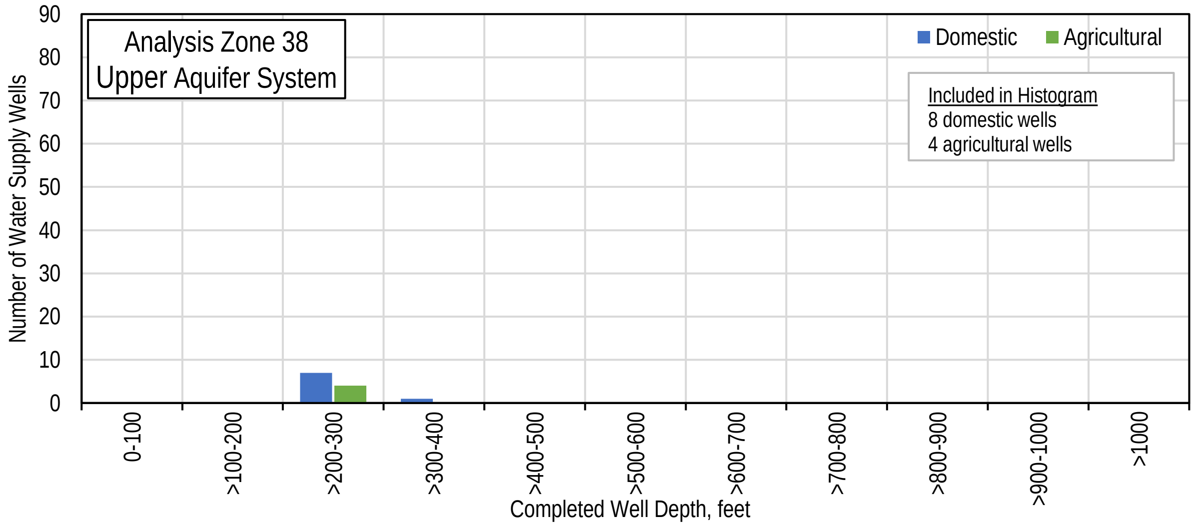

Analysis Zone 33
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
16 domestic wells
4 agricultural wells
1 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

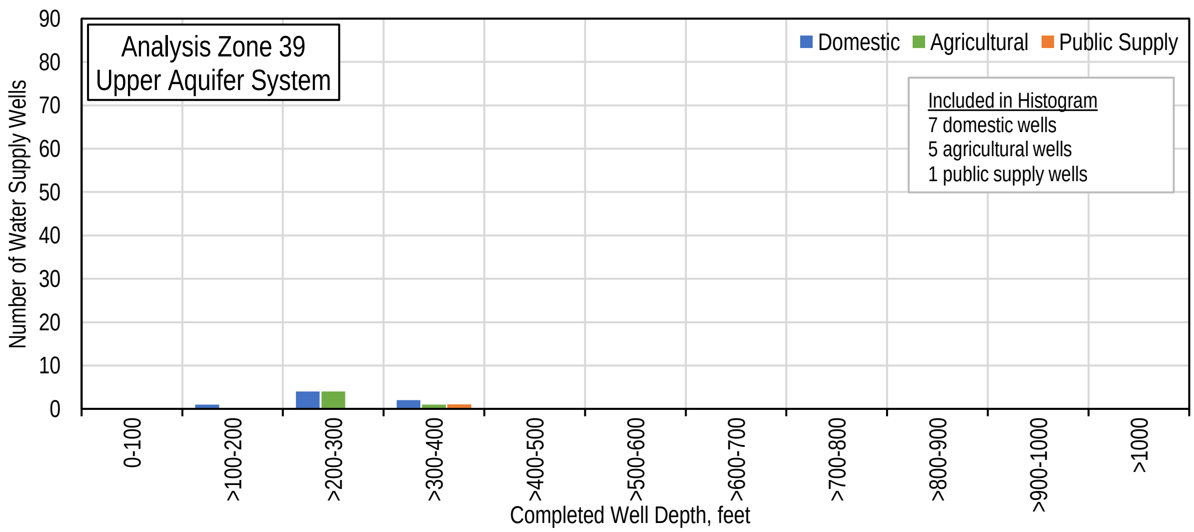

Analysis Zone 34
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
34 domestic wells
2 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

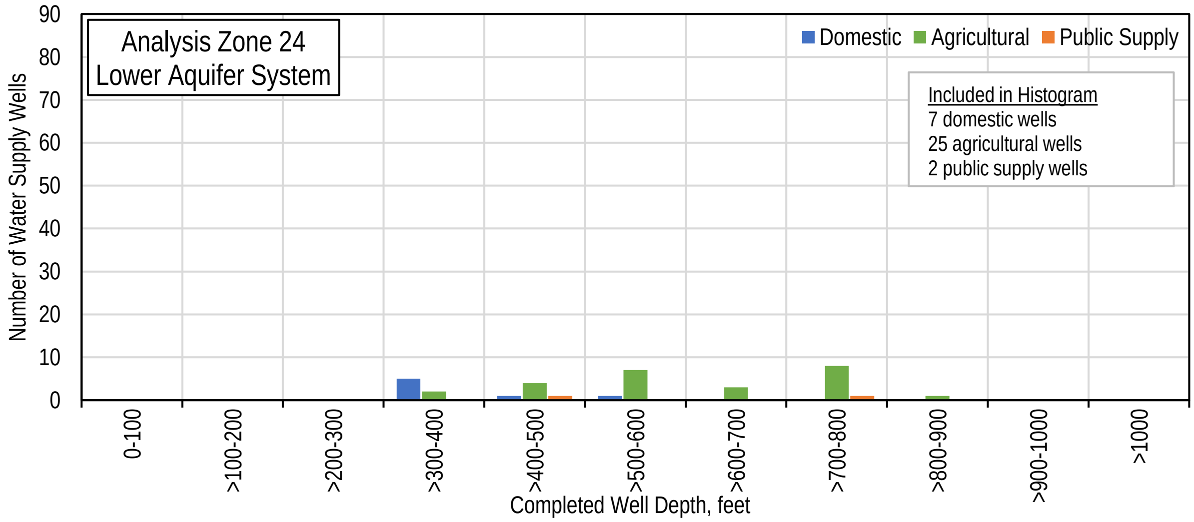

Analysis Zone 35
Upper Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
23 domestic wells
19 agricultural wells
2 public supply wells
1 industrial wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

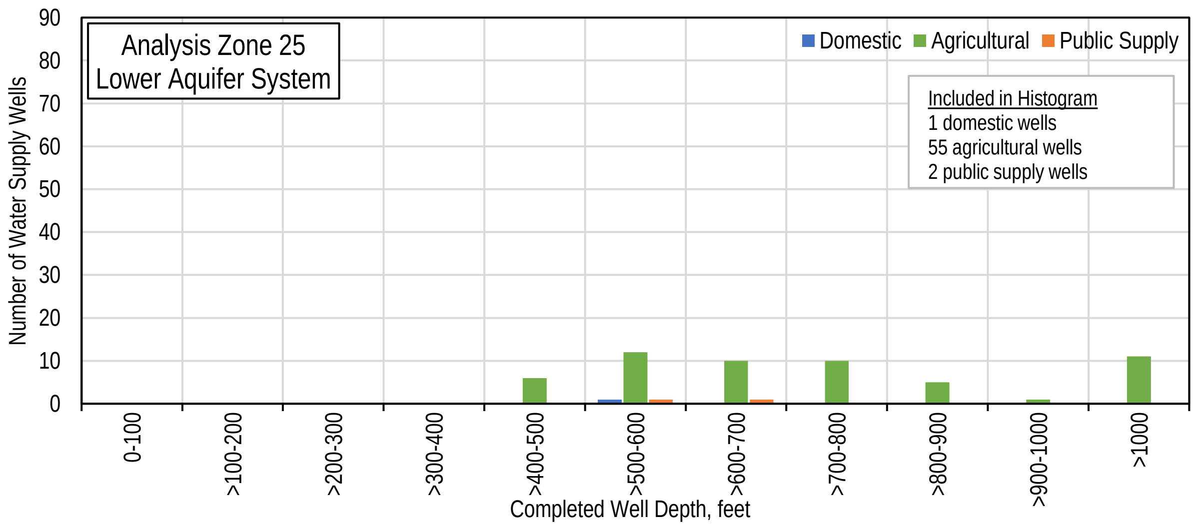

Analysis Zone 36
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
7 domestic wells
2 agricultural wells
2 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

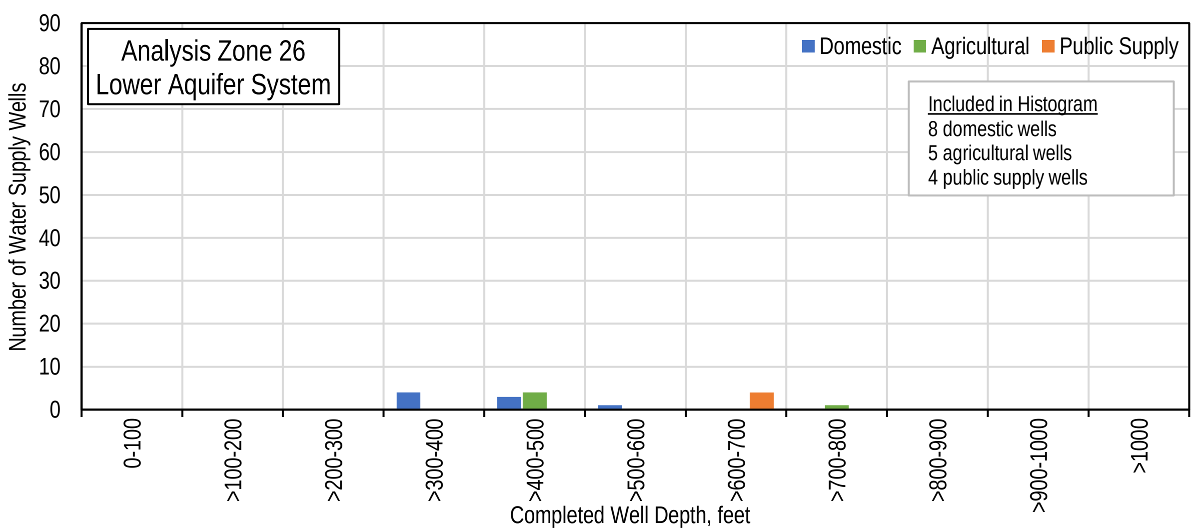

Analysis Zone 37
Upper Aquifer System
Domestic
Agricultural
Included in Histogram
8 domestic wells
1 agricultural wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

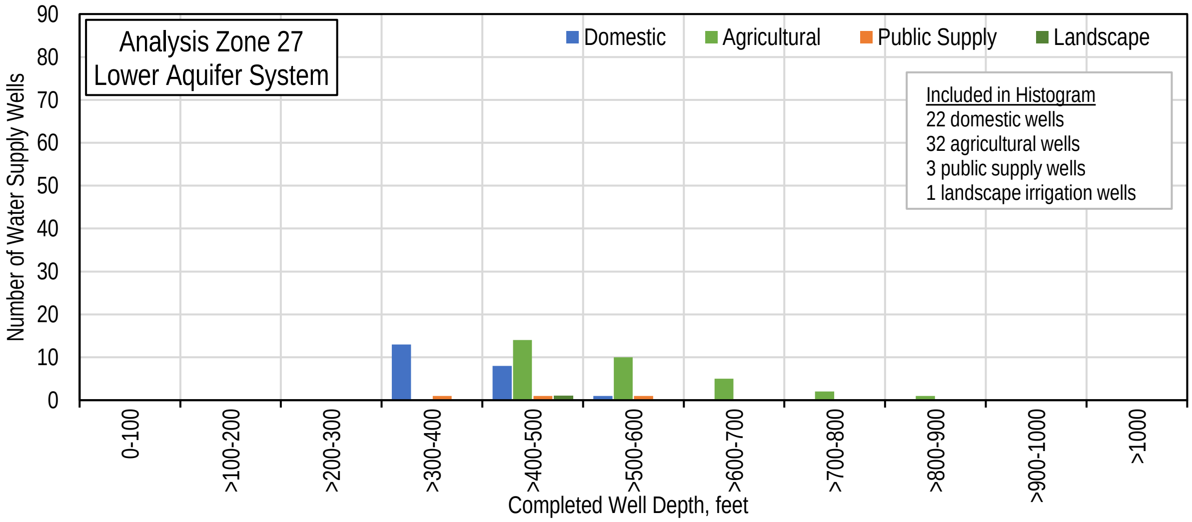

Analysis Zone 38
Upper Aquifer System
Domestic
Agricultural
Included in Histogram
8 domestic wells
4 agricultural wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

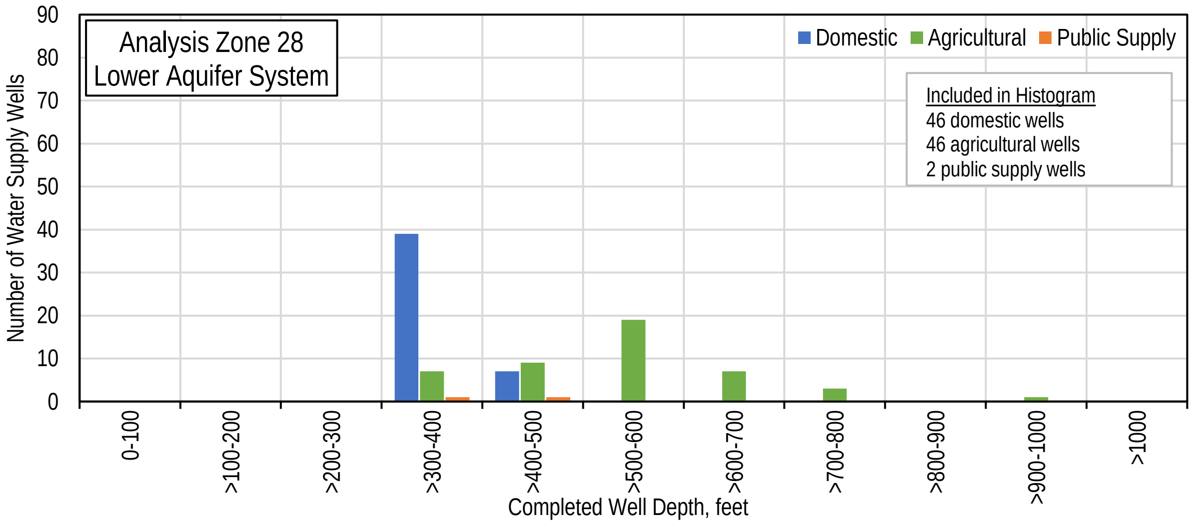

Analysis Zone 39
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
7 domestic wells
5 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

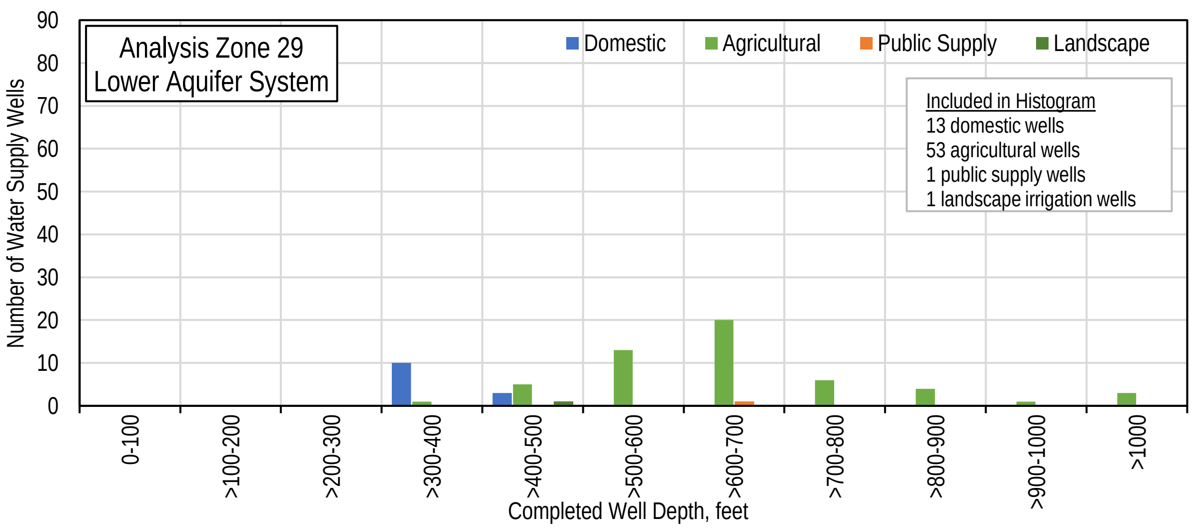

Analysis Zone 24
Lower Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
7 domestic wells
25 agricultural wells
2 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

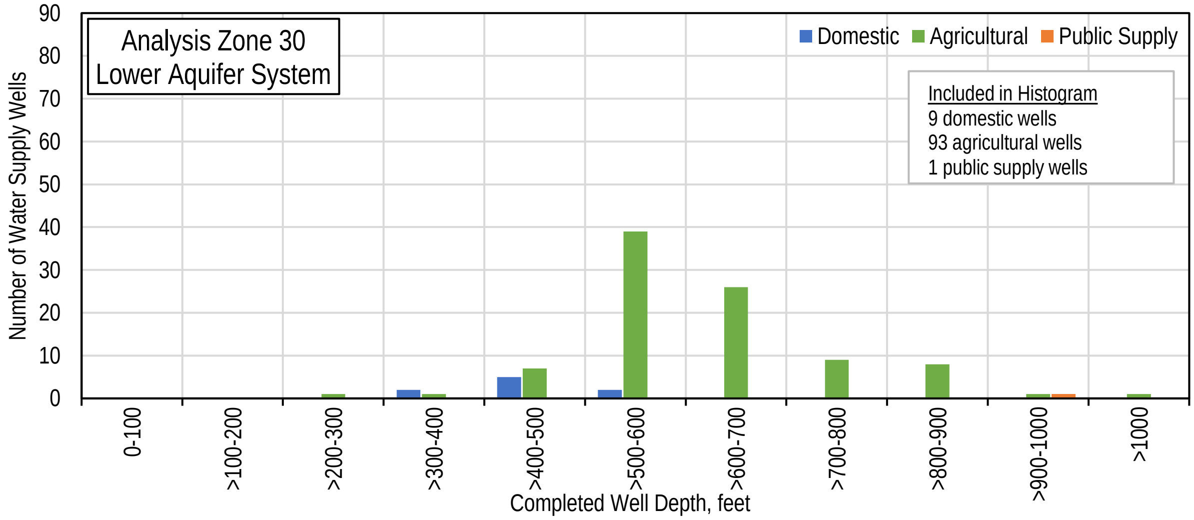

Analysis Zone 25
Lower Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
1 domestic wells
55 agricultural wells
2 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

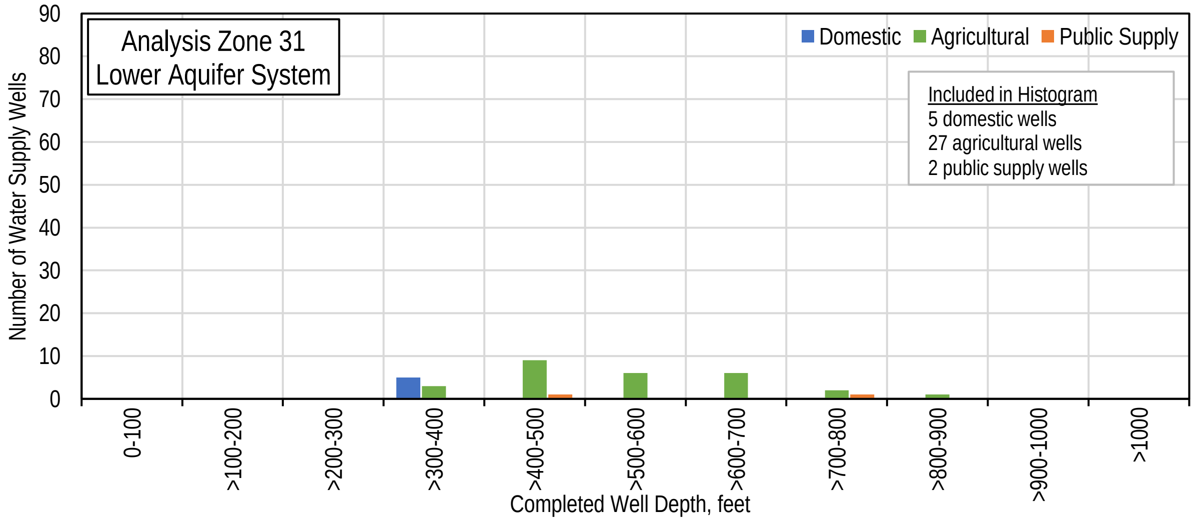

Analysis Zone 26
Lower Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
8 domestic wells
5 agricultural wells
4 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

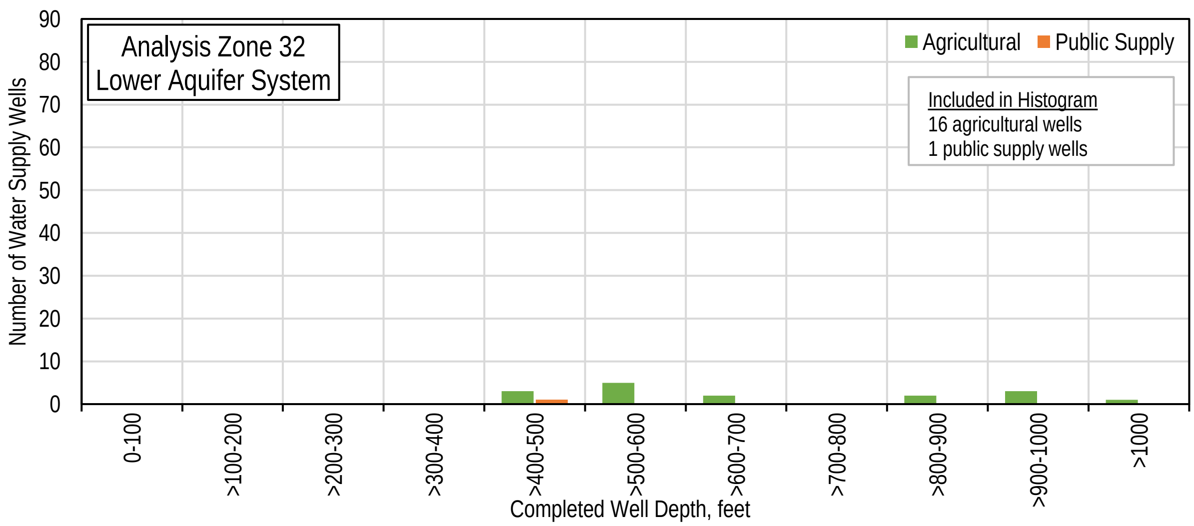

Analysis Zone 27
Lower Aquifer System
Domestic
Agricultural
Public Supply
Landscape
Included in Histogram
22 domestic wells
32 agricultural wells
3 public supply wells
1 landscape irrigation wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

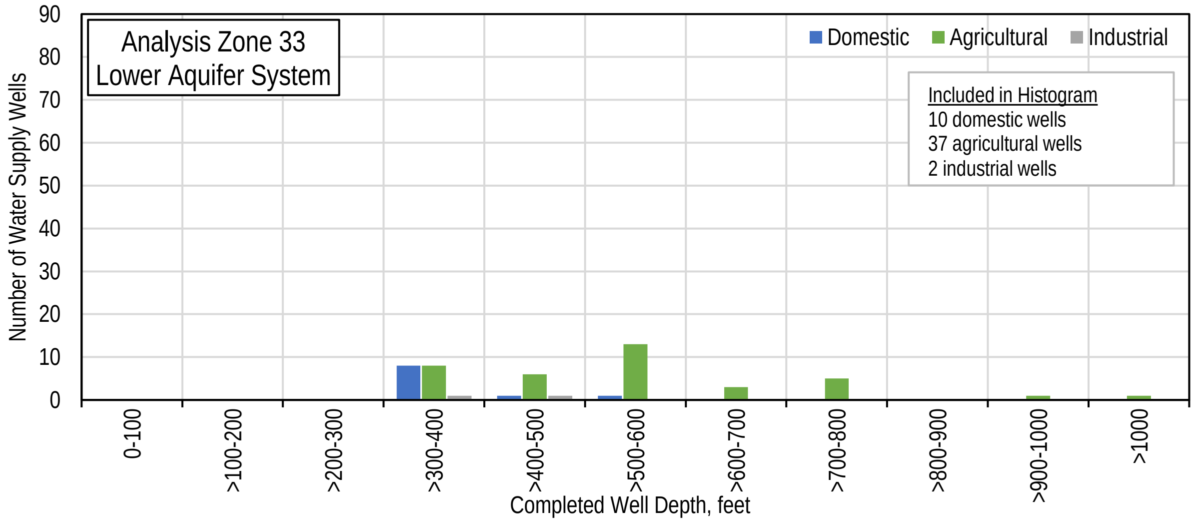

Analysis Zone 28
Lower Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
46 domestic wells
46 agricultural wells
2 public supply wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

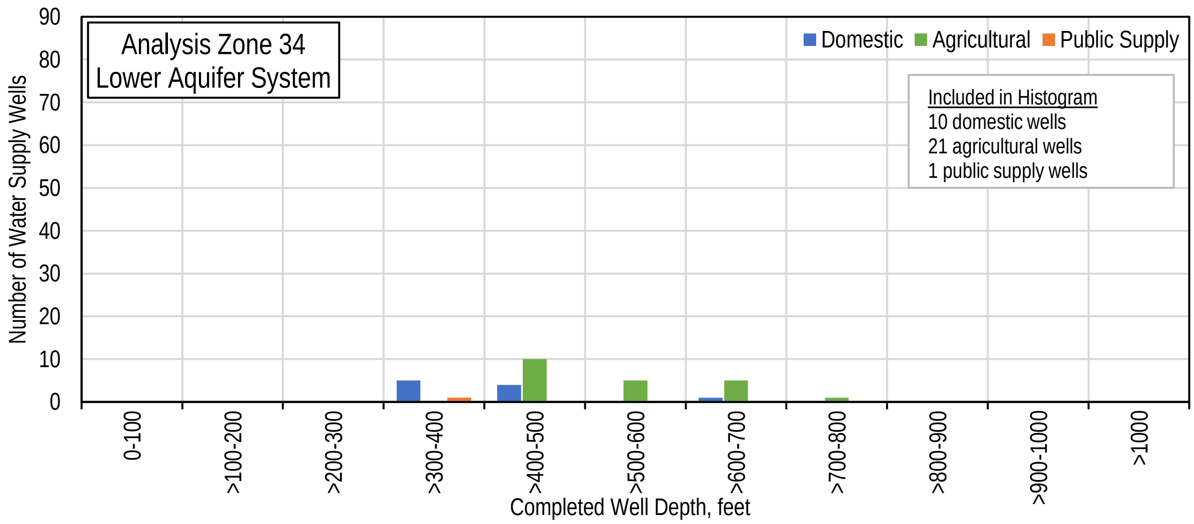

Analysis Zone 29
Lower Aquifer System
Domestic
Agricultural
Public Supply
Landscape
Included in Histogram
13 domestic wells
53 agricultural wells
1 public supply wells
1 landscape irrigation wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

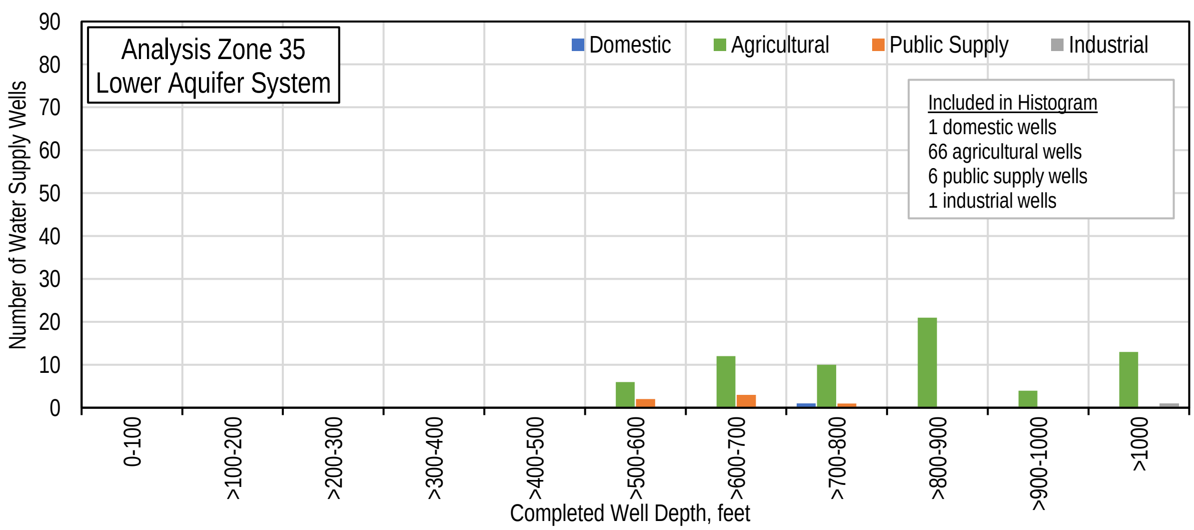

Analysis Zone 30
Lower Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
9 domestic wells
93 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

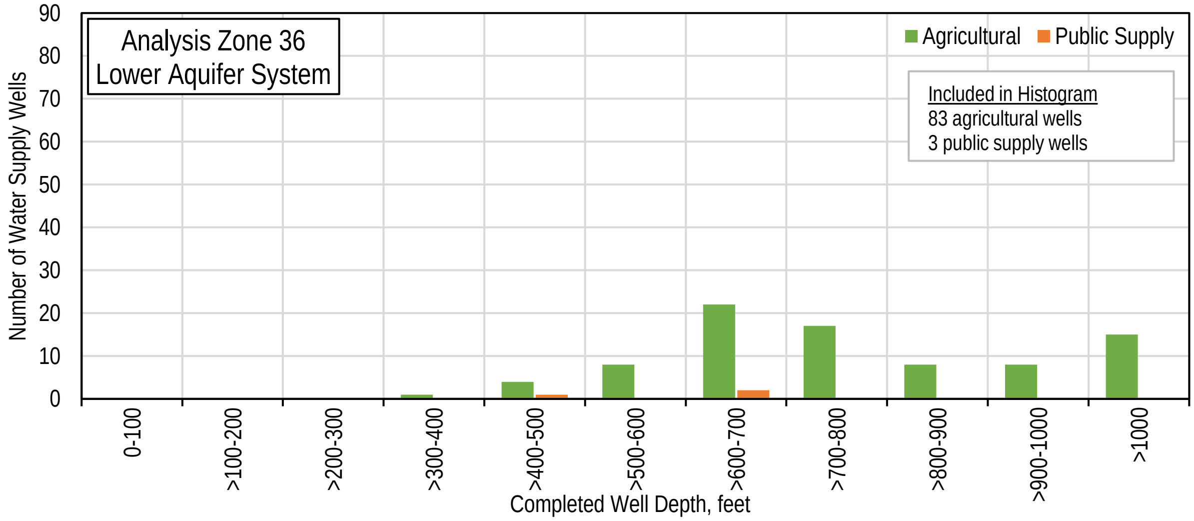

Analysis Zone 31
Lower Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
5 domestic wells
27 agricultural wells
2 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

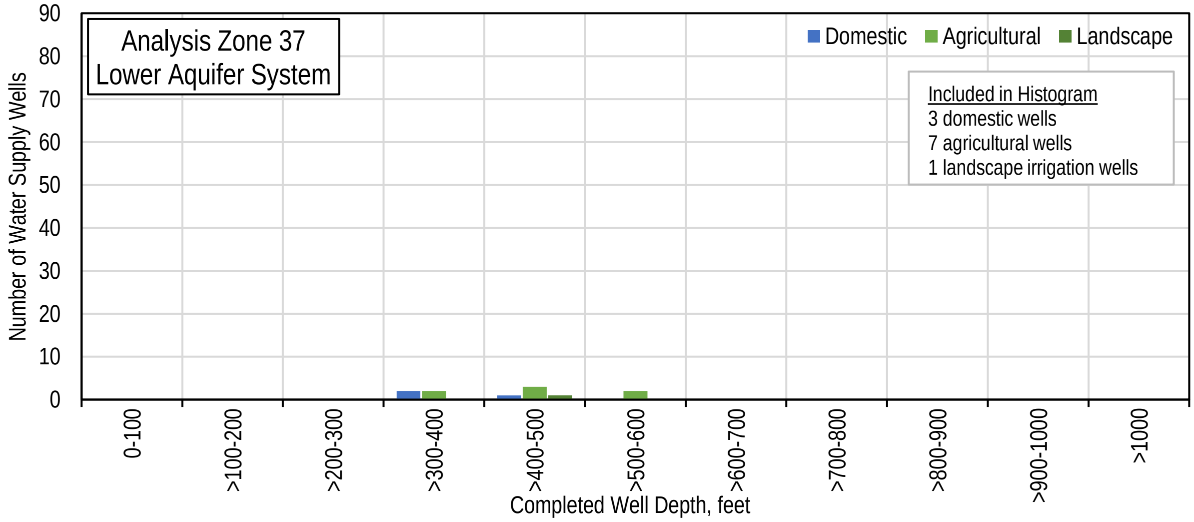

Analysis Zone 32
Lower Aquifer System
Agricultural
Public Supply
Included in Histogram
16 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

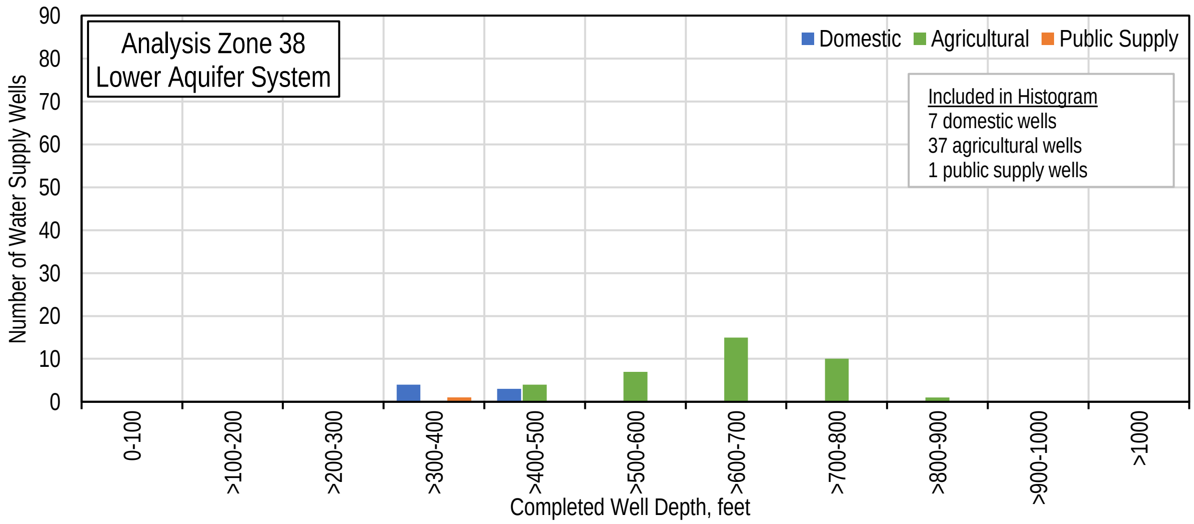

Analysis Zone 33
Lower Aquifer System
Domestic
Agricultural
Industrial
Included in Histogram
10 domestic wells
37 agricultural wells
2 industrial wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

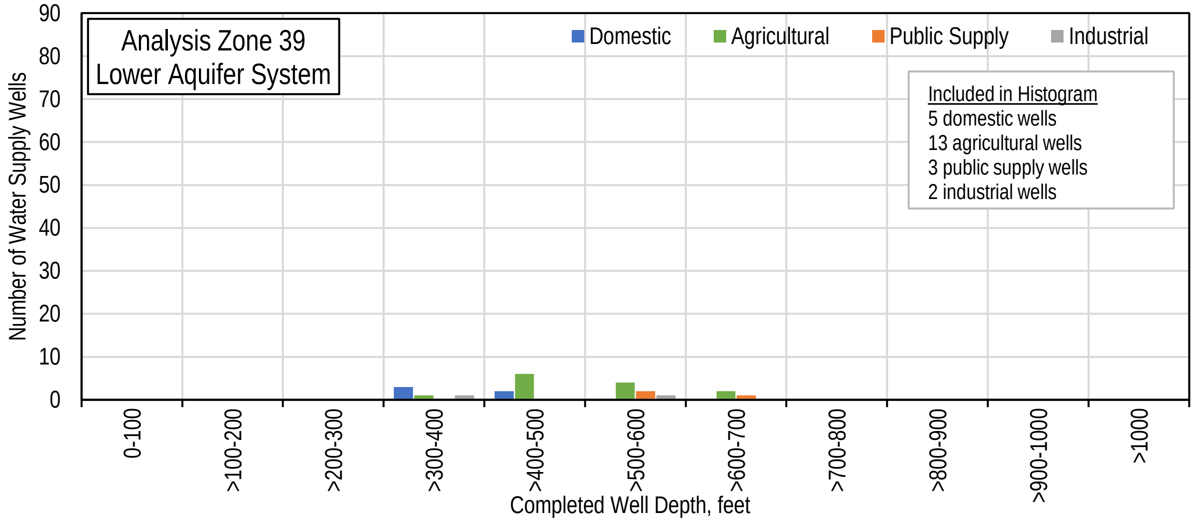

Analysis Zone 34
Lower Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
10 domestic wells
21 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet


Analysis Zone 35
Lower Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
1 domestic wells
66 agricultural wells
6 public supply wells
1 industrial wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet


Analysis Zone 36
Lower Aquifer System
Agricultural
Public Supply
Included in Histogram
83 agricultural wells
3 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet


Analysis Zone 37
Lower Aquifer System
Domestic
Agricultural
Landscape
Included in Histogram
3 domestic wells
7 agricultural wells
1 landscape irrigation wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet


Analysis Zone 38
Lower Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
7 domestic wells
37 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet


Analysis Zone 39
Lower Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
5 domestic wells
13 agricultural wells
3 public supply wells
2 industrial wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

MONTGOMERY & ASSOCIATES

Appendix C

90% Protective Elevations (Methodology 1), Groundwater Level Trend Elevations (Methodology 2), and Interpolated Minimum Threshold (Methodology 3) for Representative Monitoring Site Minimum Thresholds

MONTGOMERY & ASSOCIATES

90% Protective, Groundwater Level Trend, and Interpolated Minimum Threshold Elevations for Kaweah Subbasin Representative Monitoring Sites

Unique Well ID	Local Well ID	GSA	Aquifer System	Analysis Zone	Methodology 1 90% Protective Elevation (feet)	Methodology 2 Groundwater Level Trend Projection Elevation (feet)	Methodology 3 Interpolated Minimum Threshold (feet)
16S25E36M002M	16S25E36M002M	East Kaweah	Single	2	260	292	-
16S26E30Q001M	16S26E30Q001M	East Kaweah	Single	2	285	292	-
17S25E25A001M	17S25E25A001M	East Kaweah	Single	1	124	185	-
17S25E35E001M	KSB-2107	East Kaweah	Single	1	110	185	-
17S26E04F002M	KSB-2369	East Kaweah	Single	2	276	292	-
17S26E07C001M	17S26E07C001M	East Kaweah	Single	2	233	292	-
17S26E21E001M	KSB-2354	East Kaweah	Single	2	266	292	-
17S26E29R001M	17S26E29R001M	East Kaweah	Single	2	269	292	-
18S26E02D002M	18S26E02D002M	East Kaweah	Single	2	295	292	-
18S26E06D001M	18S26E06D001M	East Kaweah	Single	1	130	185	-
18S26E24J003M	18S26E24J003M	East Kaweah	Single	4	306	365	-
18S27E17H002M	18S27E17H002M	East Kaweah	Single	4	327	365	-
18S27E29E001M	18S27E29E001M	East Kaweah	Single	4	330	365	-
18S27E30H001M	18S27E30H001M	East Kaweah	Single	4	327	365	-
19S26E03A001M	19S26E03A001M	East Kaweah	Single	5	207	244	-
19S26E11R001M	19S26E11R001M	East Kaweah	Single	5	198	244	-
19S26E13R001M	19S26E13R001M	East Kaweah	Single	9	123	145	-
19S26E23E001M	Lindsay Well 15	East Kaweah	Single	9	103	145	-
19S26E25R001M	19S26E25R001M	East Kaweah	Single	9	98	145	-
19S26E34R006M	Lindsay Well 14	East Kaweah	Single	10	43	75	-
19S26E35C001M	19S26E35C001M	East Kaweah	Single	9	88	145	-
19S27E29D001M	19S27E29D001M	East Kaweah	Single	7	197	312	-
20S26E08H001M	KSB-2333	East Kaweah	Single	10	30	75	-
20S26E11R001M	20S26E11R001M	East Kaweah	Single	9	100	145	-
20S26E12H001M	Lindsay Well 11	East Kaweah	Single	9	112	145	-
20S26E16R001M	20S26E16R001M	East Kaweah	Single	10	39	75	-
20S26E20J001M	20S26E20J001M	East Kaweah	Single	10	32	75	-
20S26E23R001M	20S26E23R001M	East Kaweah	Single	9	98	145	-
20S26E32A001M	KSB-2344	East Kaweah	Single	10	35	75	-
20S26E35H001M	20S26E35H001M	East Kaweah	Single	9	104	145	-
20S27E08A001M	20S27E08A001M	East Kaweah	Single	7	211	312	-
20S27E15R001M	20S27E15R001M	East Kaweah	Single	6	354	429	-
20S27E18R001M	20S27E18R001M	East Kaweah	Single	8	194	235	-
20S27E25N001M	20S27E25N001M	East Kaweah	Single	6	363	429	-
21S26E11H001M	21S26E11H001M	East Kaweah	Single	9	110	145	-
21S27E03B001M	21S27E03B001M	East Kaweah	Single	8	237	235	-
21S27E06F001M	21S27E06F001M	East Kaweah	Single	9	119	145	-
21S27E08F001M	21S27E08F001M	East Kaweah	Single	8	199	235	-
21S27E12F001M	21S27E12F001M	East Kaweah	Single	7	287	312	-
SCID Office	SCID Office	East Kaweah	Single	2	243	292	-

Unique Well ID	Local Well ID	GSA	Aquifer System	Analysis Zone	Methodology 1 90% Protective Elevation (feet)	Methodology 2 Groundwater Level Trend Projection Elevation (feet)	Methodology 3 Interpolated Minimum Threshold (feet)
17S23E34J001M	KSB-1161	Greater Kaweah	Upper	32	-5	67	-
17S24E34B001M	KSB-1580	Greater Kaweah	Single	11	5	78	-
17S24E36H003M	KSB-1775	Greater Kaweah	Single	12	55	73	-
17S26E36R001M	KSB-2690	Greater Kaweah	Single	4	299	288	-
18S22E24D001M	KSB-0818	Greater Kaweah	Upper	37	-38	59	-
18S23E14A001M	KSB-1222	Greater Kaweah	Upper	32	5	73	-
18S23E30D001M	KSB-0905	Greater Kaweah	Lower	36	-311	-207	-
18S23E30D901M	KSB-0903	Greater Kaweah	Upper	36	-26	71	-
18S25E05Q001M	KSB-1936	Greater Kaweah	Single	13	93	81	-
18S25E15C001M	KSB-2058	Greater Kaweah	Single	13	109	110	-
18S25E23J001M	KSB-2147	Greater Kaweah	Single	14	164	169	-
18S26E17L001M	KSB-2297	Greater Kaweah	Single	15	250	313	-
18S26E27B001M	KSB-2466	Greater Kaweah	Single	5	199	349	-
18S27E05J001M	KSB-2822	Greater Kaweah	Single	16	328	415	-
19S22E24B001M	KSB-0856	Greater Kaweah	Upper	36	-36	25	-
19S22E28D001M	KSB-0616	Greater Kaweah	Upper	35	33	19	-
19S22E31B002M	KSB-0531	Greater Kaweah	Upper	35	27	57	-
19S23E12L001M	KSB-1259	Greater Kaweah	Lower	38	-129	56	-
19S23E21C001M	KSB-1055	Greater Kaweah	Upper	29	-9	51	-
19S25E09H001M	KSB-2017	Greater Kaweah	Single	14	142	92	-
19S25E13A002M	KSB-2200	Greater Kaweah	Single	19	151	114	-
19S25E16A002M	KSB-2015	Greater Kaweah	Single	18	75	91	-
19S25E27A001M	KSB-2089	Greater Kaweah	Single	18	72	57	-
19S25E28H001M	KSB-2021	Greater Kaweah	Single	20	23	56	-
19S25E32J001M	KSB-1937	Greater Kaweah	Upper	24	82	49	-
19S25E35B002M	KSB-2139	Greater Kaweah	Single	18	66	47	-
19S26E05C001M	KSB-2291	Greater Kaweah	Single	14	171	229	-
19S26E16J002M	KSB-2411	Greater Kaweah	Single	18	106	124	-
19S26E20A001M	KSB-2322	Greater Kaweah	Single	18	92	106	-
20S22E07A003M	KSB-0550	Greater Kaweah	Upper	35	20	-28	-
20S22E24R001M	KSB-0889	Greater Kaweah	Upper	30	-73	-17	-
20S22E36A001M	KSB-0890	Greater Kaweah	Upper	30	-79	-10	-
20S24E24H001M	KSB-1783	Greater Kaweah	Upper	24	51	56	-
20S25E03R001M	KSB-2095	Greater Kaweah	Single	20	8	17	55
20S25E12A001M	KSB-2197	Greater Kaweah	Single	20	17	18	65
20S25E14F004M	KSB-2114	Greater Kaweah	Single	21	-72	2	60
20S25E24R001M	KSB-2203	Greater Kaweah	Single	21	-63	-2	65
21S24E03L001M	KSB-1535	Greater Kaweah	Upper	25	89	-24	**
21S24E08A001M	KSB-1425	Greater Kaweah	Lower	25	-262	10	-

Unique Well ID	Local Well ID	GSA	Aquifer System	Analysis Zone	Methodology 1 90% Protective Elevation (feet)	Methodology 2 Groundwater Level Trend Projection Elevation (feet)	Methodology 3 Interpolated Minimum Threshold (feet)
025-01	KSB-1696	Mid-Kaweah	Upper	39	112	13	138
036-01	KSB-1884	Mid-Kaweah	Single	22	79	27	-
047-01	KSB-1699	Mid-Kaweah	Upper	39	107	157	-
053-01	KSB-1977	Mid-Kaweah	Single	23	52	56	-
075-01	KSB-1447	Mid-Kaweah	Upper	39	81	60	-
077-01	KSB-1427	Mid-Kaweah	Upper	39	81	33	-
18S24E13N001M	KSB-1689	Mid-Kaweah	Single	22	69	75	-
18S24E22E001M	KSB-1526	Mid-Kaweah	Upper	39	103	-139	85
18S24E25D001M	KSB-1690	Mid-Kaweah	Upper	39	114	161	-
18S25E28R001M	KSB-2014	Mid-Kaweah	Single	23	54	69	-
18S25E30Q001M	KSB-1819	Mid-Kaweah	Single	22	75	34	-
19S23E20C001M	KSB-0994	Mid-Kaweah	Lower	29	-12	71	-
19S23E22H001M	KSB-1168	Mid-Kaweah	Upper	29	3	30	-
19S23E31R001M	KSB-0946	Mid-Kaweah	Upper	29	-27	-72	-
19S23E35H001M	KSB-1226	Mid-Kaweah	Upper	29	3	-101	-
19S24E08D002M	KSB-1384	Mid-Kaweah	Upper	38	47	38	-
19S24E20F001M	KSB-1408	Mid-Kaweah	Upper	28	75	Drilled after 2016	-
19S24E22E001M	KSB-1545	Mid-Kaweah	Upper	28	86	Drilled after 2016	-
19S24E25D001M	KSB-1709	Mid-Kaweah	Upper	27	2	-6	88
19S24E34D001M	KSB-1536	Mid-Kaweah	Upper	28	77	Drilled after 2016	-
19S24E35E001M	KSB-1628	Mid-Kaweah	Lower	26	-109	-92	-
19S24E36C002M	KSB-1903	Mid-Kaweah	Lower	27	-98	-43	-
19S25E06A001M	KSB-1862	Mid-Kaweah	Single	22	76	35	-
19S25E20P001M	KSB-1905	Mid-Kaweah	Upper	27	24	90	-
20S23E03L001M	KSB-1129	Mid-Kaweah	Upper	29	-9	-81	-
20S23E18R001M	KSB-0948	Mid-Kaweah	Upper	30	-66	-173	-
20S23E21B001M	KSB-1071	Mid-Kaweah	Upper	30	-66	-126	-
20S23E26C001M	KSB-1206	Mid-Kaweah	Upper	30	-64	-20	-
20S24E01H002M	KSB-1770	Mid-Kaweah	Lower	26	-289	-150	-
20S24E04K001M	KSB-1506	Mid-Kaweah	Lower	26	-123	-39	-
20S24E07C001M	KSB-1320	Mid-Kaweah	Upper	31	58	Drilled after 2016	-
20S24E11J002M	KSB-1695	Mid-Kaweah	Lower	26	-119	-121	-
20S24E16H001M	KSB-1538	Mid-Kaweah	Lower	31	-115	62	-
20S24E17P001M	KSB-1431	Mid-Kaweah	Upper	31	58	88	-
20S24E28L001M	KSB-1477	Mid-Kaweah	Upper	31	58	60	-
21S23E05A002M	KSB-0976	Mid-Kaweah	Upper	30	-84	-141	-
21S23E07J001M	KSB-0922	Mid-Kaweah	Upper	30	-36	-22	-
361856N1193313W001	KSB-1706	Mid-Kaweah	Lower	26	-136	-287	-

Note. bolded elevation indicates the minimum threshold assigned to the representative monitoring site

Appendix 6-2 of the Coordination Agreement

Well Impact Analysis Hydrographs

1 SUMMARY PURPOSE

This summary describes all water supply well completion data available for the San Joaquin Valley - Kaweah Subbasin (Subbasin) since January 1, 2002. The purpose of this summary is estimate for the number of wells that may be impacted by groundwater levels declining to elevations protective of 90% of wells in the Subbasin (described in Appendix 5A). These estimates can be used by the Groundwater Sustainability Agencies (GSAs) to develop well mitigation plans for their respective Groundwater Sustainability Plans (GSPs).

The majority of minimum thresholds described in Appendix 5A are at higher elevations than elevations protective of 90% of wells. The estimates of potentially impacted wells therefore overestimate the number of wells. However, since these estimates are to be used for determining the magnitude of wells to be addressed by mitigation plans, they can be considered worst-case estimates.

2 WELL RECORDS IN THE KAWEAH SUBBASIN

A majority of water supply wells installed in the Subbasin since 2002 have well construction information available from Department of Water Resources (DWR) Well Completion Reports submitted by well drillers. These well records are used to develop chronic lowering of groundwater level sustainable management criteria (SMC), as described in Appendix 5A. This summary supplements potential well impacts described in Appendix 5A by including wells without completed well depth information.

2.1 Data Sources and Quality Control

Well completion information compiled in this appendix is from the DWR Well Completion Report (WCR) dataset, downloaded on March 1, 2022. The WCR dataset does not contain a complete accurate dataset, however, it is the best public source of data available. For example, some wells in the dataset are likely dry or have been destroyed. To filter out wells that may have been abandoned or no longer represent typical modern well depths and current groundwater elevations, only well records drilled since 2002 are used for analysis. Furthermore, well completion reports are not always accurately located. Where coordinates of wells are unavailable, DWR locates the well in the middle of the Public Land Survey System section. The location given by DWR in the WCR dataset is used in this analysis.

2.2 Total Well Records

The majority of water supply well records used in the analysis have known well depths, and the well use type for wells without well depth data are generally proportional to those with depth information. The number of wells installed in the Subbasin both with and without known well depths are included in Table 1. Approximately 3,758 supply wells have been installed in the Subbasin since 2002. Of these, 3,353, or about 89%, have well completion data in the WCR dataset and are used in the SMC analysis described in Appendix A. The proportion of wells used for various purposes is nearly identical for the full WCR dataset compared to the subset of wells with known depths; almost all supply wells are either used for agricultural use (55%) or domestic use (41%). Comparatively small numbers of wells are used for public supply (3%), and industrial (1%) purposes. Since the subset of wells with known depths includes a majority of well records in the dataset and closely approximates well types installed in the Subbasin, it is an appropriate dataset to use to develop mitigation plans.

Table 1. Water Supply Well Records by Use Type

Well Use	All Water Supply Well Records from Jan 1, 2002		Well Records with Depth Information	
	Number of Wells	Percentage	Number of Wells	Percentage
Agricultural	2,061	55%	1,859	55%
Domestic	1,546	41%	1,364	41%
Public Supply	129	3%	117	3%
Industrial	22	1%	13	<1%
TOTAL	3,758	-	3,353	-

2.3 Well Records by GSA

Table 2 summarizes the number of well records by well use type for each GSA. There are approximately 1,276 well records in East Kaweah, 1,814 in Greater Kaweah, and 668 in Mid-Kaweah.

Table 2. Summary of Wells by GSA

Well Use Type	East Kaweah		Greater Kaweah		Mid-Kaweah		Total
	Number of Wells	Percentage	Number of Wells	Percentage	Number of Wells	Percentage	
Domestic	463	36%	814	45%	269	40%	1,546
Agricultural	793	62%	914	50%	354	53%	2,061
Public Supply	17	1%	71	4%	41	6%	129
Industrial	3	<1%	15	1%	4	1%	22
Total	1,276	-	1,814	-	668	-	3,758

2.4 Well Records by Analysis Zone

Well records from each analysis zone may be used by GSAs for well mitigation plans. The total number of well records in each aquifer zone is summarized in Table 3. Figure 1 shows the location of the analysis zones.

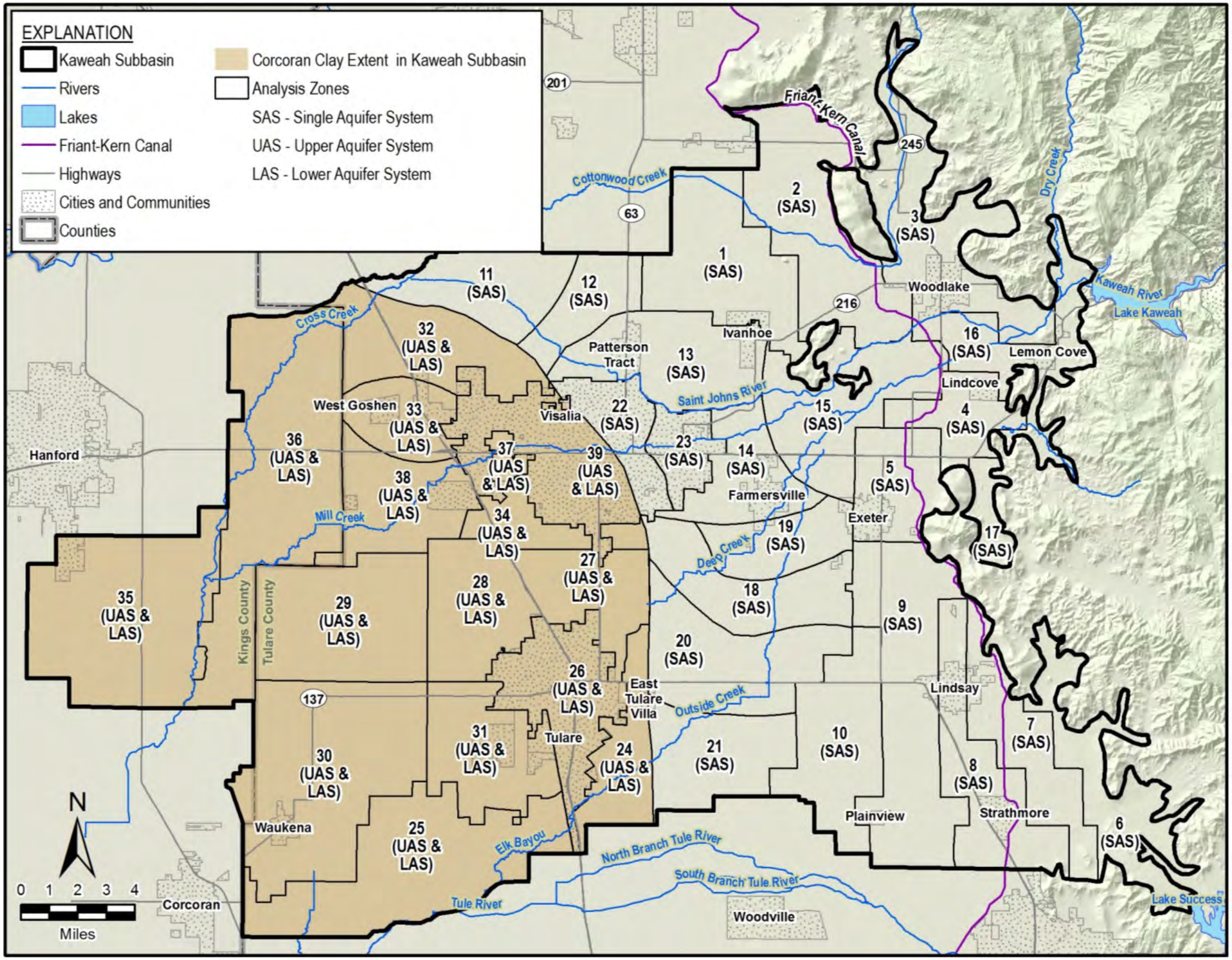


Figure 1. Kaweah Subbasin Analysis Zones

Table 3. Total Well Records by Analysis Zone

Analysis Zone	Agricultural Well Records	Domestic Well Records	Public Well Records	Industrial Well Records	Total Well Records
1	211	118	1	5	335
2	149	23	1	0	173
3	52	39	0	1	92
4	46	42	0	6	94
5	43	29	1	1	74
6	25	9	0	0	34
7	46	18	0	0	64
8	51	56	0	2	109
9	137	99	0	7	243
10	69	52	0	1	122
11	24	2	0	2	28
12	33	30	0	3	66
13	85	146	0	7	238
14	42	52	1	7	102
15	65	73	0	2	140
16	19	46	1	1	67
17	11	3	0	0	14
18	56	62	0	3	121
19	25	87	0	3	115
20	55	88	0	5	148
21	38	12	1	5	56
22	16	6	0	7	29
23	3	7	0	1	11
24	33	33	1	2	69
25	70	3	0	4	77
26	14	18	0	7	39
27	49	75	0	4	128
28	50	69	0	2	121
29	61	19	0	2	82
30	108	52	1	10	171
31	33	8	0	4	45
32	18	1	3	1	23
33	44	32	3	1	80
34	25	52	1	2	80
35	89	29	4	9	131
36	87	8	0	6	101
37	9	15	0	0	24
38	43	16	0	2	61
39	27	17	3	4	51
Total	2,061	1,546	22	129	3,758

3 POTENTIALLY IMPACTED WELLS

3.1 Well Records Shallower than Protective Well Depth by GSA

Wells shallower than protective well depths described in Appendix 5A may be impacted should groundwater elevations approach or exceed minimum thresholds during GSP implementation. The total number of well records shallower than protective well depths in each GSA is estimated using the percentage of wells shallower than the 90th percentile well depth by well use type. Selection of the 90th percentile well depth accounts for uncertainty in the data, especially regarding the likelihood the shallowest wells have been destroyed and replaced during ongoing dry conditions and declining groundwater levels. The analysis is completed using only wells with known well depths. The majority of minimum thresholds described in Appendix 5A are at higher elevations than elevations protective of 90% of wells. The tables that follow therefore overestimate the number of potentially impacted wells. However, since these estimates are to be used for determining the magnitude of wells to be addressed by mitigation plans, they can be considered worst-case estimates.

Table 4 through Table 6 show the approximate number of impacted wells in each GSA, including wells with unknown well depths.

- East Kaweah GSA – approximately 122 wells may be impacted, including 64 domestic wells, 55 agricultural wells, and 3 public supply wells (Table 4).
- Greater Kaweah GSA – approximately 167 wells may be impacted, including 105 domestic wells, 55 agricultural wells, and 7 public supply wells (Table 5).
- Mid-Kaweah GSA – approximately 43 wells may be impacted, including 22 domestic wells and 21 agricultural wells (Table 6).

Table 4. East Kaweah GSA Potentially Impacted Wells

Well Use Type	Well Records with Known Depth			All Well Records		
	Number of Wells	Number of Potentially Impacted Wells	Percentage Potentially Impacted Wells	Number of Wells	Number of Potentially Impacted Wells	Density of Impacted Wells (wells per square mile)
Domestic	418	58	14%	463	64	0.35
Agricultural	721	50	7%	793	55	0.30
Public Supply	16	3	19%	17	3	0.02
Industrial	2	0	0%	3	0	0
Total	1,157	111		1,276	122	0.67

Table 5. Greater Kaweah GSA Potentially Impacted Wells

Well Use Type	Well Records with Known Depth			All Well Records		
	Number of Wells	Number of Potentially Impacted Wells	Percentage Potentially Impacted Wells	Number of Wells	Number of Potentially Impacted Wells	Density of Impacted Wells (wells / square mile)
Domestic	732	96	13%	814	105	0.30
Agricultural	829	49	6%	914	55	0.16
Public Supply	64	6	10%	71	7	0.02
Industrial	8	0	0%	15	0	0
Total	1,633	151		1,814	167	0.48

Table 6. Mid-Kaweah GSA Potentially Impacted Wells

Well Use Type	Well Records with Known Depth			All Well Records		
	Number of Wells	Number of Potentially Impacted Wells	Percentage Potentially Impacted Wells	Number of Wells	Number of Potentially Impacted Wells	Density of Impacted Wells (wells / square mile)
Domestic	214	17	8%	269	22	0.13
Agricultural	309	18	6%	354	21	0.13
Public Supply	37	0	0%	41	0	0
Industrial	3	0	0%	4	0	0
Total	563	35		668	43	0.26

3.2 Well Records Shallower than Protective Well Depth by Analysis Zone

The total number of well records within each analysis zone may be used by the GSAs to estimate potential impacts to be addressed by Well Mitigation Programs. The approximate number of well records that are shallower than the protective well depth in each aquifer zone are summarized in Table 7. Figure 1 shows the location of the analysis zones.

Table 8. East Kaweah GSA Potentially Impacted Wells Summarized by Analysis ZoneTable 8 through Table 10 summarize estimated GSA-specific potential well impacts by well use type.

Table 7. Basinwide Potentially Impacted Wells Summarized by Analysis Zone

Analysis Zone	Agricultural Well Records	Domestic Well Records	Public Well Records	Industrial Well Records	Total Well Records
1	15	19	0	0	34
2	15	3	0	0	18
3	2	2	0	0	4
4	2	7	0	0	9
5	3	4	0	0	7
6	3	1	0	0	4
7	6	1	0	0	7
8	1	9	0	1	11
9	7	14	0	2	23
10	3	7	0	0	10
11	2	1	0	0	3
12	3	3	0	0	6
13	1	16	0	1	18
14	0	10	0	0	10
15	5	10	0	0	15
16	2	4	0	0	6
17	1	1	0	0	2
18	2	11	0	0	13
19	2	6	0	0	8
20	0	14	0	0	14
21	3	2	0	0	5
22	3	1	0	0	4
23	0	2	0	0	2
24	2	4	0	0	6
25	8	1	0	0	9
26	2	0	0	0	2
27	2	4	0	0	6
28	1	3	0	0	4
29	2	2	0	0	4
30	7	8	0	0	15
31	2	1	0	0	3
32	4	0	0	0	4
33	3	4	0	0	7
34	0	6	0	1	7
35	7	1	0	2	10
36	8	1	0	1	10
37	0	1	0	0	1
38	0	6	0	2	8
39	2	1	0	0	3
Total	131	191	0	10	332

Table 8. East Kaweah GSA Potentially Impacted Wells Summarized by Analysis Zone

Analysis Zone	Agricultural Well Records	Domestic Well Records	Public Well Records	Industrial Well Records	Total Well Records
1	15	19	0	0	34
2	15	3	0	0	18
3	2	2	0	0	4
4	1	5	0	0	6
5	2	3	0	0	5
6	3	1	0	0	4
7	6	1	0	0	7
8	1	9	0	1	11
9	7	14	0	2	23
10	3	7	0	0	10
Total	55	64	0	3	122

Table 9. Greater Kaweah GSA Potentially Impacted Wells Summarized by Analysis Zone

Analysis Zone	Agricultural Well Records	Domestic Well Records	Public Well Records	Industrial Well Records	Total Well Records
3	0	0	0	0	0
4	1	2	0	0	3
5	1	1	0	0	2
11	2	1	0	0	3
12	3	3	0	0	6
13	1	16	0	1	18
14	0	10	0	0	10
15	5	10	0	0	15
16	2	4	0	0	6
17	1	1	0	0	2
18	2	11	0	0	13
19	2	6	0	0	8
20	0	14	0	0	14
21	3	2	0	0	5
22	0	0	0	0	0
23	0	0	0	0	0
24	2	4	0	0	6
25	8	1	0	0	9
30	0	0	0	0	0
32	4	0	0	0	4
33	3	4	0	0	7
34	0	6	0	1	7
35	7	1	0	2	10
36	8	1	0	1	10
37	0	1	0	0	1
38	0	6	0	2	8
Total	55	105	0	7	167

Table 10. Mid-Kaweah GSA Potentially Impacted Wells Summarized by Analysis Zone

Analysis Zone	Agricultural Well Records	Domestic Well Records	Public Well Records	Industrial Well Records	Total Well Records
22	3	1	0	0	4
23	0	2	0	0	2
24	0	0	0	0	0
26	2	0	0	0	2
27	2	4	0	0	6
28	1	3	0	0	4
29	2	2	0	0	4
30	7	8	0	0	15
31	2	1	0	0	3
39	2	1	0	0	3
Total	21	22	0	0	43

Appendix 6-3:

Kaweah Subbasin Mitigation Program Framework

MITIGATION PROGRAM FRAMEWORK
KAWEAH COORDINATION AGREEMENT APPENDIX 6
Groundwater Levels and Land Subsidence

Introduction

Sustainable Management Criteria identified in each of the Kaweah Subbasin GSAs have been developed to avoid significant and unreasonable impacts to domestic, municipal, agricultural, and industrial beneficial uses and users of groundwater. However, analysis based on available data suggests that numerous wells may be impacted during the implementation period between 2020 and 2040 as a result of continued lowering of groundwater levels.[1] Wells, land use, property and infrastructure may also be impacted from land subsidence during this period.

As a result of the foregoing, the Kaweah Subbasin GSAs agree to each individually implement a Mitigation Program (Mitigation Program) subject to the following minimum requirements and subject to the schedule provided herein. The purpose of the Mitigation Program is to mitigate for continued overdraft pumping for groundwater levels and land subsidence. Each Kaweah Subbasin GSA will adopt and implement a Mitigation Program to identify impacts caused by pumping within the GSA's boundaries that may require mitigation. Each Mitigation Program will separately identify the impacts to beneficial uses that the Mitigation Program is intended to address. Each Mitigation Program will include a claim process to address impacts to: (i) domestic and municipal wells; (ii) agricultural wells; and (iii) critical infrastructure. Because the Mitigation Program will resolve impacts from groundwater management, significant and unreasonable results to wells and land uses that may occur prior to reaching Minimum Thresholds will be avoided.

Mitigation Program Framework

Each GSA shall include a Mitigation Program as a project or management action identified in that GSA's GSP, describing the following elements:

Identification of Need for Mitigation

The Mitigation Program will begin with a plan to establish the process for identification of wells or land uses in need for mitigation. The process may include: 1) an application process by the landowner or well user; or 2) data collection by the GSA and outreach to the affected user. The GSPs in the Subbasin set Measurable Objectives and Minimum Thresholds based on 2015 groundwater levels and land elevation. Impacts from that point further will be evaluated as potentially affected due to the allowance of some level of continued overdraft.

[1] See Technical Appendix 5A, Technical Approach for Developing Chronic Lower of Groundwater Levels Sustainable Management Criteria in the Kaweah Subbasin for a detailed description of the establishment of MT; Technical Appendix 5C, Potential Well Impact Summary.

Evaluation

Once a potential well or land use has been identified as possibly impacted, an evaluation will occur by the GSA to determine whether the well has been adversely impacted by declining groundwater levels or by land subsidence which have been identified as occurring because of allowable continued overdraft conditions.

Qualifications

GSAs may qualify mitigation based on a user's compliance with the GSA's GSP, Rules & Regulations, and other laws or regulations. For example, a user who has caused or contributed to overdraft may not qualify for the Mitigation Program.

Mitigation

Once a well has been identified as adversely impacted due to declining groundwater levels or land subsidence, the proper mitigation to alleviate impacts must be determined. This could be any of the following:

For groundwater level impacts, this could include any of the following:

1) Repairing the well;
2) Deepening the well;
3) Constructing a new well;
4) Modifying pump equipment;
5) Provide temporary or permanent replacement water;
6) Coordinate consolidation with existing water systems; or
7) With the consent of the affected user, providing other acceptable means of mitigation.

For land use impacts, this could include any of the following:

1) Increased restrictions in groundwater extractions for certain regional areas;
2) Repair to canals, turnouts, stream channels, water delivery pipelines, and basins;
3) Repair to damaged wells;
4) Addressing flood control;
5) Repair to other damaged infrastructure including highways, roads, bridges, utilities, and buildings; or
6) With the consent of the affected user, providing other acceptable means of mitigation.

Various factors may reflect the proper mitigation methods for the specific well or land use at issue. For example, age, location, the financial impact to the beneficial user as a result of mitigation, and the beneficial user of the well may reflect which mitigation measures are optimal.

Outreach

Public outreach and education will be provided during development of the Mitigation Program and prior to implementation by each GSA. Prior to implementation, extensive outreach will be geared toward notifying landowners of the Mitigation Program requirements, facilitate how to qualify for the Mitigation Program, and how to apply for assistance. Outreach will be offered in multiple languages as appropriate for the GSA. Outreach methods could include workshops, mailings, flyers, website postings, Board meeting announcements, etc.

Common elements developed at the Kaweah Subbasin level shall be shared with the public through coordinated workshops and public meetings. As material and data become available, the Kaweah Subbasin GSAs will coordinate workshops for the public to attend. While special workshops can be utilized, the Kaweah Subbasin GSAs will utilize the quarterly Kaweah Subbasin Management Committee (Management Committee) meetings as a resource to share Workplan updates. The Management Committee is a coordinated meeting between representatives from each GSA, and the public is invited to attend and participate in the meetings. Meetings shall be noticed on GSA websites and shall be sent to interested parties. Interested parties are collected on an ongoing basis in the Kaweah Subbasin. Individual outreach plans specific to each GSA Mitigation Program shall be developed and shared with the public via individual outreach efforts at each.

Mitigation Program Adoption Schedule

Each GSA will formulate and implement a mitigation claims process for domestic and municipal use impacts within the first quarter of 2023, and complete all other aspects of the Mitigation Program by June 30, 2023. The initial claims process shall include reference to local programs and resources from the County, State, non-profit organizations, and the Kaweah Basin Water Foundation.

As the Kaweah Subbasin GSAs anticipate that the individual Mitigation Programs will require time to be developed and established in a public and transparent fashion, in the interim, the Kaweah Subbasin GSAs will coordinate the development of an Interim Domestic Well Mitigation Program at a yet to be determined funding level and emergency criteria to make the limited funding available for drinking water well mitigation.

Mitigation Program Funding Source

Each GSA will develop a funding mechanism for the Mitigation Program, which is dependent on the specific GSA needs for specific expected impacted wells, critical infrastructure, and land uses within each GSA. Funding is anticipated to be available for each GSA's Mitigation Program through implementation of assessments, fees, charges, and penalties. In addition, the GSAs will explore grant funding. The State has many existing grant programs for community water systems and well construction funding. County, state, and federal assistance will be needed to successfully implement the respective Mitigation Programs. Each GSA may, separately or in coordination with other GSAs, also work with local NGOs that may be able to provide assistance or seek grant monies to help fund the Mitigation Program. GSAs may act individually or collectively to address and fund mitigation measures.

Below is a list of funding being sought within the Kaweah Subbasin:

- The Safe and Affordable Funding for Equity and Resilience (SAFER) Program through the California State Water Resources Control Board
- Household Water Well Program through the United State Department of Food and Agriculture
- Household Water Well System Grant Program through the United State Department of Food and Agriculture

Annual Reporting and Mitigation Evaluations

The Kaweah Subbasin GSAs intend to utilize the Annual Report submitted to DWR to report on and update progress on the Mitigation Program(s).

With the information presented, the Kaweah Subbasin GSAs anticipate pursuing locating and refining the potential number of wells impacted by lowering of groundwater levels to the MTs in the Kaweah Subbasin. The Kaweah Subbasin GSAs intend to leverage new tools developed by the California Department of Water Resources such as the Dry Domestic Well Susceptibility Tool and well surveys to establish a refined estimate of drinking water well impacts. The Kaweah Subbasin GSAs will continue to evaluate impacts to beneficial uses and users of Land Subsidence.

Appendix 7

Groundwater Modeling Technical Memorandum

KAWEAH SUBBASIN
GROUNDWATER MODELING REPORT

Final 12/31/19

Contents

Introduction

This memorandum describes the application of the Kaweah Subbasin Hydrologic Model (KSHM) to analysis of future conditions in the Kaweah Subbasin during the GSP implementation period from 2020 to 2040. The model is applied to estimate future water deficit and water levels under base no-action scenarios. It is also applied to assess the impacts of projects and management actions proposed by the Subbasin GSAs. The modeling results helped inform the GSAs in finalizing their sustainable management criteria including articulation of a basin wide sustainability goal statement and verifying the reasonableness of the measurable objectives, minimum thresholds, and interim milestones set at each groundwater level representative monitoring well for the 20-year GSP implementation period. The results are also intended to inform collaboration with other agencies and entities to arrest chronic water-level and groundwater storage declines, reduce or minimize land subsidence where significant and unreasonable, decelerate ongoing water quality degradation where feasible, and protect beneficial uses. The modeling approach and results of verification runs have been previously described in an earlier report which is provided in Appendix 1 of this report.

Model Scenarios

The first modeling task initiated includes extending the duration of the model from the modeled period of water years 1999 to 2017 through the SGMA compliance period of water years 2020 to 2040. All modeling runs, from the no-action "Base Case" scenario through the projects and management action scenarios, incorporate climate change in accordance with DWR's climate change direction. The base case was used to identify measurable objectives and to facilitate planning for projects and management actions. The set of model runs to be performed was determined through iterative discussions and summarized in a presentation to the Kaweah Subbasin management team on April 17, 2019. The model runs implemented consisted of the following:

- Case 1, Base No-Action Scenario: Base Case Run with averaged water year repeated and adjusted to account for long term trend due to climate projections
- Case 2, Variable Base No-Action Scenario: Base case with historical sequence of wet and dry years
- Case 3, Reversed Variability Base No-Action Scenario: Base case with reversed historical sequence of wet and dry years
- Case 4, Future Management Actions Only: Built on the Base No-Action Scenario but with Pumping Reductions
- Case 5, Future Projects and Management Actions: Built on the Base No-Action Scenario but with Pumping Reductions and Projects

Preparing Projected Hydrology

Projected climate conditions for the implementation period are important inputs for the determination of measurable objectives and ultimately the sustainability of the basin. The GSP Emergency Regulation which was issued by DWR to guide development of GSPs includes guidance for preparation of Project Hydrology for 2020 to 2040 implementation period. Section 354.18(c)(2)(B) of the GSP Emergency Regulation outlines the relevant requirements for preparing historical and projected water budgets.

For historical water budget, the regulation requires a quantitative assessment based on a minimum of 10 years of data including with the most recently available information. The 20-year current period (1997 to 2017) used for the Kaweah basin historical water budget meets and exceeds this requirement. For projected hydrology, the regulation requires future hydrology to be established using 50 years of historical precipitation, evapotranspiration, and streamflow information as a baseline. The regulation also requires projected hydrology information to be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.

To support the development of a projected hydrology that meets the requirements of the regulation, DWR has provided a gridded, statewide dataset that contains over 89 years of detrended hydrologic time series (1922 to 2011) to capture variability. DWR has also computed the climate states at 1995, 2030 and 2070 using a combination of global climate models, and the climate states have been applied to the detrended time series to generate three future hydrologic time series. For estimation of imported water supplies such as those from the Friant-Kern system, DWR has simulated 82 years of future hydrologic time series using the CalSim model. Three climate time series, each 50 or more years long, were extracted from the DWR data and used to characterize projected hydrology in the Kaweah Basin under 1995, 2030 and 2070 conditions.

Case 1: Base Case of Future with Averaged Conditions and No Projects

To meet the GSP Emergency Regulation requirements, a base case of projected hydrology covering the 20-year period for 2020 to 2040 is developed based on historical monthly averages. The average monthly hydrologic conditions experienced between 1997 through 2017 (the "current period") are assumed for each year of the compliance period, and annual change factors are applied to account for the long-term trend due to climate change. Future water supply projections (including Class I, II and other water deliveries) from the Friant Water Authority are included in the base case. Detailed steps for generating the projected hydrology time series are described in the following steps:

- First Year (2020): Projected hydrology for the first year (2020) are computed as the monthly averages of the current hydrology (1997 to 2017). An implied change factor of 1 is used for the first year of projected hydrology.

- Early Years (2021 to 2030): Projected hydrology for subsequent years from 2021 to 2030 are computed by applying a set of change factors to account for climate change. Twelve climate change factors are computed using the percent change of the mean monthly values between two DWR-provided climate projection datasets centered around years 1995 and 2030, respectively. The linear trend is used to incremental apply the monthly change factors to each year between 2021 and 2030, and the change factors are applied to the monthly averages of the current (2020) hydrology to generate the projected hydrology.

- Later Years (2031 to 2040): Projected hydrology for the later years from 2031 to 2040 are computed by similarly applying factors to account for climate change. The climate change factors for later years is computed using the rate of change of the mean monthly values between DWR-provided climate projection datasets centered around years 2030 and 2070, respectively. The trend is applied incremental to the monthly values beginning with 2030 hydrology to generate projected hydrology for each year between 2031 and 2040.

Table 1 shows the monthly change factors computed for use in projecting future precipitation, evapotranspiration and water supply in the Kaweah Subbasin. Separate change factor values are provided for use in 2030 and 2040. Since a value of 100% is assumed for the first year 2020, change factors are easily interpolated for all intermediate years between 2020 and 2040 using a linear trend. Different change factors are computed in each of the three GSAs, and different change factors are also applied for water supplies from Kaweah Lake, Kings and the Friant Kern system.

Table 1: Monthly Hydrologic Change Factors Derived from DWR-Provided Climate Change Projections.

	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation (Percent of 2020 Values)													
East Kaweah	2030	92	102	98	108	104	109	103	85	88	101	109	105
East Kaweah	2040	89	97	97	111	104	109	99	80	87	104	112	111
Greater Kaweah	2030	92	101	97	108	105	108	103	87	88	101	112	105
Greater Kaweah	2040	90	96	97	110	105	108	100	83	87	101	113	110
Mid-Kaweah	2030	92	101	96	108	105	108	103	87	88	100	109	105
Mid-Kaweah	2040	90	96	95	110	105	108	100	83	87	100	110	110
Evapotranspiration (Percent of 2020 Values)													
East Kaweah	2030	104	103	103	105	103	103	102	104	104	103	103	103
East Kaweah	2040	105	105	106	106	105	104	103	105	105	104	104	104
Greater Kaweah	2030	104	103	104	105	103	103	102	104	104	103	103	103
Greater Kaweah	2040	105	105	106	106	104	103	103	105	105	104	104	104
Mid-Kaweah	2030	104	103	104	105	103	102	102	104	104	103	103	103
Mid-Kaweah	2040	105	105	106	107	104	103	103	105	105	104	104	104
Water Supply (Percent of 2020 Values)													
Kaweah Lake	2030	102	106	110	125	121	119	105	82	58	64	91	99
Kaweah Lake	2040	99	101	111	131	128	124	104	75	51	61	90	102
Kings	2030	100	111	118	135	131	127	115	96	64	58	84	96
Kings	2040	97	107	122	144	142	137	119	92	57	53	81	99
Friant-Kern	2030	85	97	146	152	116	110	101	97	85	90	85	85
Friant-Kern	2040	83	94	144	157	118	112	102	93	82	87	81	83

To generate the projected hydrology, the monthly change factors are applied to the fluxes from the calibrated model for the current period. The precipitation, evapotranspiration and water supply change factors are applied to different fluxes as follows:

- Mountain Front Runoff (precipitation change factors)
- Agricultural Pumping (evapotranspiration change factors)
- Agricultural Irrigation Return Flow (evapotranspiration change factors)
- Ditch Percolation (future estimated surface water allocations)
- Precipitation Percolation (precipitation change factors)
- River Recharge (water supply change factors)

Case 2: Future with Interannual Variability and No Projects

The second modeling case is used to evaluate the impacts of interannual variability including extreme conditions such as wet and dry years and multi-year droughts which could impact water quality or induce subsidence. The projected hydrology is based on the historical hydrologic time series (1997 to 2017) with a climate adjustment applied to reflect climate conditions centered at 2030. This model run includes over 10 years of current hydrology and 50 years of projected hydrology as required by the GSP regulations. However, the results cannot be used for setting intermediate 5-year targets between 2020 and 2040 since the historical sequence of wet and dry years cannot be assumed to recur in the future. The results of this model run are used primarily to estimate the magnitude of uncertainty in future projections of performance targets.

Case 3: Future with Interannual Variability Reversed and No Projects

The third modeling case also uses the historical time series used in Case 2 to evaluate the impacts of interannual variability and extreme wet and dry years. However, the sequence of historical time series is reversed such the model run begins with the most recent historical years of data while the oldest year of data enters the model last. The time series reversal changes the sequencing of hydrologic years but preserves the seasonal patterns that occurred within each year. To account for the impacts of climate change, a set of 12 monthly change factors is computed from the DWR climate projections centered at 2030 and applied to each year of the reversed time series.

The results of Case 3 run are useful for assessing the sensitivity of projected hydrology and sustainability indicators to the sequence of future annual droughts and wet years. However, the results cannot be used for setting intermediate 5-year targets between 2020 and 2040 since the sequence of years cannot be assumed to recur in the future. The results of this model run are also used to assess the magnitude of uncertainty in future projections of performance targets.

Case 4: Altered Future with Management Actions

The fourth modeling case reflects a future scenario where only management actions would be employed to achieve sustainability. Management actions are to be implemented with the goal of reducing pumping and mitigating further decline in aquifer water levels. They include conservation and monitoring programs aimed at limiting extraction and reducing water use. They also include market-based mechanisms and external assistance programs to reduce the economic impact of reduced water use. Table 2 shows the list of near-term management actions to be implemented in the Kaweah Subbasin in Case 4 which does not include implementation of any projects, with the exception of relatively new and operating water exchanges within Mid-Kaweah GSA.

Table 2: List of Management Actions included in Case 4

Region	Management Actions
East Kaweah GSA	• 5% Demand Reduction • 2025 Demand Reduction Programs/Policies • 2030 Demand Reduction Programs/Polices • 2035 Demand Reduction Programs/Polices
Greater Kaweah GSA	• Modified Surface Water Deliveries • Fallowing Program
Mid-Kaweah GSA	• Extraction Measurement Program • Groundwater Extraction Allocation Implementation

Case 5: Altered Future with Management Actions and Projects

The fifth modeling case reflects a future scenario where projects and management actions would be employed to achieve sustainability. While management actions are aimed at reducing pumping, projects are proposed with the primary goal of increasing recharge. Table 3 shows the list of initial projects and management actions included in Case 5. Case 5 is expected to generate the smallest water deficit since it reflects the combined impacts of recharge projects and pumping reduction from all the management actions previously listed in Case 4. Not all of the projects and management actions listed in table three

Table 3: List of Projects and Management Actions included in Case 5

Region	Management Actions	Projects
East Kaweah GSA	• 5% Demand Reduction • 2025 Demand Reduction Programs/Policies • 2030 Demand Reduction Programs/Policies • 2035 Demand Reduction Programs/Policies	• Lewis Creek Delivery • Cottonwood Creek Delivery • Yokohl Creek Delivery • Micro-Basins • Lindsay Recharge Basin • Wutchumna Ditch Delivery • Rancho de Kaweah
Greater Kaweah GSA	• Modified Surface Water Deliveries • Fallowing Program	• Cross Creek Layoff Basin • Improved LIWD Basins • New LIWD Basins • New Delta View Canal • Deliveries to Delta View Landowners thru Lakeland • On-Farm Recharge • Kings River Floodwater Arrangement • Buying Surplus Water in Wet Years • Paregien Basin • Basin No. 4 • Hannah Ranch • Lewis Creek Water Conservation • Ketchum Flood Control & Recharge • St Johns River Water Conservation • Peoples Recharge Expansion
Mid-Kaweah GSA	• Extraction Measurement Program • Groundwater Extraction Allocation Implementation	• Cordeniz Recharge Basin • Okieville Recharge Basin • Tulare Irrigation District / GSA Recharge Basin • On-Farm Recharge Programs • McKay Point Reservoir • Kaweah Subbasin Recharge Facility • City of Visalia / Tulare Irrigation District Exchange Program • Sun World International / Tulare Irrigation District Exchange Program • City of Tulare / Tulare Irrigation District Catron Basin • Packwood Creek Water Conservation Project • Visalia Eastside Regional Park & Groundwater Recharge

Boundary Conditions

The Kaweah Subbasin numerical groundwater model is intended to be used as a valuable planning tool to guide groundwater managers in planning projects and management actions to achieve sustainability within the implementation period. To achieve this goal, particular attention is paid to how the head boundary conditions are specified in the model. Within the groundwater model, the General Head Boundary (GHB) surrounds the Kaweah Subbasin model at a distance of approximately 3 miles beyond the KSB boundary, located within the neighboring subbasins to the north, west and south. The area between the GHB and the Kaweah Subbasin is considered a "buffer zone," the purpose of which is to evaluate subsurface inflow and outflow (underflow) between the adjacent subbasins. Figure 1 shows the model extent with the General Head Boundary represented by the line marking the edge of the model extent.

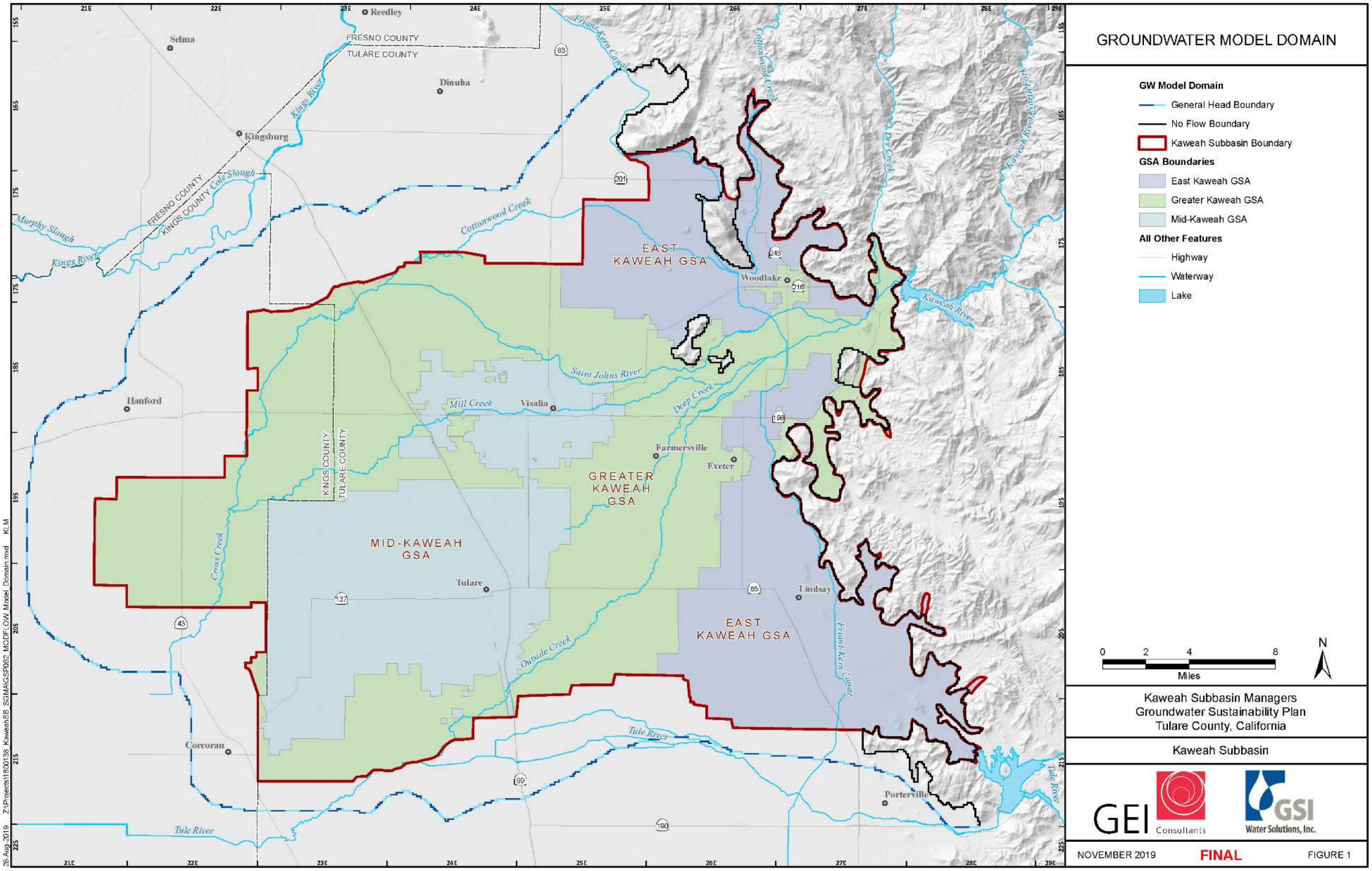


Figure 1: Kaweah Subbasin Model Domain

Head boundary conditions play an important role in modeling because, along with aquifer properties, they determine the magnitude of flows in and out of the subbasin. Boundary water levels for a modeling run must be specified for each month in the simulation period prior to each model run. They are difficult to specify accurately since they are based on water levels that respond to the change in fluxes due to actions in neighboring subbasins. However, they must be specified accurately enough to reflect changing fluxes entering and leaving the subbasin through the boundary.

In the Kaweah model, future water levels at the general head boundary are prescribed based on observed water elevations and simulated current hydrology (1997-2017) from the calibrated model. Future boundary water elevations from 2020 to 2040 were set by repeating the 12 average monthly values of the period from 1997 through 2017. This approach preserves the seasonal water level changes at boundary. It also ensures that the magnitude of underflow fluxes entering and leaving the basin for the base case are of the same order of magnitude as underflow fluxes for current hydrology. As projects and management actions are implemented within Kaweah and surrounding subbasins, the head boundary conditions and underflow will also change but these changes cannot be predicted without full knowledge of all projects and management actions in the region. The surrounding subbasins have the same modeling issues which can only be resolved in future by setting boundary conditions with modeled water levels from surrounding subbasins.

Figure 2 shows contours of the potentiometric surface for initial water levels at the start of the planning period in 2020. The elevation of the water table generally decreases from east to west. The highest water level elevations of between 300 and 400 ft occur in East Kaweah GSA at the transition from the Sierras to the valley floor. The lowest water levels of 40 ft or less occur along Cross Creak at the western edge of Greater Kaweah and Mid-Kaweah GSAs.

Figure 3 shows contours of the projected potentiometric surface changes between 2020 and 2040 under the base, no-project scenario. Contour values are generally negative indicating water levels in the Kaweah Subbasin would continue to decline without action to reduce extraction or increase supply. The largest declines would occur in the middle of the subbasin with declines exceeding 80 ft around Visalia. The region of decline is shaped like a cone centered around Visalia and extending over the entire subbasin.

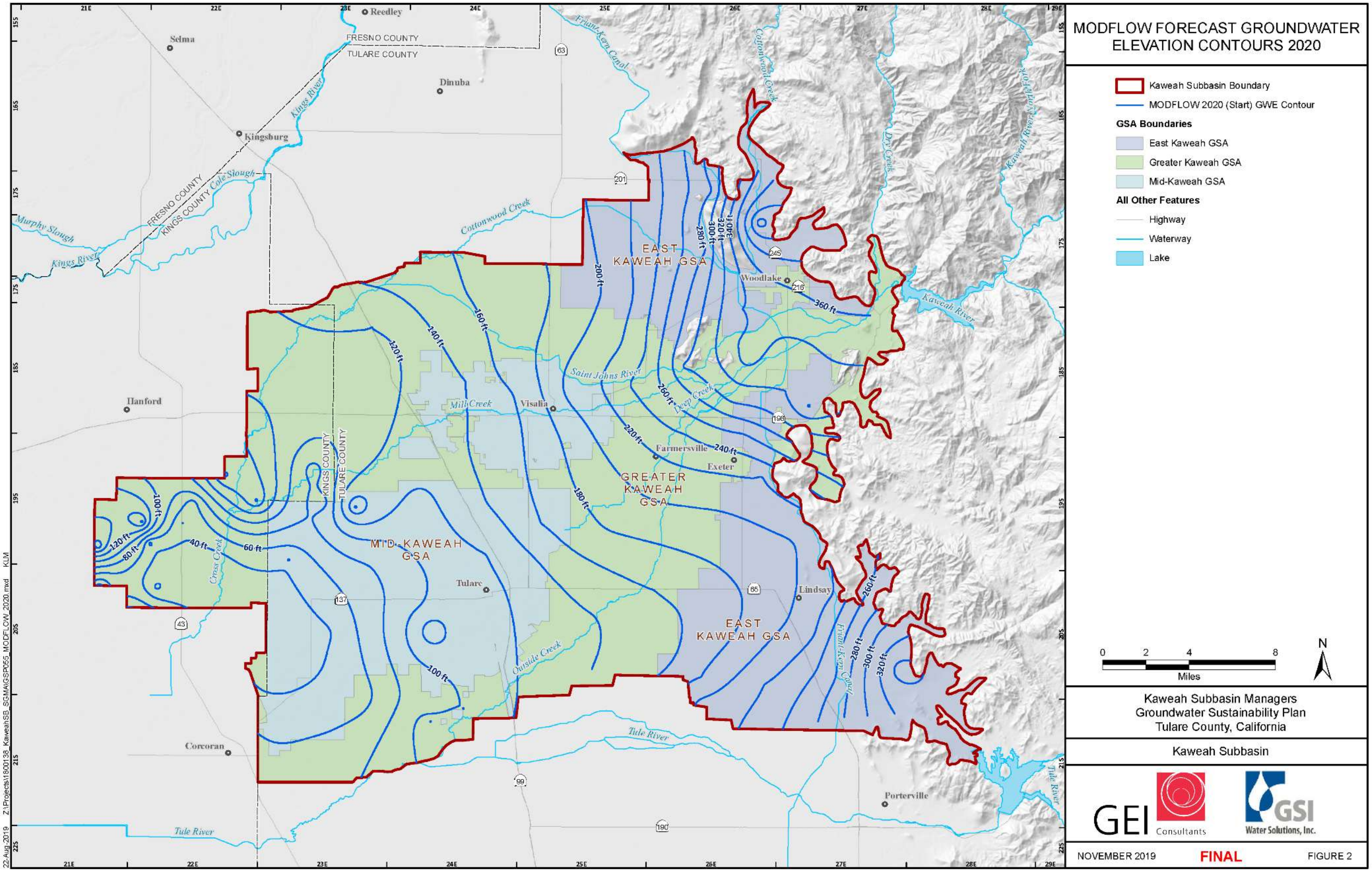


Figure 2: Potentiometric Surface Map showing Water Levels at the Beginning of the Simulation Period in 2020.

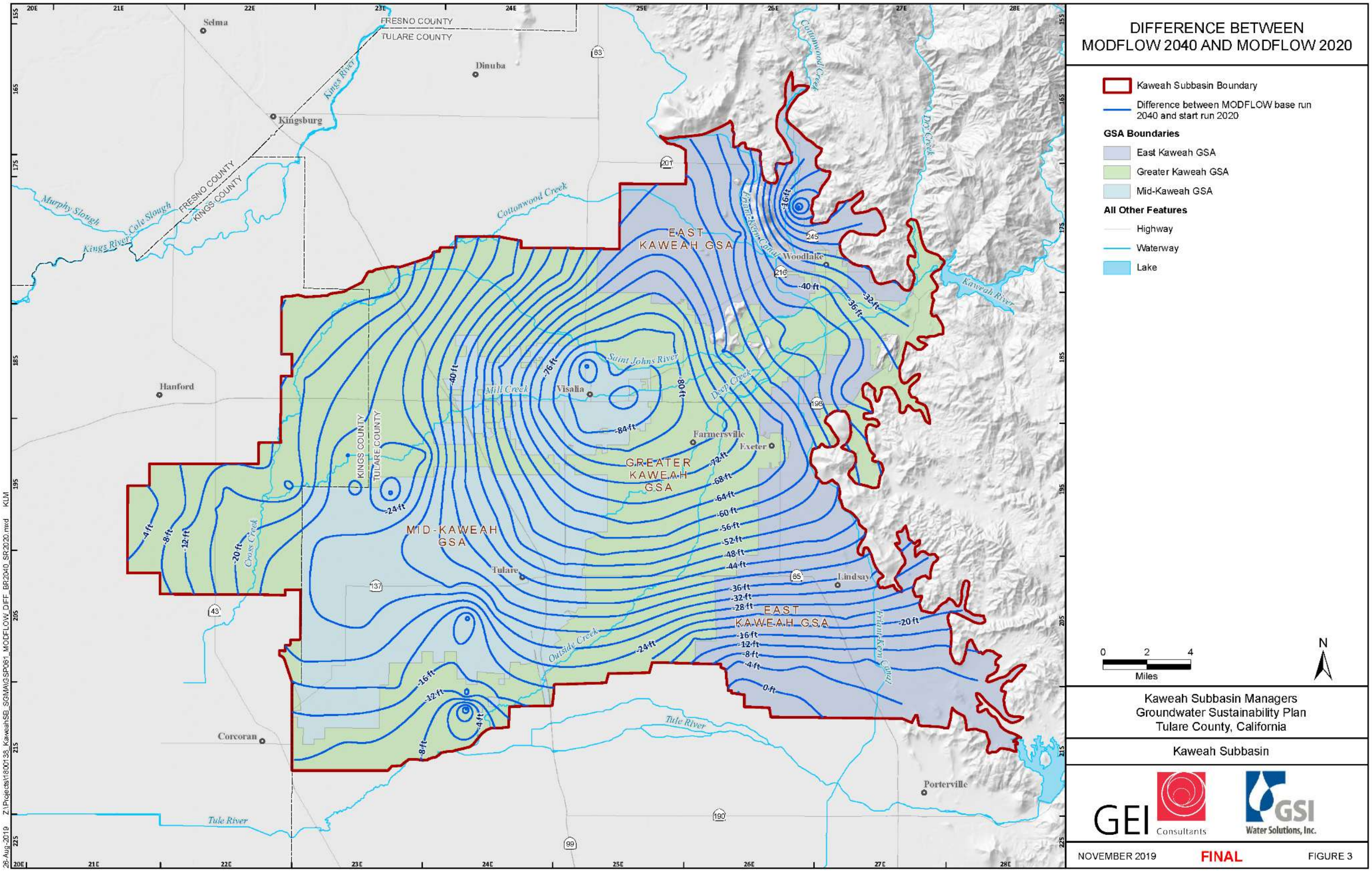


Figure 3: Map of Potentiometric Surface Changes from 2020 to 2040 under the Base Case with No Projects.

Recharge and Pumping Projections

As shown in the Basin Setting chapter of the GSP for the Kaweah Subbasin, climate change is projected to increase temperatures and evapotranspiration, leading to an equivalent increase in crop demands and groundwater pumpage. Percolation also increases with increases in the volume of applied irrigation water. The increase in evapotranspiration coupled with shifts in the seasonal patterns of precipitation could also affect changes to the quantity and timing of deep percolation and groundwater storage. With projected demands anticipated to increase by approximately 10 percent by 2040 (Table 34 of the Kaweah Basin Setting Report), a combination of demand management and recharge programs are required to close the deficit in the Projected Water Budget.

Surface water availability changes are incorporated as presented in the Projected Water Budget section of the Basin Setting document. This availability affects surface water delivery to crops and, by extension, groundwater pumpage to satisfy crop requirements. Surface water availability also impacts recharge along streams, ditches and recharge basins. Additional recharge (on-farm recharge) and recharge basins are included as future projects in the basin. In the interest of maximizing the surface water supply during wet periods, the future projects evaluated in modeling case 5 include on-farm recharge or other large-scale recharge projects.

Municipal pumping within each city and overall agricultural pumping within each GSA are adjusted as percentages of the base case scenario. Municipal pumpage is modeled as documented in the Basin Setting, in accordance with anticipated pumpage documented in urban water management plans. For the base period, irrigated agriculture demand averaged 1,055,700 AF/WY, which was satisfied by a combination of surface water and groundwater. Recent crop survey data indicate that this demand is from a variety of crops including almonds, alfalfa, citrus, cotton, grapes, olives, truck crops, walnuts, wheat and several others (Davids Engineering, 2018). Crop ET was derived for each of these crops for each year during the recent period of 1999 to 2017, based upon trends in water use for each crop. During the period, total water demand related to the growing of almonds has increased by 14 percent, while total water demand to satisfy miscellaneous field crops has declined by 18 percent. By considering all of the trends for a total of 16 crop categories on a net basis, the average change in crop water ET demand has been relatively unchanged, increasing modestly each year between 1999 and 2018. Future projection of crop demand to 2040 and 2070 indicates that agricultural demand will increase to 1,138,200 AF/WY in 2030 and 1,239,500 AF/WY in 2070, which includes projected climate change effects.

Changes in agriculture water use are implemented through cropping changes, land fallowing or other land-use conversion alternatives. Cropping changes are included in the no-action model runs (Case 1, 2 and 3) as presented in the Projected Water Budget section of the Basin Setting document. Land retirement is included as a management action in the fourth and fifth scenarios.

Each GSA is able to model separate reduced pumpage “ramp downs” and specific projects and management actions in increments of 5 years or less. The results of the numerical modeling are summarized at a GSA-level along with water level changes, hydrographs, and water budget components in 5-year increments from 2020 through 2040. The 5-year summaries allow the GSAs to determine the anticipated effectiveness of projects and management actions.

Agricultural pumping reductions are incorporated into the groundwater model relative to the baseline run for many of the predictive scenarios. Reductions in pumpage are specified in areas smaller than the GSA such as the scale of an entitlement holder or a water district. Pumpage reductions are also allowed to vary temporally. To accommodate these spatial and temporal variations within the model, a shapefile is developed of the areas where pumpage reductions are proposed and used to assign a proportional reduction in pumpage for modeling areas. Likewise, reductions of pumpage are assigned evenly throughout the agricultural pumpage at the GSA scale. Temporally, these reductions are assigned in approximately 5-year periods (such as 2021 - 2025 or 2026 - 2030) to allow sufficient time for planning operational changes. A relative adjustment is also applied to irrigation return flows to maintain consistency with the prescribed agricultural pumping reductions.

Change in water levels from the baseline can readily be summarized over specified pumpage areas at the end of each 5-year period. However, the groundwater zone budget determining underflow, change in storage, other groundwater model fluxes, and objectives are only computed at the GSA level.

Water from Management Actions and Projects

The impacts of Management Actions and Projects on reducing average annual water deficits in the Kaweah Subbasin over the implementation period 2020 to 2040 are shown in Table 4. The water deficit reductions are provided in thousands of acre-feet per year. Separate values are shown for the Management Actions (Case 4) and the combined impact of Projects and Management Actions (Case 5) for East Kaweah GSA, Greater Kaweah GSA and Mid-Kaweah GSA. Summary results for the full Kaweah Subbasin are also provided. For Mid-Kaweah GSA, the proposed Management Actions are included in Case 4 while Case 5 includes only proposed Projects without Management Actions. This is because Management Actions in Mid-Kaweah GSA include reoperation of existing projects such as capturing and storing local or regional flood flows that would otherwise leave the subbasin and operating existing Packwood Creek recharge facilities.

Table 4: Water Deficit Reduction from Projects and Management Actions in Thousands of Acre-Feet per Year

	Water Deficit Reduction (1000 Acre-Feet/Year)							
	East Kaweah GSA		Greater Kaweah GSA		Mid-Kaweah GSA		Kaweah Subbasin	
Water Year	Case 4: Management Actions	Case 5: Total	Case 4: Management Actions	Case 5: Total	Case 4: Management Actions and Existing Projects	Case 5: Projects without Management Actions	Case 4: Management Actions	Case 5: Total
2020	0	1.8	3.3	12.7	5	5	8.3	19.5
2021	1.5	5.1	4.5	14.2	5	5	11	24.3
2022	1.5	8.3	4	13.7	5	5	10.5	26.9
2023	1.5	8.3	8	77.4	5	5	14.5	90.6
2024	1.5	11	4	14.2	5	5	10.5	30.2
2025	7.5	14.5	4.5	14.7	5.6	10	17.6	39.2
2026	7.5	23.5	16.3	26.4	6.3	10	30	59.9
2027	7.5	23.5	16.3	99.3	6.9	10	30.6	132.8
2028	7.5	23.5	16.3	26.6	7.5	10	31.3	60
2029	7.5	23.5	16.3	26.6	8.1	10	31.9	60
2030	16.5	27	16.3	26.6	8.8	15	41.5	68.5
2031	16.5	27	36	130.1	9.4	15	61.9	172.1
2032	16.5	27	36	46.5	10	15	62.5	88.4
2033	16.5	27	36	46.5	10.6	15	63.1	88.4
2034	16.5	27	36	46.5	11.3	15	63.8	88.4

2035	30	30.5	36	140	11.9	15	77.9	185.5
2036	30	30.5	65	75.6	12.5	15	107.5	121.1
2037	30	30.5	65	75.6	13.1	15	108.1	121.1
2038	30	30.5	65	75.6	13.8	15	108.8	121.1
2039	30	30.5	65	172.6	14.4	15	109.4	218
2040	30	30.5	65	75.6	15	15	110	121.1
Min	**0**	**1.8**	**3.3**	**12.7**	**5**	**5**	**8.3**	**19.5**
Max	**30**	**30.5**	**65**	**172.6**	**15**	**15**	**110**	**218**
Mean	**14.6**	**21.9**	**29.3**	**58.9**	**9**	**11.4**	**52.9**	**92.2**

The results show that proposed management actions (case 4) in the Kaweah Subbasin could yield approximately 52,900 acre-feet per year of reductions in water deficit. Case 5 results in a total water deficit reduction of 92,200 acre-feet annually on average and in the last five years the deficit reduction is 121,000 acre-feet which implies that the projects alone would yield 39,300 acre-feet per year. The Kaweah Subbasin Basin Setting Report estimates the basin Safe Yield at 720,000 acre-feet per year and the average annual groundwater pumping in the basin during the current water budget period is 798,000 acre-feet. Therefore, a reduction in deficit of 121,000 through the implementation of projects and management actions will ensure that we are operating within the safe yield of the basin. The Greater Kaweah GSA contributes to 64% of deficit reduction while East Kaweah and Mid-Kaweah contribute 24% and 12%, respectively. Implementation of most management actions increases gradually in each GSA over the 20-year planning horizon but with some stepped increases occurring approximate every five years. Projects in East Kaweah and Mid-Kaweah steadily reduce water deficits within their respective GSAs over the planning horizon. However, in Greater Kaweah, the projects yield gradually increasing volumes of water punctuated by large recharge volumes during wet years which are assumed to recur every four years.

Figure 4 shows contours of difference in 2040 water levels between the base no-action scenario and the scenario in which management actions are implemented but with no projects. The introduction of Management Actions would result in an overall rise in 2040 water levels relative to the no-action scenario. The largest improvements occur in the area between Cottonwood Creek and Saint Johns River with water levels rising up to 28 ft. Rises of over 20 ft are seen in other across the middle of the subbasin, stretching from areas along Mill Creek near Visalia to the Friant-Kern Canal near Lindsay.

Figure 5 shows contours of difference in 2040 water levels between the base no-action scenario and the scenario with full implementation of proposed projects and management actions. Under this scenario, the largest improvements in water levels of over 52 ft occur along Saint Johns River and Deep Creek, just west of Mckays Point. Improvements of over 40 ft are also seen between Mill Creek and Cross Creek near Remnoy.

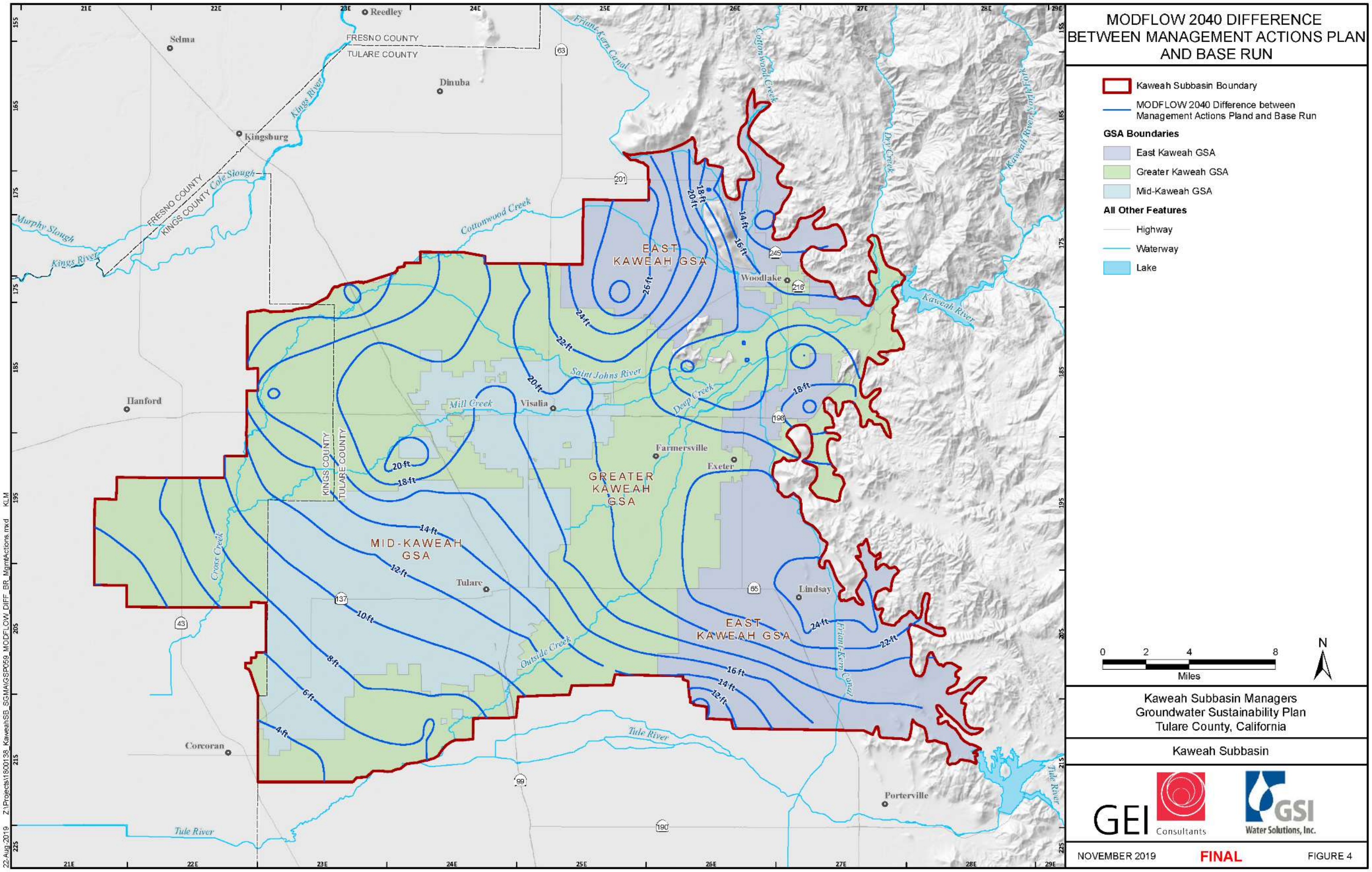


Figure 4: Map of Differences in Potentiometric Surfaces between Base Case 1 with No Projects and Case 4 with Management Actions Only in 2040.

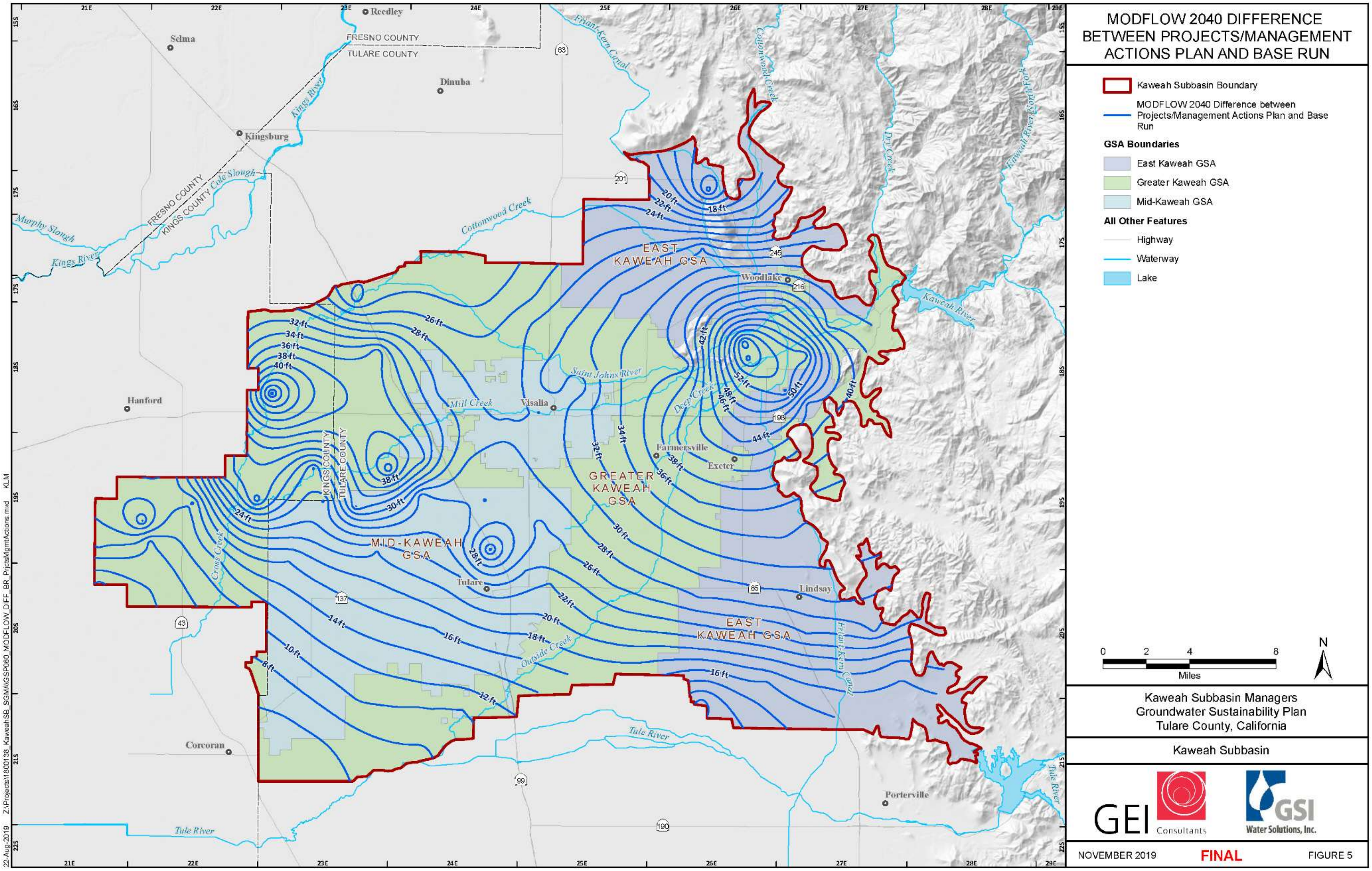


Figure 5: Map of Differences in Potentiometric Surfaces between the Base Case 1 with No Projects and Case 5 with Management Actions and Projects in 2040.

Summary Results for Kaweah Subbasin

The impacts of the management actions and projects on groundwater fluxes and storage in the basin for the five modeling cases analyzed are summarized in Table 5. For each run, fluxes are presented for the initial water year (2020) followed by average fluxes for the next 5-year period. Inflow fluxes presented include recharge, underflow entering the Kaweah Subbasin from surrounding buffer zone, and total inflow fluxes. Outflow fluxes presented include pumping from agricultural wells, aquifer discharge to streams, pumping from non-agricultural wells, underflow discharged from the Kaweah Subbasin to the surrounding buffer zone, and total outflow. Annual rates of change in storage and cumulative storage changes at the end of each period are also presented.

The results show that for Base Case 1, water deficits would continue to increase steadily through the planning horizon, reaching a cumulative storage decline of 1.5 million acre-feet by 2040. The deficits increase during the period because total inflows increase by 7.7% while total outflows increase by 14.7%. While their total recharge fluxes are identical, simulations for the variable Case 2 and reversed variability Case 3 result in values of cumulative storage declines that are over 1.2 million acre-feet apart by 2040. The difference is mostly due to a difference in underflow into the Kaweah Subbasin of over 1 million acre-feet between the two cases. The reversal of fluxes also changes the water balance dynamics and results in intermediate storage deficits that are more severe in Case 3 than in Case 2. While future sequences of wet and dry water years cannot be predicted, the results suggest that Kaweah GSAs could benefit from contingency planning for interim deficits resulting from unfavorable water year sequences.

The results for Case 4 show that implementation of Management Actions could yield a 6% reduction in pumping from agricultural wells, resulting in a 4.4% reduction in total outflow relative to Case 1. Over the 20-year planning horizon, this translates to a 46% reduction in cumulative storage decline. The combination of Projects and Management Actions in Case 5 yields an 8.3% increase in recharge and a 2.8% reduction in total outflow. The net impact of the changes from Case 5 is a 79.9% reduction of the average annual storage decline from 71,500 acre-feet/year (or 1,501,901 acre-feet in 21 years) to 15,100 acre-feet/year (or 316,370 acre-feet in 21 years) from January 2020 to December 2040.

Table 5: Impacts of Projects and Management Actions on Groundwater Fluxes and Storage in the Kaweah Subbasin.

	Inflow (Acre-Feet/Year)			Outflow (Acre-Feet/Year)						
Period in Water Years	**Recharge**	**Underflow Buffer to KSB**	**Total Inflow**	**Ag Pumping**	**Aquifer Discharge to Stream**	**Non-Ag Pumping**	**Underflow KSB to Buffer**	**Total Outflow**	**Change in Storage (Acre-Feet/Year)**	**Cumulative Change in Storage (Acre-Feet)**
Case 1: Base Case of Future with Averaged Conditions and No Projects										
2020	676,105	185,429	861,534	726,105	0	101,360	60,420	887,886	-26,352	-26,352
2021 - 2025	674,117	206,914	881,031	747,316	0	108,481	62,235	918,032	-37,001	-211,359
2026 - 2030	674,117	218,869	892,987	783,289	0	120,729	64,877	968,895	-75,908	-590,899
2031 - 2035	674,106	236,257	910,364	803,716	0	132,728	64,898	1,001,341	-90,977	-1,045,786
2036 - 2040	674,566	253,312	927,878	813,133	0	141,028	64,940	1,019,101	-91,223	-1,501,901
Case 2: Future with Interannual Variability and No Projects										
2020	927,137	157,959	1,085,096	503,909	0	94,915	68,183	667,008	418,089	418,089
2021 - 2025	709,912	206,077	915,990	680,497	521	99,663	57,998	838,678	77,311	804,646
2026 - 2030	653,687	203,723	857,410	765,822	229	123,965	71,984	962,000	-104,590	281,694
2031 - 2035	666,604	225,936	892,540	810,017	213	143,603	88,081	1,041,913	-149,373	-465,173
2036 - 2040	618,801	274,083	892,883	945,506	55	135,831	81,597	1,162,989	-270,106	-1,815,704

Case 3: Future with Interannual Variability Reversed and No Projects										
2020	1,191,324	173,864	1,365,188	507,156	43	143,667	103,103	753,969	611,219	611,219
2021 - 2025	479,819	243,678	723,498	1,040,180	239	143,185	85,176	1,268,779	-545,282	-2,115,190
2026 - 2030	659,066	281,360	940,425	821,914	179	137,714	68,758	1,028,566	-88,140	-2,555,892
2031 - 2035	671,770	308,325	980,094	719,378	72	113,587	50,052	883,089	97,005	-2,070,868
2036 - 2040	780,164	276,155	1,056,320	606,836	520	94,432	58,089	759,876	296,443	-588,650
Case 4: Altered Future with Management Actions										
2020	681,104	184,922	866,026	722,860	0	101,360	60,625	884,845	-18,819	-18,819
2021 - 2025	679,116	204,412	883,529	739,493	0	108,481	63,114	911,088	-27,560	-156,619
2026 - 2030	679,116	210,690	889,805	755,265	0	120,729	67,164	943,158	-53,353	-423,384
2031 - 2035	679,116	217,985	897,100	743,447	0	132,870	69,283	945,600	-48,500	-665,881
2036 - 2040	679,611	220,124	899,735	712,386	0	144,094	72,166	928,646	-28,911	-810,436
Case 5: Altered Future with Management Actions and Projects										
2020	693,019	184,909	877,928	722,860	0	102,029	60,664	885,553	-7,625	-7,625
2021 - 2025	709,227	199,605	908,833	740,079	0	108,555	64,540	913,174	-4,342	-29,332
2026 - 2030	728,472	199,572	928,043	760,614	0	120,771	70,815	952,199	-24,156	-150,112
2031 - 2035	753,547	201,107	954,655	756,950	0	133,173	77,059	967,182	-12,526	-212,744
2036 - 2040	738,199	201,171	939,369	734,500	0	144,715	80,879	960,094	-20,725	-316,370

Summary Results by GSA

Summary Results for East Kaweah GSA

Table 6 is a summary of predictive modeling results for East Kaweah over the 20-year planning horizon. Case 4 and Case 5 result in the lowest annual water deficit (noted as "Change in Storage" in Table 6 and subsequent tables). The results indicated that implementation of Management Actions in Case 4 could reduce well pumping by 13,900 acre-feet/year and reduce the annual water deficit from 16,200 acre-feet/year to 6,600 acre-feet/year. The combination of Management Actions and Projects in Case 5 increases total inflow by 8,900 acre-feet/year, and the annual water deficit falls to 3,000 acre-feet/year.

Table 6: Summary of Predictive Modeling Results for East Kaweah in Acre-Feet per Year

Summary Results for East Kaweah GSA	Base Case 1	Variable Base Case 2	Reversed Variable Case 3	Management Actions Case 4	Management & Projects Case 5
Recharge	118,096	118,064	117,445	118,107	126,632
Inflow from Buffer Zone	48,298	42,370	50,735	45,408	44,830
Inflow from Greater Kaweah	34,417	36,925	33,253	34,643	38,227
Total Inflow	200,811	197,360	201,434	198,159	209,689
Pumping from Ag Wells	166,025	166,324	164,666	152,120	159,167
Aquifer Discharge to Streams		0	0		
Pumping from Non-Ag Wells	2,842	2,669	2,652	2,842	2,796
Outflow to Buffer Zone	6,267	6,048	5,661	6,563	6,574
Outflow to Greater Kaweah GSA	41,843	44,553	42,017	43,278	44,121
Total Outflow	216,977	219,595	214,996	204,803	212,658
Annual Change in Storage	-16,166	-22,235	-13,563	-6,644	-2,969

Summary Results for Greater Kaweah GSA

Table 7 shows a summary of predictive modeling results for Greater Kaweah over the 20-year planning horizon. In Greater Kaweah, the Reversed Variable Case 3 achieves better reduction in water storage decline than the Management Actions Case 4. However, the results of Case 3 are unreliable for planning as the reductions occur due to significant increases in uncontrolled inflow from the buffer region relative to Case 2. The results for Case 4 indicate that implementation of Management Actions could reduce well pumping by 29,100 acre-feet/year relative to Case 1 and reduce the annual water deficit from 37,300 acre-feet/year to 20,800 acre-feet/year. The combination of Management Actions and Projects in Case 5 increases total inflow by 15,500 acre-feet/year relative to Case 1, and the annual water deficit falls to 5,400 acre-feet/year.

Table 7: Summary of Predictive Modeling Results for Greater Kaweah in Acre-Feet per Year

Summary Results for Greater Kaweah GSA	Base Case 1	Variable Base Case 2	Reversed Variable Case 3	Management Actions Case 4	Management & Projects Case 5
Recharge	375,882	376,172	375,755	375,946	412,038
Inflow from Buffer Zone	177,354	180,487	219,638	165,516	153,823
Inflow from East Kaweah	41,843	44,553	42,017	43,278	44,121
Inflow from Mid-Kaweah	78,872	95,441	77,646	80,407	79,441
Total Inflow	673,950	696,653	715,056	665,148	689,424
Pumping from Ag Wells	469,694	470,276	468,868	440,620	440,625
Aquifer Discharge to Streams	-	242	242	-	-
Pumping from Non-Ag Wells	41,251	40,544	41,703	41,573	41,676
Outflow to Buffer Zone	48,322	58,435	53,653	51,085	55,910
Outflow to East Kaweah GSA	34,417	36,925	33,253	34,643	38,227
Outflow to Mid-Kaweah GSA	117,527	133,587	131,464	117,982	118,389
Total Outflow	711,211	740,010	729,182	685,903	694,826
Annual Change in Storage	-37,261	-43,357	-14,126	-20,755	-5,402

Summary Results for Mid-Kaweah GSA

Table 8 shows a summary of predictive modeling results for Mid-Kaweah over the 20-year planning horizon. In Mid- Kaweah, the Reversed Variable Case 3 achieves better reduction in water storage decline than Case 4 and Case 5. However, the results of Case 3 are unreliable for planning as the reductions occur due to significant reductions in uncontrolled outflows to Greater Kaweah. The results for Case 4 indicate that implementation of Management Actions could reduce well pumping by 4,000 acre-feet/year relative to Case 1 and reduce the annual water deficit from 18,100 acre-feet/year to 11,100 acre-feet/year. The combination of Management Actions and Projects in Case 5 increases total inflow by 5,300 acre-feet/year relative to Case 1, and the annual water deficit falls to 6,700 acre-feet/year.

Table 8: Summary of Predictive Modeling Results for Mid-Kaweah in Acre-Feet per Year

Summary Results for East Kaweah GSA	Base Case 1	Variable Base Case 2	Reversed Variable Case 3	Management Actions Case 4	Management & Projects Case 5
Recharge	180,338	180,627	180,391	185,275	191,817

Inflow from Buffer Zone	1,120	1,288	2,077	1,027	975
Inflow from Greater Kaweah	117,527	133,587	131,464	117,982	118,389
Total Inflow	298,985	315,503	313,932	304,284	311,181
Pumping from Ag Wells	148,251	149,738	149,738	144,204	147,046
Aquifer Discharge to Streams	-	-	-	-	-
Pumping from Non-Ag Wells	80,488	81,083	78,895	80,930	81,152
Outflow to Buffer Zone	9,466	10,111	7,995	9,936	10,236
Outflow to Greater Kaweah GSA	78,872	95,441	77,646	80,407	79,441
Total Outflow	317,077	336,373	314,274	315,477	317,875
Change in Storage	-18,092	-20,870	-342	-11,193	-6,694

Conclusions and Recommendations

The Kaweah Subbasin Basin Setting Report estimates the basin Safe Yield at 720,000 acre-feet per year and the average annual groundwater pumping in the basin during the current water budget period is 798,000 acre-feet. Therefore, a reduction in deficit of 121,000 acre-feet through the implementation of projects and management actions will ensure that we are operating within the safe yield of the basin.

Through the five-year GSP assessment process and continued dialogue with neighboring subbasins as to their role in influencing the changes in storage within the Kaweah Subbasin, we expect to have improvements in our understanding of boundary conditions. Future updates to the groundwater model are expected to show stabilized groundwater levels through the implementation of the projects and management action considered in the GW modeling study. If residual storage reductions remain from these future modeling scenarios analyzed at the five year update, the GSAs will take further action to stabilize groundwater levels and reductions in storage with the implementation of additional projects and/or accelerated implementation of management actions designed to reduce groundwater extractions.

Under some modeling scenarios (such as the Reversed Variable Case 3), water levels within the buffer region can become misaligned with changing water levels within the subbasin. The misaligned water levels can significantly alter the amount of inflow or outflow moving across the buffer region or between neighboring GSAs, altering the patterns of water storage declines. Such transboundary flows are not sustainable over the long term and should not be relied upon to achieve sustainability targets. Future groundwater modeling efforts should identify approaches to account for transboundary flows to ensure reduction in water storage decline are achieved through sustainable approaches.

The Kaweah Subbasin groundwater model produced a fit between measured and model-generated data with a relative error of 3% in layer 1 and 10.7% in layer 3 during model calibration. This was determined to be an adequate fit for the planning model for GSP development. As the Kaweah Subbasin GSAs move from plan development to implementation, it is recommended that further resources be dedicated to the calibration of the model to enhance its accuracy and reliability as a decision-making tool.

Appendix 1: Model Approach and Verification

Introduction: Kaweah Groundwater Modeling

The purpose of this update is to communicate the current progress of the groundwater modeling efforts for Kaweah Subbasin. It was compiled from materials originally published on the Kaweah Subbasin website in March 2017 under the heading "Review of Existing Kaweah Subbasin GW Models and Approach for Model Development to Support GSP".

Early in 2017, the GEI Consultants, Inc. (GEI) and GSI Water Solutions, Inc. (GSI) teams prepared a Technical Memorandum (TM) to evaluate the groundwater models available for use in development of the Groundwater Sustainability Plans (GSP) for the three Groundwater Sustainability Agencies (GSA) in the Kaweah Sub- Basin (Subbasin). That TM, dated March 8, 2017, presented the significant comparative details of three numerical groundwater flow models that cover the Sub- Basin, including:

- Kaweah Delta Water Conservation District (KDWCD) Groundwater Model,
- Central Valley Hydrologic Model (CVHM), and
- California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) coarse grid and fine grid variants.

The March 2017 TM identified the water budget from the most recent update of the KDWCD Water Resources Investigation (WRI) as an accounting "model", but it is essentially a water accounting analysis that uses water consumption and soil moisture models. It is not a three-dimensional, numerical groundwater flow model, but is a valuable analysis that will be used as primary inputs to the groundwater model. The March 2017 TM recommended use of the KDWCD Groundwater Model as the preferred tool for Sustainable Groundwater Management Act (SGMA) applications based upon its relative ability to address the potential model needs cited in SGMA regulations. Model selection criteria used in the TM included: model availability; cost of development and implementation; regulatory acceptance; suitability for GSP-specific analyses; and relative abilities to assess Subbasin water budget components, future undesirable results, and impacts of future management actions and projects.

More recently, the Kaweah Management Team, consisting of the East Kaweah, Greater Kaweah, and Mid-Kaweah Groundwater Sustainability Agencies (EKGSA, GKGSA, and MKGSA) approved a scope of work to develop a Subbasin wide numerical groundwater model to support GSP development and implementation. Efforts related to groundwater model development and use of the calibrated tool were generally defined within three tasks, as follows:

- Task 1 — Perform a technical assessment of existing groundwater models that cover the Kaweah Subbasin, with emphasis on the KDWCD Model, and develop an approach to update and revise the selected source model as required to support the objectives of the GSP.
- Task 2 — Perform model revisions and updates for the selected groundwater model as documented in Task 1, with a focus on supporting GSP objectives.
- Task 3 — Apply the updated model predictively for each GSA and cumulatively for the entire Subbasin to simulate future conditions, with and without potential management actions and projects proposed to support GSP implementation.

This TM documents the results of Task 1. GEI and GSI (the Modeling Team), as part of supporting Subbasin SGMA compliance, have evaluated the existing KDWCD Groundwater Model for update to simulate the entire Subbasin and relevant adjacent areas. The following presents technical details and performance aspects of the KDWCD Model and proposes a general approach for utilizing the model to support development of the GSP. Specifics of this approach may change over the course of model development as dictated by data constraints and improved conceptualization provided by the updated Subbasin Basin Setting developed through the Management Team. This TM and associated analyses satisfy Task 1 requirements, including:

- Perform a detailed evaluation of the existing KDWCD groundwater model inputs and outputs, including test runs and simulations, comparisons with water budget data, and a general comparison with regional C2VSim and CVHM models.
- Develop a plan to move forward with the model update, including assessment of status of required hydrogeologic data, updates to model area, parameters, fluxes, spatial framework, stress periods, validation periods, and calibration periods and general approach for the model domain.
- Prepare a TM summarizing the path forward for modeling support of the GSP, including technical coordination with adjacent basin GSA representatives regarding groundwater modeling methods and assumptions.

Additionally, the Modeling Team will present the key findings of this TM in a workshop for representatives of the Subbasin GSAs. This working session will allow GSA representatives to better understand the model design and capabilities as well as provide a forum for discussion of current, future, and outstanding data as well as planning needs for model development and predictive simulations.

After submittal of this proposed modeling approach and path forward, the Modeling Team will execute the recommended actions described in this document. Once updated, the Modeling Team is recommending adoption of the name Kaweah Sub- Basin Hydrologic Model (KSHM) for this new SGMA tool to differentiate it from the previous modeling efforts and to reflect the fact that it includes complex hydrologic analyses in addition to groundwater flow.

The Modeling Team previously performed a cursory review of pertinent aspects affecting the efficient use of the three major groundwater modeling tools that cover the Subbasin. This TM is built upon that analysis and includes a more in-depth assessment of the newly released beta version of the C2VSim model provided by the California Department of Water Resources (DWR). Although the results of the March 2017 analysis were reinforced with findings from this review, the Modeling Team also looked at the datasets contained within these valuable, regional modeling tools to see if they may be of use in the development of the KSHM.

CVHM is an 11-layer model that covers the entire Central Valley. It has a spatial resolution of one square mile and includes both a coupled lithologic model and Farm Process module (model) that are used to estimate hydraulic parameters and agricultural groundwater demand and recharge, respectively. The CVHM was previously deemed not to be a viable modeling alternative for the Subbasin analyses by the Modeling Team due to several factors. Most significant of these is the fact that the model data is only current to 2009, well before the SGMA-specified accountability date of 2015. The model resolution is also not suitable to reflect all water budget components at the precision required to assess past and current groundwater responses to water management within each GSA. The CVHM is also not suitably calibrated nor reflective of the hydrostratigraphy in the Subbasin and does not match the higher resolution and more accurate crop and related groundwater pumping estimates produced by Davids Engineering, Inc. (Davids Engineering) time-series analysis of evaporation and applied water estimates for the KDWCD; soon to be provided for the entire Subbasin through water year 2017.

Lastly, the use of the Farm Process is cost prohibitive, given the fact that it would have to be rigorously calibrated to the evapotranspiration and deep percolation estimates already provided by the Davids Engineering analysis.

The DWR-supported C2VSim Fine Mesh Beta Version was assessed in greater detail as part of the development of this modeling approach. Like CVHM, the C2VSim fine mesh does not include the high resolution of crop demands and surface water deliveries that are in the existing KDWCD model and can be easily updated with the KSHM. It also does not have the element resolution, flexibility to change fluxes, cost savings, and GSA-level accuracy of a sub-regional model designed to incorporate the highest resolution and locally accurate consumptive use and recharge information available. The Modeling Team assessed model layering, significant water budget components, storage change, and groundwater level elevation changes used in C2VSim relative to KDWCD monitoring well locations. The previous KDWCD model produced a better match for the data and estimates from the WRI, and at a significantly higher resolution. Simulated storage change within the Sub- Basin was greater than that estimated by C2VSim by over 20,000 acre-feet per year (AFY); without documentation of how the quantification of water budget components was performed. Calibration of regional flow directions and gradients were reasonable but not as accurate nor locally refined as that observed with the KDWCD modeling efforts.

The beta version of the C2VSim model is not currently considered to be calibrated in a quantitative sense, and no documentation is publicly available to assess the resolution or accuracy of the model inputs for the Subbasin. Because of our analysis and comparison of the C2VSim Fine Mesh Beta Model with the water budget and groundwater conditions from the WRI and the draft Basin Setting; the C2VSim was deemed to be a viable source of regional information to supplement development of the KSHM. However, relative to a modeling approach using the KSHM, the C2VSIM model would not provide a more accurate or cost-efficient option for satisfying SGMA regulations.

The KDWCD Groundwater Model was originally developed by Fugro Consultants, Inc. (Fugro) under the direction and sponsorship by KDWCD. Model development was documented in the report "Numerical Groundwater Flow Model for the Kaweah Delta Water Conservation District, Final Report" (April 2005). The objective of the model was to simulate the water budget estimates as refined under the WRI in 2003 and evaluate calibrated groundwater elevations, and modeled fluxes to and from adjacent subbasins.

In May 2012, the KDWCD model was expanded to the east and southeast by Fugro to include the service areas of the Cities of Lindsay and Exeter, and adjacent irrigation districts, including: the Lewis Creek Water District; some unincorporated land and significant portions of Exeter Irrigation District, Lindmore Irrigation District, and Lindsay-Strathmore Irrigation District. The purpose of this effort was to update only the geographic extent, and it did not include updates to the simulation period or the calibration. The model was intended to be updated, refined, and improved in the coming years to provide a rigorously calibrated model over this larger extent, but this proposed work was not performed prior to initiation of SGMA and GSP development efforts.

Modeling Code and Packages

The KDWCD model was developed using MODFLOW 2000. MODFLOW, developed and maintained by the United States Geological Survey (USGS), is one of the most commonly used groundwater modeling codes in the world and is considered an industry standard. The pre- and post-processing of groundwater model data was performed using Groundwater Vistas, a third-party graphical user interface (GUI) that is among the most commonly used software in the groundwater industry to facilitate the use of MODFLOW.
The previous two KDWCD model variants used the following MODFLOW modules, or "packages":

- Well Package (WELL) Recharge
- Package (RCH)
- General Head Boundary (GHB) Package

MODFLOW utilizes large text files of numerical values as input files that provide the model with the values of various physical parameters and fluxes; all incorporated into the three-dimensional (3D) model structure. Much of the pre-processing and spatial organization of the data used to develop the MODFLOW input files was accomplished by Fugro using customized FORTRAN routines, as well as a geographic information system (GIS). Because of more recently available evapotranspiration and applied water estimates from Davids Engineering, the use of these FORTRAN routines is no longer necessary; providing a significant cost and time savings.

A summary of the construction and implementation of various water budget components into these model packages is discussed in following sections.

Model Extent and Discretization

The spatial extent of the KDWCD model is presented in Figure 1. The figure displays the original model extent as well as the expanded extent to the east from the 2012 update. The model extends approximately twelve miles from east to west and 7.5 miles from north to south. It is composed of uniform 1,000 foot by 1,000- foot model cells for each layer.
There are some areas of the Subbasin that are not currently within the model domain (Figure 1), including much of what is now the EKGSA area. To evaluate the entire Subbasin area, in support of SGMA, it will be necessary to expand the model area to include all of the areas within the Subbasin. The updated model must also have shared boundaries and shared buffer zones with all adjacent groundwater sub- basins, as well as an evaluation of subsurface inflow and outflow (underflow) between the subbasins. Figure 2 shows the proposed, expanded model grid for the new KSHM extent.

Model Layers

The KDWCD model is vertically discretized into three layers as shown on hydrogeologic cross sections shown on Figures 3, 4, and 5. These hydrogeologic cross sections show the principal aquifers, aquitard, and associated geologic units located throughout the Subbasin. Layer 1 represents the unconfined, basin sediments from the ground surface down to the Corcoran Clay in the western portion of the model domain or deeper; also including some older Quaternary alluvial deposits in the eastern portion of the domain. Layer 2 represents the Corcoran Clay, which is the primary aquitard in the Subbasin, where it is present in the western portion of the domain. In the eastern portion of the model area, where the Corcoran Clay pinches out, Layer 2 is simply represented with a minimal thickness and hydraulic parameters comparable to those of Layer 1. Layer 3 represents the largely confined basin sediments below the Corcoran Clay, where it is present, and deeper unconsolidated sediments to the east of the occurrence of this regional confining unit.

Although some of the regional models covering large areas of the Central Valley (i.e., CVHM and C2VSim) have a more highly discretized vertical layering, the Modeling Team believes that the three-layer conceptual model represented in the KDWCD model is justified given the available data and therefore suitable for the primary modeling objectives that support GSP development.

Model Simulation Time Periods

The KDWCD model was originally set up with 38 6-month stress periods to simulate the 19-year (calendar) calibration period of 1981 through 1999. Water budget components as documented in the 2003 WRI were used as input into the model and spatially distributed to the degree feasible given the spatial resolution and precision of the data sources and model grid.

It is likely that, after any recommended changes to the KDWCD model are implemented into the KSHM, the Modeling Team will calibrate the model through water year 2017 and perform validation simulations to confirm that the previous calibration developed with the historic WRI information is a suitable starting point the new simulation period. After validation, additional model refinements and updates can proceed to further improve the predictive capabilities of the KSHM using the aforementioned recent, high-resolution datasets as well as updated Basin Setting information.

Model Parameters

- **Hydraulic Conductivity/Transmissivity.** Hydraulic conductivity values are documented in the 2005 Model Report as well as in previous iterations of the WRI and conform with industry-standard literature values for the types of aquifer materials encountered at these depth intervals. Calibrated, horizontal hydraulic conductivities for Layer 1 (upper, unconfined aquifer) range from 50 feet/day (ft/d) to 235 ft/d, with the highest values in the southwest portion of the model area. Horizontal hydraulic conductivities for the portion of Layer 2 representing the Corcoran Clay were set at 0.024 ft/d. In the eastern area of Layer 2, where the Corcoran Clay pinches out, hydraulic conductivity values range from 50 to 150 ft/d and are essentially equal to the values assigned to the same area in Layer 1. Horizontal hydraulic conductivities for Layer 3 range from 25 ft/d to 125 ft/d. This distribution of hydraulic conductivity is consistent with previously published estimates from both the WRI and industry-standard literature estimates for the lithologies encountered.
- **Vertical Hydraulic Conductivity.** Vertical hydraulic conductivity in the model is set to a ratio of the estimated horizontal hydraulic conductivity, or an anisotropy ratio of 1:1. This means that the vertical hydraulic conductivity of the Corcoran Clay was assumed to be equal to its horizontal conductivity and was apparently based upon the extensive perforation of the Corcoran Clay and other aquifer units by fully penetrating wells. This perforation of the regional aquitard allows for greater hydraulic connection between the upper and lower aquifer units. The Modeling Team will assess the validity of this anisotropy ratio during the validation simulation and adjust where merited.
- **Storage Parameters.** Specific yields in the unconfined aquifer (Layer 1) range from approximately 8% to 14%. Storage coefficients for the confined areas were set at an order of magnitude of approximately 1 x 10-4. The storage coefficients used for the unconfined and the confined portions of the model are typical of those found in the basin and documented in the WRI as well as other commonly referenced literature for large basin fill valleys.

Model Boundary Packages and WRI Water Budget Components

As mentioned previously, the KDWCD model uses three MODFLOW packages: WELL, RCH, and GHBs. A discussion of how those packages are used follows below.

- **Well Package (WELL).** As currently constructed, the KCWCD model represents the following WRI water budget components; which were calculated outside of the model Groundwater Vistas graphical user interface (GUI) using GIS and a FORTRAN routine that are unavailable to the Modeling Team. The flux values specified in the WELL package input files are essentially "lumped" fluxes representing the sum of the following water budget components:
    - Well pumpage (outflow)
    - Rainfall-based recharge (inflow)
    - Irrigation return flows (inflow)
    - Ditch loss (inflow)
    - Recharge basins (inflow)

The compilation of multiple water budget components into a single MODFLOW package makes tracking and assessment of the individual water budget components from model simulations difficult. Additionally, this model flux accounting approach and design makes evaluation of possible changes in the water budget because of management actions, changes in water demand or availability, and groundwater projects problematic. Because of this lumping of separate water budget components, every cell in Layer 1 is represented in the WELL Package. This makes the exact validation of the test runs and verification of the calibration with the WRI challenging. Without access to the spatial and temporal distributions of all water budget components utilized by Fugro, it is not possible to recreate the exact WELL package input file. However, the gross water budget inflow, outflow and storage values from the earlier WRI's match those simulated by the model and were reproduced by the Modeling Team.

- Recharge Package (RCH). The natural stream channels of the St. John's and the Lower Kaweah Rivers are represented in the model using the MODFLOW RCH Package. The RCH package applies a flux (ft/yr) in the surficial (shallowest) cells at the location where applied. The natural seepage flux values (or groundwater recharge) applied to the model correspond to the values of stream infiltration spatially estimated for these rivers and documented in the WRI.
- General Head Boundaries (GHB). The KDWCD model has GHBs assigned to all cells on the exterior perimeter of the model, as seen on Figure 1. GHBs are commonly used to represent the edges of a model domain within a larger aquifer extent. Reference heads (groundwater elevations) and "conductance" terms for adjacent aquifers just outside the model domain are used by this package to calculate fluxes in and out across the boundary. The Modeling Team generally agrees with the use of GHBs in the north, south, and west portions of the Subbasin. However, we propose the removal of the GHBs along the eastern portion of the subbasin at the Sierra Nevada mountain front. Conceptually, the eastern model boundary, especially with the expansion and inclusion of the EKGSA area, is not a head-dependent boundary, but a flux-dependent one based on mountain front recharge and seepage from natural drainages and streams adjacent to relatively impermeable material. Thus, this boundary is better represented using a no-flow condition coupled with a recharge or prescribed underflow component.

Previous WRIs have included estimates of inflow and outflow across the study boundaries, and comparisons between modeled and calculated values vary significantly both spatially and by magnitude. However, there are several variables that directly impact estimated underflow values that have not been sufficiently constrained, due to the focus of previous work being on the interior of the KDWCD area. Recently updated basin conditions, improved understanding of appropriate regional groundwater conditions adjacent to the Subbasin and use of an expanded model area will significantly improve the certainty of these underflow estimates.

- Model Calibration. Calibration of the KDWCD model for the historic simulation period of 1981-1999 is discussed in the April 2005 model report. These include charts of observed versus modeled water levels for three different time periods and transient hydrographs for 30 target well locations. The density of calibration targets was deemed adequate by the Modeling Team for a model of this area and with the resolution of the model input datasets. Detailed calibration statistics are not documented in the report, but qualitative inspection of the hydrographs indicates that the calibration is adequate for future use in predictive simulations. Additionally, an open-source and industry-standard parameter estimation and optimization algorithm and code (PEST) was used to enhance model calibration. This is a common and robust industry practice that typically improves model calibration statistics.

Adequacy of the KDWCD Groundwater Model for GSP Development

Layering Scheme. The 3-layer model layering scheme incorporated into the KDWCD model was deemed adequate by the Modeling Team for use in GSP analyses, and likely does not need significant revision prior to use. This decision was based upon the agreement of the model layers with the hydrogeologic conceptual model for the Subbasin as well as the ability of the previous model to simulate historic fluctuations in groundwater elevations over an extensive spatial extent and temporal period. However, should the refinement of the lithologic and stratigraphic understanding of the basin and identification of specific pumping intervals require additional vertical resolution, both Layer 1 and Layer 2 can be split into two layers to improve the model's ability to match and describe key vertical gradients and changes in groundwater level elevations and pressures near prominent pumping centers. At present, this vertical refinement is not required nor supported by data.

Model Area. The model area will need to be expanded so that the entire Subbasin is included in the model. In addition, at the request of and in coordination with the technical groups for both Kaweah and adjacent subbasins, a buffer zone will be included outside the defined Subbasin boundaries so that adjacent models will overlap and share model input and monitoring data. This overlap will assist in reconciling differences between the direction and magnitude of groundwater gradients along subbasin boundaries. The preliminary extent of this buffer zone is proposed to be approximately 3 miles; however, this value will be revised in areas based on of the estimated locations of pervasive groundwater divides or apparent hydrologic boundaries.

Cell Size. The 1,000 feet square cell size appears to be adequate for the data density for most model inputs. However, due to improvements in computing speed and power, the Modeling Team recommends initially using a smaller cell size of 500 feet square to 1) accommodate improvements in assigning real world boundaries to the model grid, and 2) leverage the improved resolution of crop demand and evapotranspiration data available for this effort.

Parameters. Hydraulic conductivity and storage parameters will remain unchanged at the start of model revisions and calibration scenarios. These will be adjusted if the Modeling Team determines it is necessary during the model validation run or if model calibration standards require parameter refinements.

Stress Periods. The previous temporal discretization of the model incorporated 6- month stress periods. To appropriately characterize seasonal rainfall, surface water delivery and pumping patterns; one-month stress periods should be adopted for predictive simulations. This decision will be finalized after review and conditioning of the input groundwater demand and recharge datasets.

With these revisions to the model framework and geometry of the KDWCD model to support the development of the KSHM will be adequate for use to support GSP analyses. The following section summarizes additional, recommended revisions to the organization of the model inputs, parameters, boundary conditions, and MODFLOW packages.

Proposed Revisions to KDWCD Groundwater Model and Model Approach

The Modeling Team concludes that the KDWCD model is suitable to support GSP development if the following revisions and refinements to the model are performed to develop the KSHM. As mentioned above, once updated, the Modeling Team is recommending adoption of the name Kaweah Subbasin Hydrologic Model for this new SGMA tool. This nomenclature is based upon that fact that this model incorporates more than simply a groundwater model in the final analysis. It also incorporates crop demand/evapotranspiration (with precipitation modeling) and applied water models.

The Modeling Team recommends that the relationships between the water budget components, as defined in the WRI (December 2003, revised July 2007), and the MODFLOW modeling packages currently available, be re-organized such that lumping of different water budget components within single MODFLOW packages is minimized. Some degree of aggregation may be unavoidable, but efforts will be made to apply unique water budget components from the updated WRIs and associated water budget components to more appropriate and recent MODFLOW packages.

Additionally, we will utilize features of MODFLOW and Groundwater Vistas that allow for tracking of unique components within a single model package when possible. The current and proposed revised conceptual assignments of water budget components to MODFLOW packages are summarized below.

A major change and advantage of this effort relative to previous modeling work involves the availability and use of time-series evapotranspiration and applied water estimates from 1999 through water year 2017, provided by Davids Engineering. This data set uses remote sensing imagery from Landsat satellites to estimate agricultural water demand throughout the Subbasin at a very high resolution (approximately 30 meters). This information was not available for previous model builds, and its use will not only improve the understanding and accuracy of agricultural water requirements relative to the previous land use and soil moisture balance calculations that have been used, but also enhance the spatial calibration and predictive capability of the updated and expanded KSHM. The Davids Engineering dataset also includes estimates of deep percolation of applied water and precipitation. During the review of the KDWCD model and development of this modeling approach, the Modeling Team performed testing of the use of this dataset and was able to readily develop crop requirements and associated pumping estimates at a resolution even finer than the proposed model resolution.

Well Pumping. Groundwater pumpage will be the dominant water budget component represented in the WELL package. Other, more limited fluxes may also be used to represent mountain front fluxes or other unforeseen fluxes that are specified but do not have a specific package that is appropriate. All pumpage will be coded within the WELL package input files to identify the pumping by source, use, or entity. Municipal wells will be specifically located and simulated when well permits and required data reports are accessible and provide data specific to each well. Agricultural well pumpage will likely be spatially averaged, or "spread across", irrigated areas because of the uncertainty associated with irrigation well location, construction, and monthly or seasonal pumping rates.

Precipitation-based recharge. The Modeling Team proposes to represent this water budget component using the Recharge package.

Natural channel infiltration. Infiltration of surface water in the natural stream channels of the St. John's and the Lower Kaweah Rivers is currently assigned to the Recharge Package. The Modeling Team proposes to maintain this data in the recharge package along the spatial location of the courses of the rivers. If deemed appropriate and more beneficial the latest version of the Stream Package (SFR2) may be used for localized reaches of continuously flowing water, where gages do not adequately monitor seepage that can be applied directly as recharge. The Stream package calculates infiltration (inflow) to the aquifer based on defined parameters regarding bed geometry and vertical conductivity, and this will likely involve some iterative re-definition of STREAM package components to accurately portray the calculated water budget component flux. Native evapotranspiration (ET), where relevant, will be subtracted from either the precipitation or natural channel infiltration modules. The inclusion of natural, riparian ET will be addressed specifically upon finalization of the water budget for the Subbasin.

Man-made channel recharge. (i.e., ditch and canal loss). This is currently incorporated with four other water budget components as a single summed value in the Well Package. The Modeling Team proposes to represent this water budget component using either the Recharge package or another Type 3 boundary condition type, such as a prescribed stage above land surface. Should another more advanced MODFLOW module prove to more effective in simulating this flux, it will be utilized, and the reasoning documented in the model development log.

Irrigation Return Flows. Irrigation return flows are the component of the water budget that infiltrates into the subsurface due to over-watering of crops. This is currently incorporated with four other water budget components as a single summed value in the Well Package. The Modeling Team proposes to represent this water budget component using the Recharge package, but to differentiate it from precipitation-based recharge within Groundwater Vistas by assigning zone identifiers that are different from the rainfall-based recharge.

Artificial Recharge Basins. This is currently incorporated with four other water budget components as a single summed value in the Well Package. Recharge basins are likely to be a common management strategy to help achieve sustainability in the Subbasin. As such, the model should be able to individually represent each recharge basin. These could be represented in the Recharge Package or other more sophisticated module if specifically merited.

Lateral Model Boundaries. These are currently simulated using the GHB Package. We will maintain this concept, but the locations of the GHBs will be moved to locations beyond the edge of the Subbasin up to the extent of the expanded model area. Assigned reference heads for the GHB cells will be based on observed groundwater elevations from historic groundwater elevation maps. GHB head assignments for predictive runs may be lowered over time if current trends indicate declining water levels over the next 20-40 years. These head assignments were finalized in consultation and coordination with adjacent subbasin technical groups as well as any regional modeling or State-derived predictive information.

Mountain Front Recharge. Currently, a GHB is assigned to the eastern edge of the Subbasin, along the front of the Sierra Nevada foothills. The modeling team will remove this GHB and represent mountain front recharge using the Recharge Package. Conceptually, mountain front recharge is not a head-dependent boundary, but a specified flux-dependent boundary.

Calibration Period and Validation Period. As discussed previously, the original model was calibrated to a 19-year calibration period using 6-month stress periods. The Modeling Team suggests that upon completion of the KSHM model, a validation run simulating the time period of 1999-2017 be made to assess that the model is still adequately calibrated. Upon assessment of the validation simulation, the KSHM will undergo the calibration process using both qualitative and quantitative measures, such as parameter estimation software (PEST), to produce the final calibrated simulation modeling tool to be used to refine the Subbasin water budget and be used for predictive simulations. Moving forward, the updated groundwater model for the Kaweah Subbasin will begin in 1999 and continue to be updated as new GSP updates are required and deemed necessary by the GSAs. This new start date is due to the substantially increased accuracy and spatial resolution of water budget features, primarily crop demand and surface water deliveries that result in agricultural pumping estimates, beginning with the first year that high quality satellite imagery and associated evapotranspiration/soil moisture balance models were provided by Davids Engineering. This modeling effort can be updated in the future with newer and more accurate local and regional data from neighboring GSAs to benefit required SGMA reporting, refinements, and optimization of the GSPs within the Subbasin.

Predictive Simulations. Predictive simulations through the SGMA timeframe of 2040 and beyond are performed using the same monthly stress period interval and are developed using the projected climate dataset provided by DWR. Correlations between this climatic projection and previously quantified groundwater demands and surface water deliveries are developed to produce a suitable baseline predictive simulation that will serve as a starting point for assessing the impacts of various adaptive management actions and groundwater projects.

Simulations are performed for individual GSAs, but also the cumulative effects of future groundwater management in the Subbasin are assessed relative to the baseline predictive simulation.

Collaboration with Neighboring Subbasins

The Modeling Team collaborated with neighboring subbasin technical representatives during the update and application of the KSHM, with permission from the Kaweah Subbasin GSAs. The purpose for this coordination is to accomplish the following objectives:

- Receive input from GSAs' representatives on modeling tools and approaches in adjacent basins.
- Exchange data and information for consistency between tools.
- Agree on boundary conditions including both gradients and heads located at and outside of the boundaries of the Subbasin.
- Ensure that the KSHM integrates well, to the extent possible, with adjacent tools that our approaches for Kaweah Subbasin will not result in conflicting boundary conditions or water budgets.

The Modeling Team recommends that inter-basin model coordination meetings begin in August of 2018 and continue until the simulations required for use in developing the draft GSP is are completed. We anticipate the need for four (4) focused meetings on this approximate schedule:

1. KSHM Approach Meeting — Mid September 2018
2. KSHM Update Meeting — Late October 2018
3. KSHM Model Baseline Run and Boundary Flux Meeting — Late November 2018
4. KSHM Model Simulation Results Meeting — January 2019

The Modeling Team attended one meeting with the Tulare Lake Subbasin modeling group on June 15th, 2018 to facilitate data transfer between the two modeling efforts and improve agreement and conceptual consistency between the Sub- Basins. Upon request from the Kaweah Subbasin managers and committees, the Modeling Team will continue to collaborate and improve consensus with adjacent modeling groups to improve model agreement and sub-regional consistency between calibrated and predictive simulations. The Modeling Team is also prepared to develop and share baseline predictive simulation results with neighboring basins and accept in-kind data sharing to further improve predictive accuracy and understanding on adaptive management and project options and collaboration. These activities are approved by GSA representatives prior to the Modeling Team sharing any information or data.

Conclusions and Recommendations Regarding Model Updates

In general, the Modeling Team believes that the KDWCD model provides an adequate precursor model that is suitable for use in GSP development if the following revisions and updates are incorporated.

Groundwater Vistas Version 7 will be the processing software package utilized. We will maintain MODFLOW as the basic code and will update to MODFLOW-USG or MODFLOW-NWT to take advantage of advances in numerical solution techniques that are available in these updated MODFLOW revisions.

1. **Extent.** The model will need to be expanded to fill the area between the general head boundary of the current model and the Subbasin boundary shown in Figure 1 to include the entire area of the Kaweah Subbasin.

2. **Layers.** The model layering scheme depicting two water-bearing layers above and below the Corcoran Clay is suitable for the objective of supporting the GSP development.

3. **Historical Simulations.** The KDWCD model has been calibrated to the 1981- 1999 hydrologic period. Based on inspection of the hydrographs presented in the 2005 modeling report and the 2012 Model update report, observed water levels are adequately simulated to consider this model effectively calibrated. The objective is to have a model suitable to simulate projected management actions through the entire Subbasin. No changes will be made to the inputs to the 1981-1999 run. Therefore, it is already calibrated to that period. We are just re-organizing the assignment of water budget components to different MODFLOW packages from 1999-2017, and beyond. Monthly stress periods will be used.

4. **Assignment of water budget components to MODFLOW Packages.** The Modeling Team proposes to revise the conventions used in the KDWCD model. This will be the most involved part of the model revision. The updated water budget values that have been generated by the GSA will continue to be the primary input as far as flux values go. However, we propose to organize them into more readily identifiable currently available MODFLOW packages to help with the analyses of potential water budget changes that may correspond to management actions in the future.
5. **Recharge Components.** Spatial distribution of such water budget components as percolation of precipitation, irrigation return flow, recharge basins, etc., will be updated based on the most currently available data.
6. **Model Parameters.** Hydraulic conductivity (horizontal and vertical) and storage coefficient will initially stay unchanged during the validation period simulation. If the calibration target hydrographs for the validation period indicate that a suitable match is retained between observed and modeled water levels, the existing parameters will be retained.
7. **Flow Boundaries.** In areas where the existing GHB boundaries are within the Kaweah Subbasin, they will be expanded approximately 1-2 miles, or at locations of any likely groundwater divides from the Subbasin boundary on the north, south, and west sides of the Subbasin. The assigned heads for these GHBs for the 1999-2017 verification run will be based on published groundwater elevations in the vicinity as depicted in contour maps published by DWR. Seasonal variability in assigned GHB heads can be incorporated.
8. **No-Flow Boundaries.** The eastern GHB along the base of the Sierra foothills will be removed. Instead, the flux in the Recharge Package will be increased along this boundary to represent mountain front recharge. The flux volume from the GHB will be evaluated, and this flux volume will be approximated using the Recharge Package.

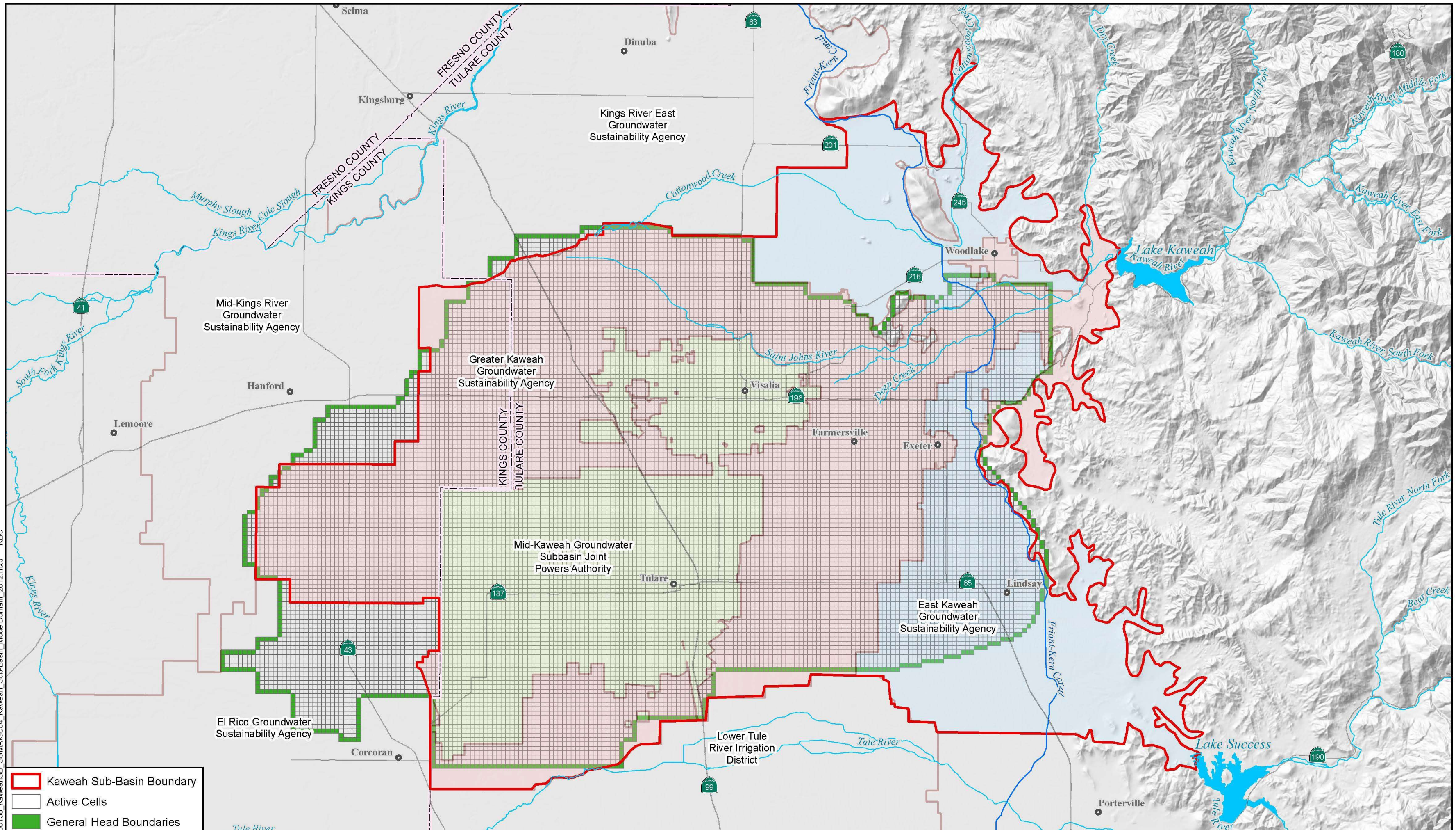
Estimated Schedule of Model Update Activities

The Modeling Team proposes the following schedule for the major groundwater model update activities. Estimated timeframes for key inter-basin model coordination meetings and updates are also included in the following table to provide a more comprehensive schedule and to facilitate meeting planning. Specific model development and simulation tasks may shift to earlier or later timeframes, but it is the intention of the Modeling Team to comply with the overall schedule and satisfy deadlines for the final deliverable of the calibrated modeling tool and associated predictive scenarios. Should information not be available to the Modeling Team in time to use them in development of the calibrated model simulation or predictive simulations, the data will either not be included, or the schedule may be adjusted to accommodate their inclusion, per guidance from Sub- Basin GSA leadership.

Updates and presentations on the status of the groundwater modeling efforts will occur at regular intervals during Coordinated Subbasin and individual GSA meetings, per the scope of work for the groundwater modeling task order.

Modeling Activity	Estimated Completion
Refinement and expansion of model domain and boundary conditions	Early September 2018
Update water budget with David's Engineering and EKGSA data	Early September 2018
Development of calibration targets	Mid-September 2018
Parameterization of model layers	Mid-September 2018
Refinement of groundwater fluxes	Mid-September 2018
Inter-basin KSHM Approach Meeting (inter-basin)	Mid-September 2018

Adjust boundary conditions, fluxes, and parameters using any new adjacent basin data	Late September 2018
Initiate Formal Calibration Process	Early October 2018
Inter-basin KSHM Update Meeting	Late October 2018
Complete initial calibration process	Early November 2018
Calibration and model refinements and preparation for predictive simulations	Late November 2018
Inter-basin KSHM Calibrated Model and Boundary Flux Meeting	Late November 2018
Develop predictive baseline scenario — Subbasin level	Early December 2018
Develop GSA specific predictive simulations	Mid December 2018
Cumulative Subbasin simulations	Early January 2019



Kaweah Sub-Basin
Groundwater Modeling Task 1
Tulare County, California

Kaweah Sub-Basin

GSI Water Solutions, Inc.
GEI Consultants

2012 KDWCD EXPANDED MODEL DOMAIN WITH GENERAL HEAD BOUNDARIES

AUGUST 2018 DRAFT FIGURE 1

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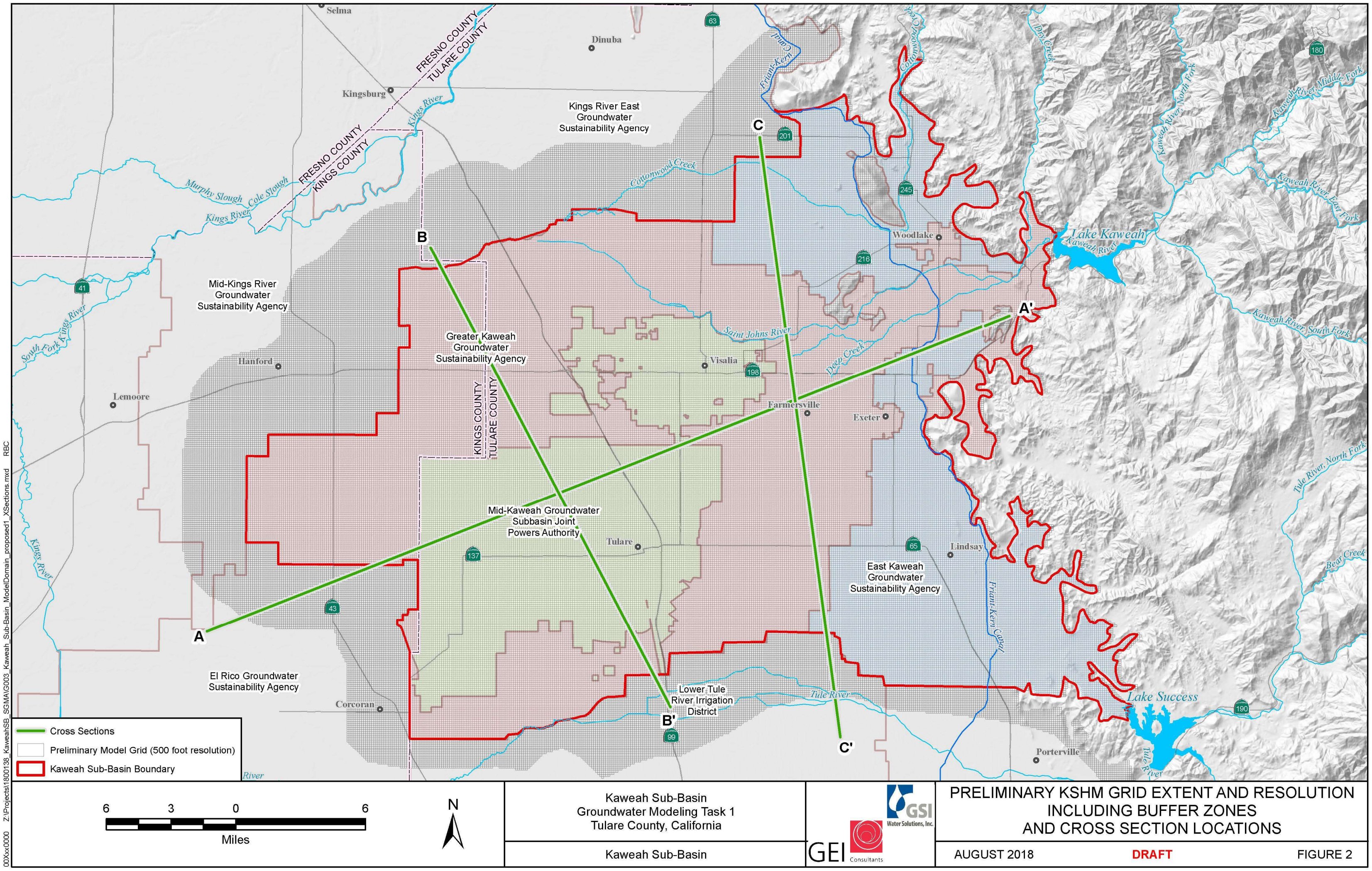

Selma
Dinuba
Kingsburg
FRESNO COUNTY
TULARE COUNTY
FRESNO COUNTY
KINGS COUNTY
Kings River East Groundwater Sustainability Agency
Mid-Kings River Groundwater Sustainability Agency
Greater Kaweah Groundwater Sustainability Agency
KINGS COUNTY
TULARE COUNTY
Mid-Kaweah Groundwater Subbasin Joint Powers Authority
East Kaweah Groundwater Sustainability Agency
El Rico Groundwater Sustainability Agency
Lower Tule River Irrigation District
Hanford
Lemoore
Visalia
Farmersville
Exeter
Woodlake
Tulare
Lindsay
Corcoran
Porterville
Lake Kaweah
Lake Success
A
A'
B
B'
C
C'
Cross Sections
Preliminary Model Grid (500 foot resolution)
Kaweah Sub-Basin Boundary
6 3 0 6
Miles
N
Kaweah Sub-Basin
Groundwater Modeling Task 1
Tulare County, California
Kaweah Sub-Basin
PRELIMINARY KSHM GRID EXTENT AND RESOLUTION INCLUDING BUFFER ZONES AND CROSS SECTION LOCATIONS
AUGUST 2018
DRAFT
FIGURE 2

Groundwater Model Modifications

Modifications were made to the Kaweah Subbasin Hydrologic Model (KSHM) by the groundwater modeling team during the period of July through September 2018. The modifications which were reported first reported in Progress Report Number 1- November 2018 include the following.

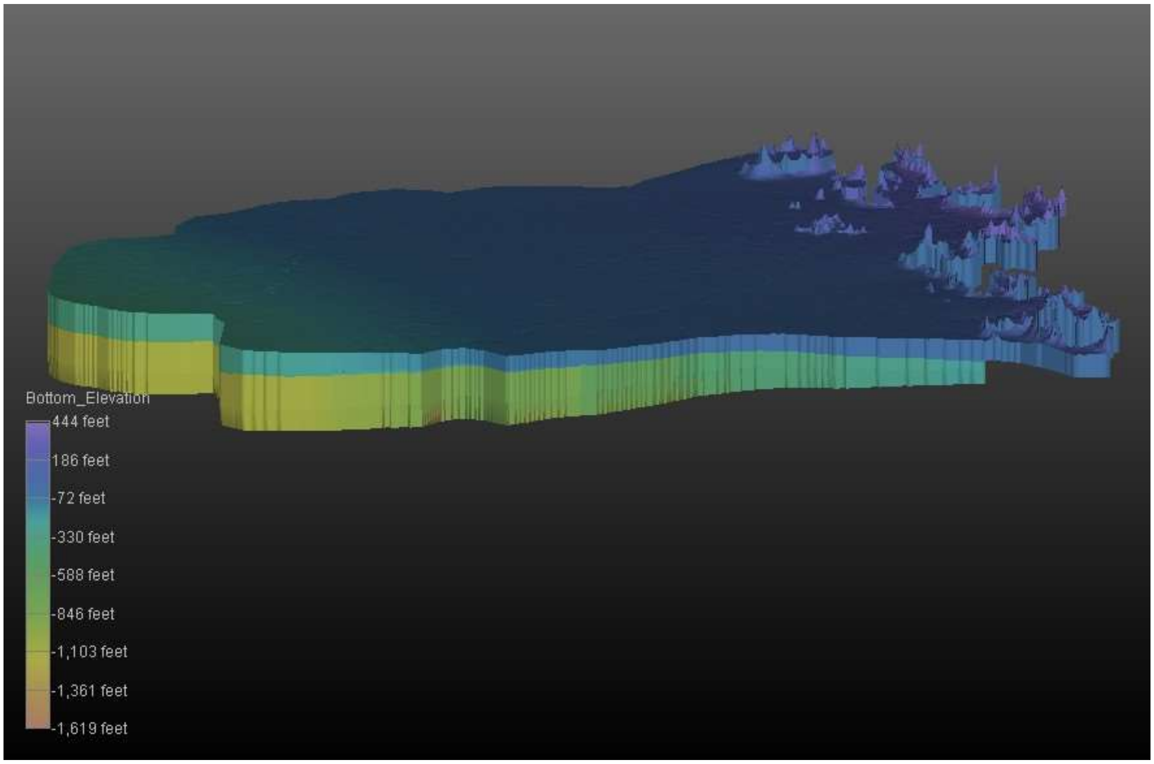
1. Added the general head boundaries
    a. What is a general head boundary? Water levels are fixed, and fluxes change

       - The General-Head Boundary package is used to simulate head-dependent flux boundaries. In the General-Head Boundary package the flux is always proportional to the difference in head.

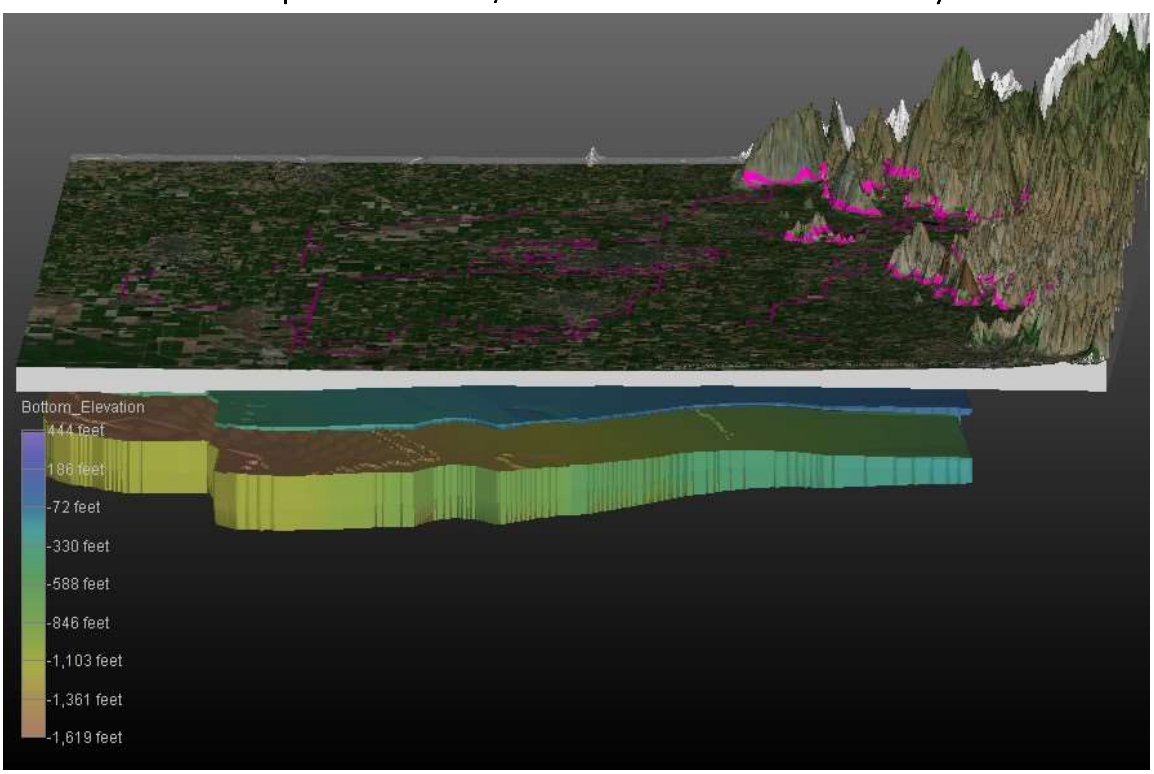
    b. The general head boundary condition is set on the north, west and south boundaries of the model and in model layers 1, 2, and 3.
2. Set the agricultural pumping based on Davids Engineering crop demand analysis for the period 1999 to 2017.
3. Distributed surface water delivery information spatially.
4. Refined the model grid from 1000 to 500-foot grids.
5. Refined stress periods from 6-month to 1-month step stress periods.
6. Expanded model layers into East Kaweah GSA area and up to the Eastern edge of the Kaweah Subbasin. Total model thickness in the east determined by the evaluation of the wells penetrating into the bedrock.
7. Added mountain front recharge and distributed recharge volumes proportionally based on upstream watershed size.
8. Increased the thickness of model layer three by lowering the base to near the bottom of the Tulare Formation.

Exploded View of Groundwater Model Layers

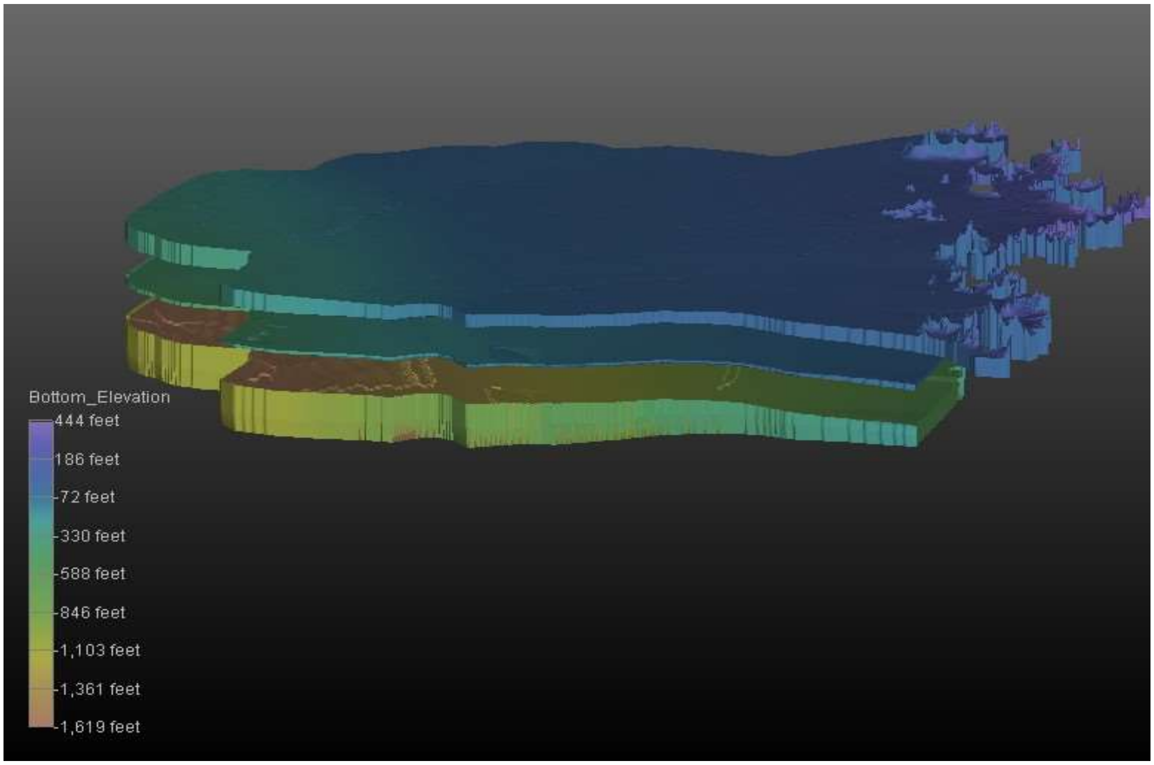
3-Dimensional Oblique Elevation of Entire Model Domain



3-Dimensional Oblique Elevation w/Aerial Photo and GSA Boundary Outlined

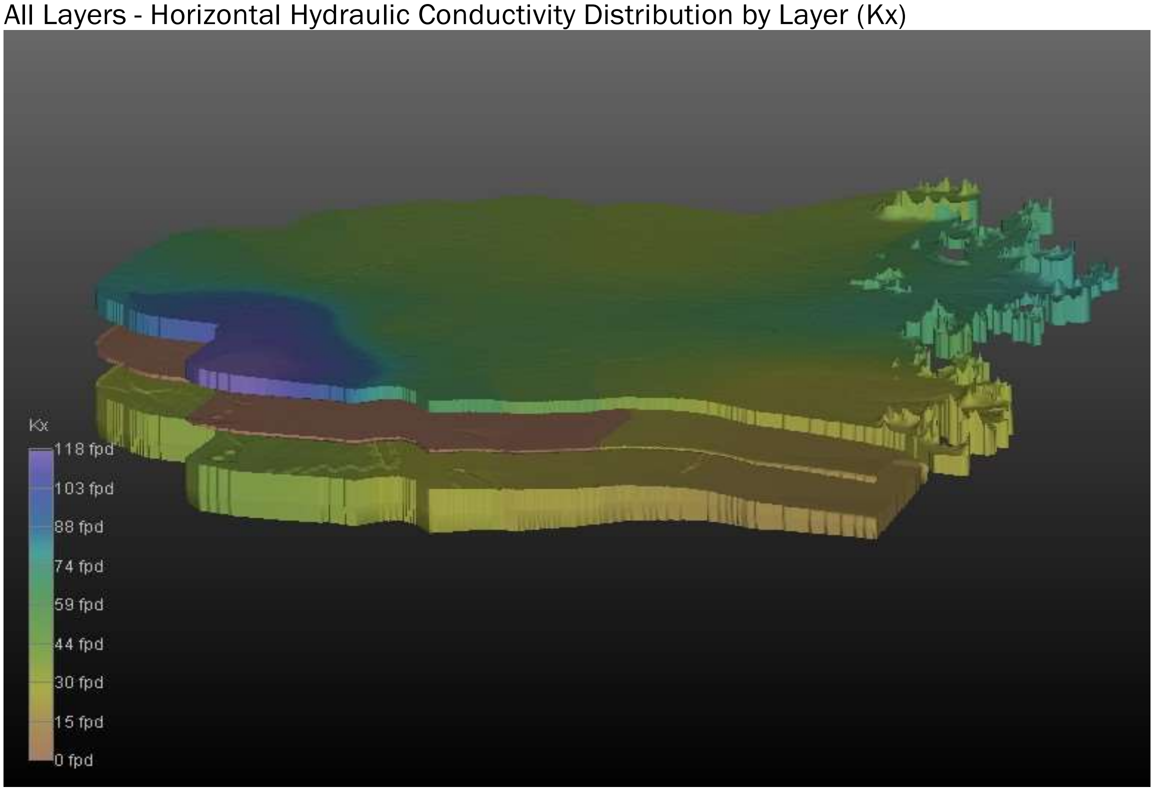


Exploded View of Groundwater Model Layers

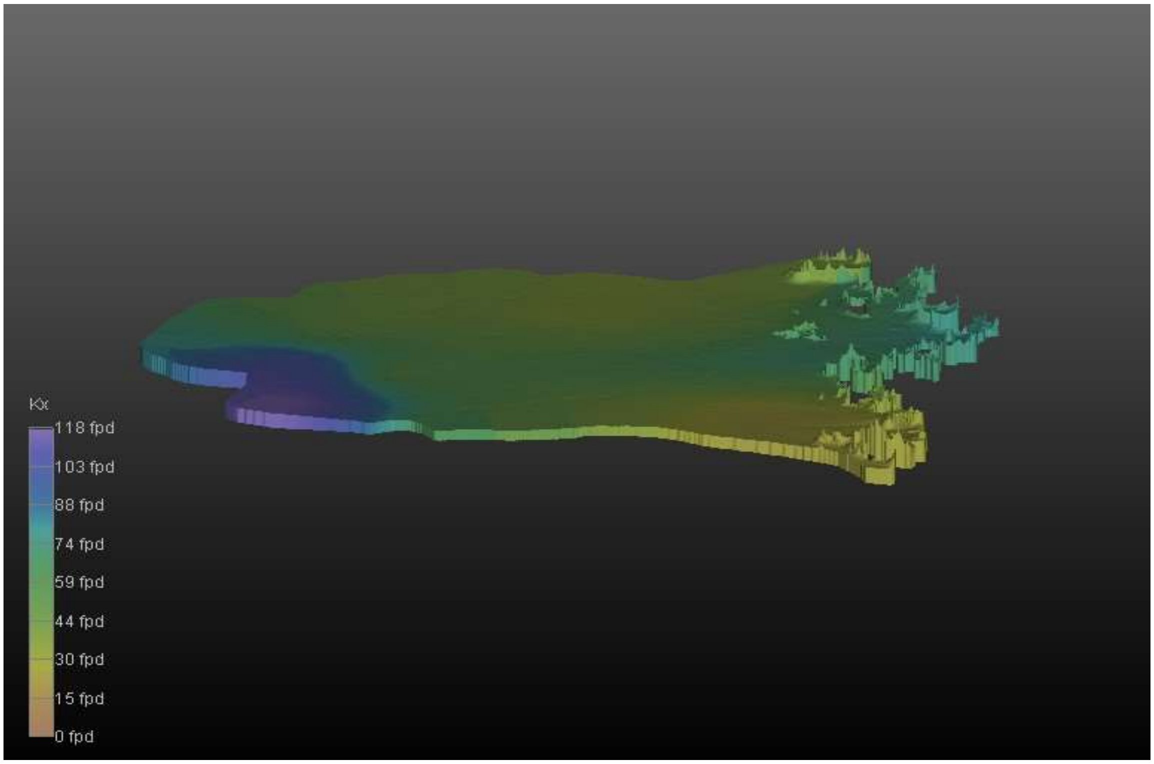


Horizontal Hydraulic Conductivity Distribution by Layer (Kx)

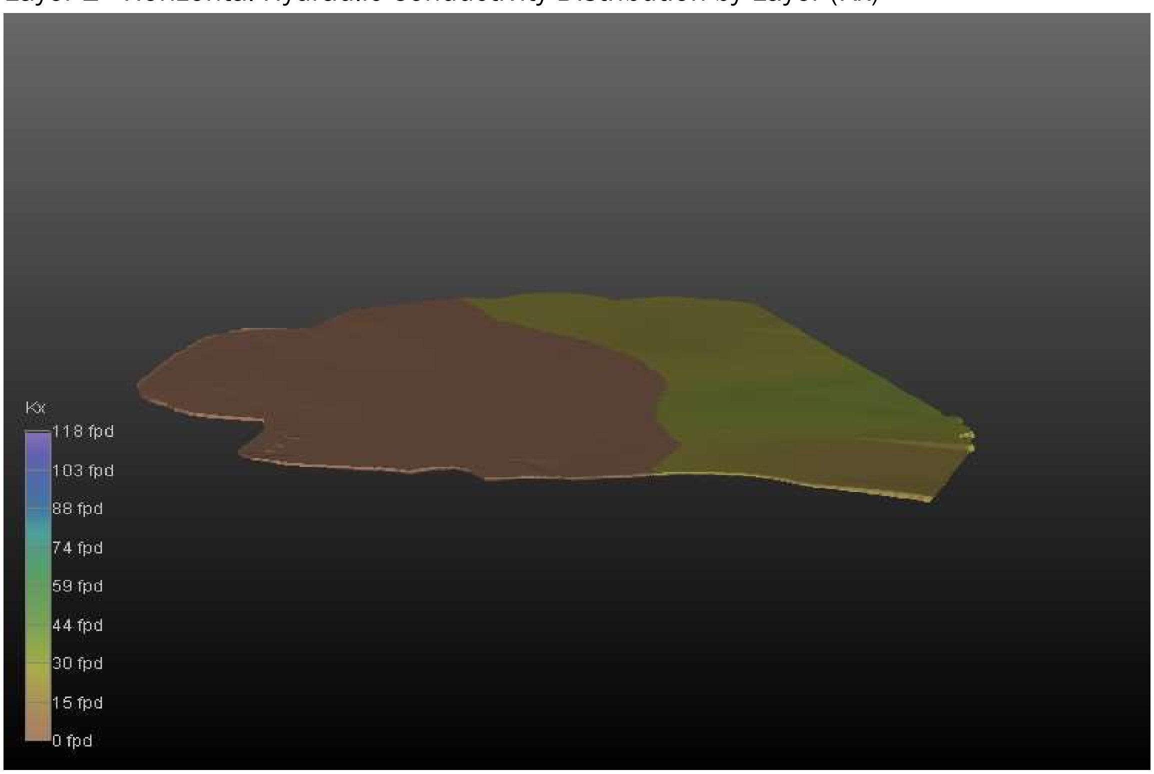
All Layers - Horizontal Hydraulic Conductivity Distribution by Layer (Kx)



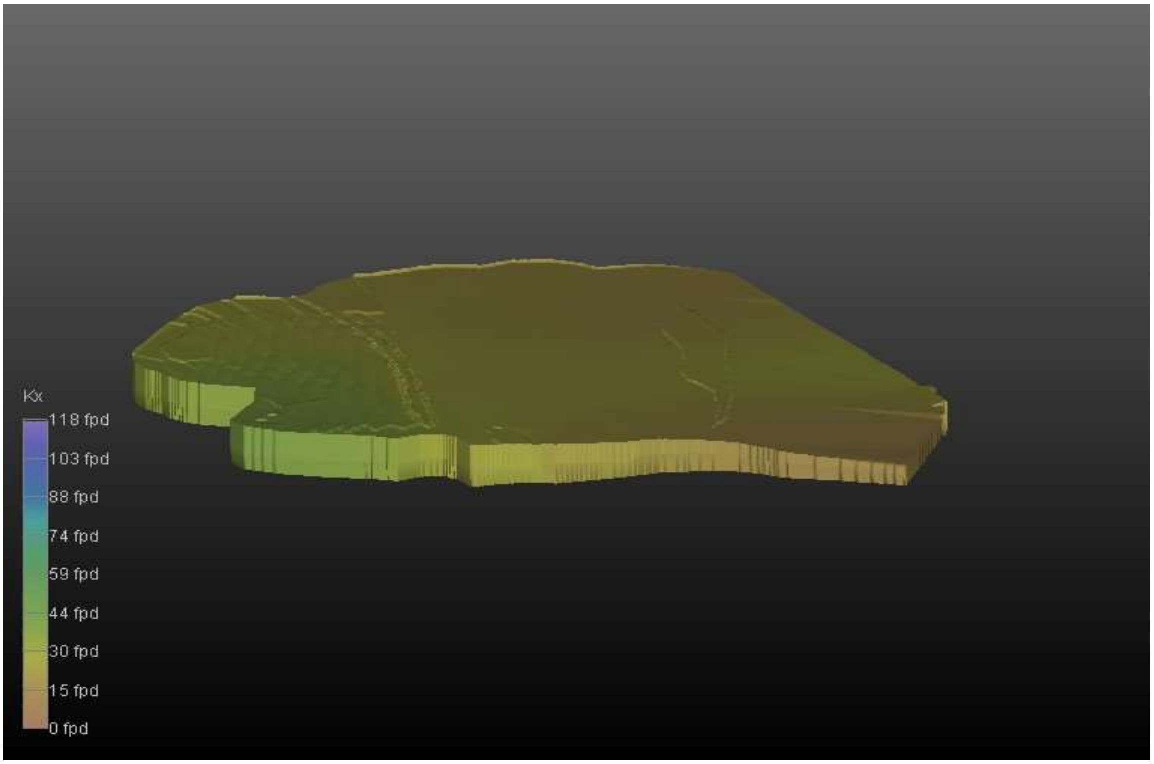
Layer 1 - Horizontal Hydraulic Conductivity Distribution by Layer (Kx)



Layer 2 - Horizontal Hydraulic Conductivity Distribution by Layer (Kx)

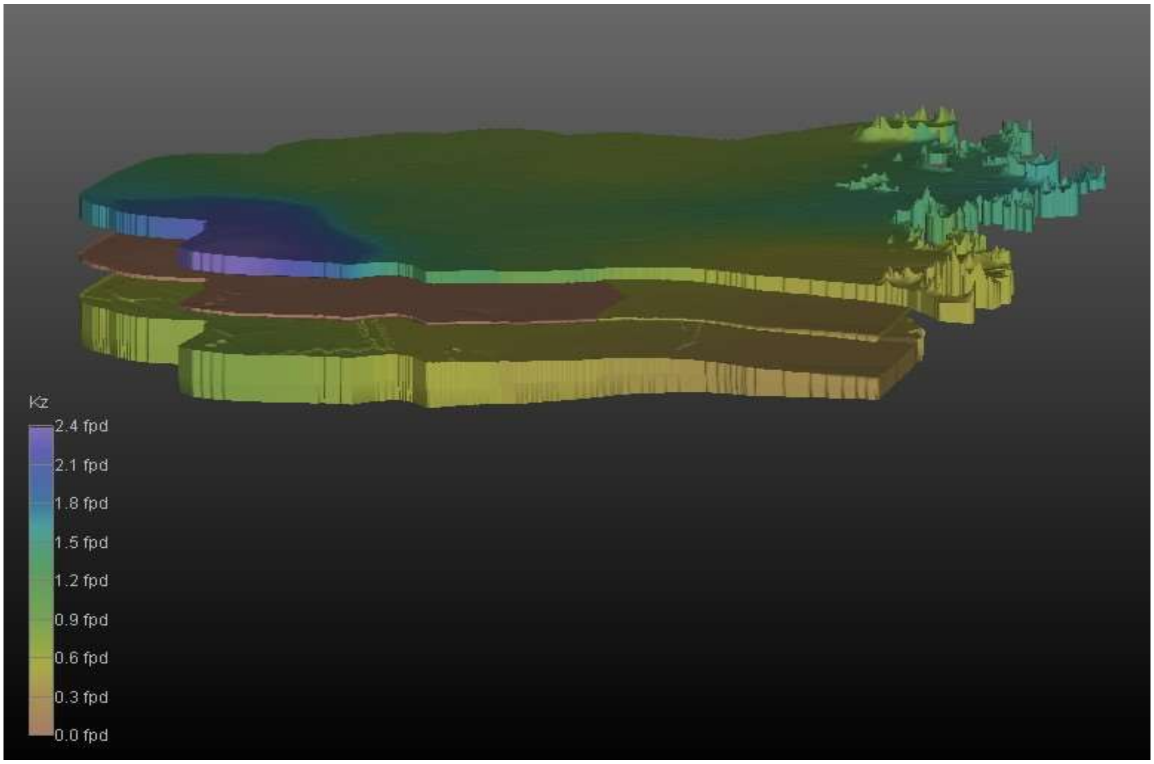


Layer 3 - Horizontal Hydraulic Conductivity Distribution by Layer (Kx)

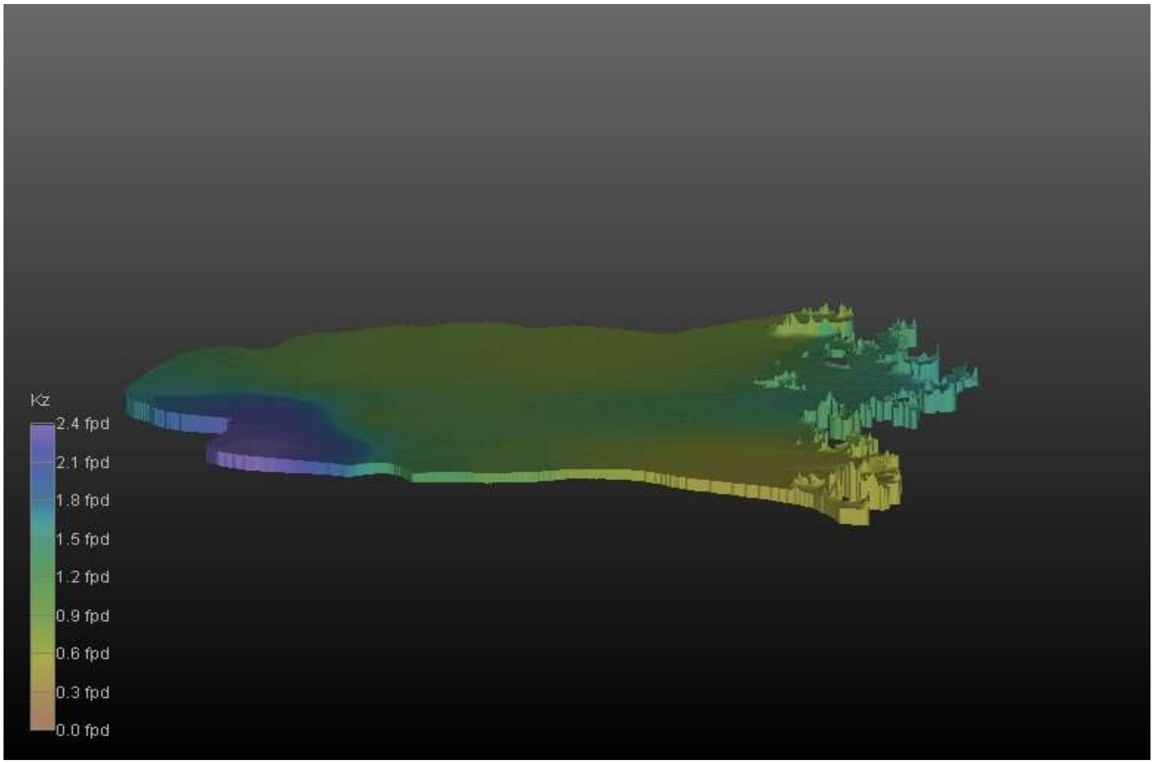


Vertical Hydraulic Conductivity Distribution by Layer (Kz)

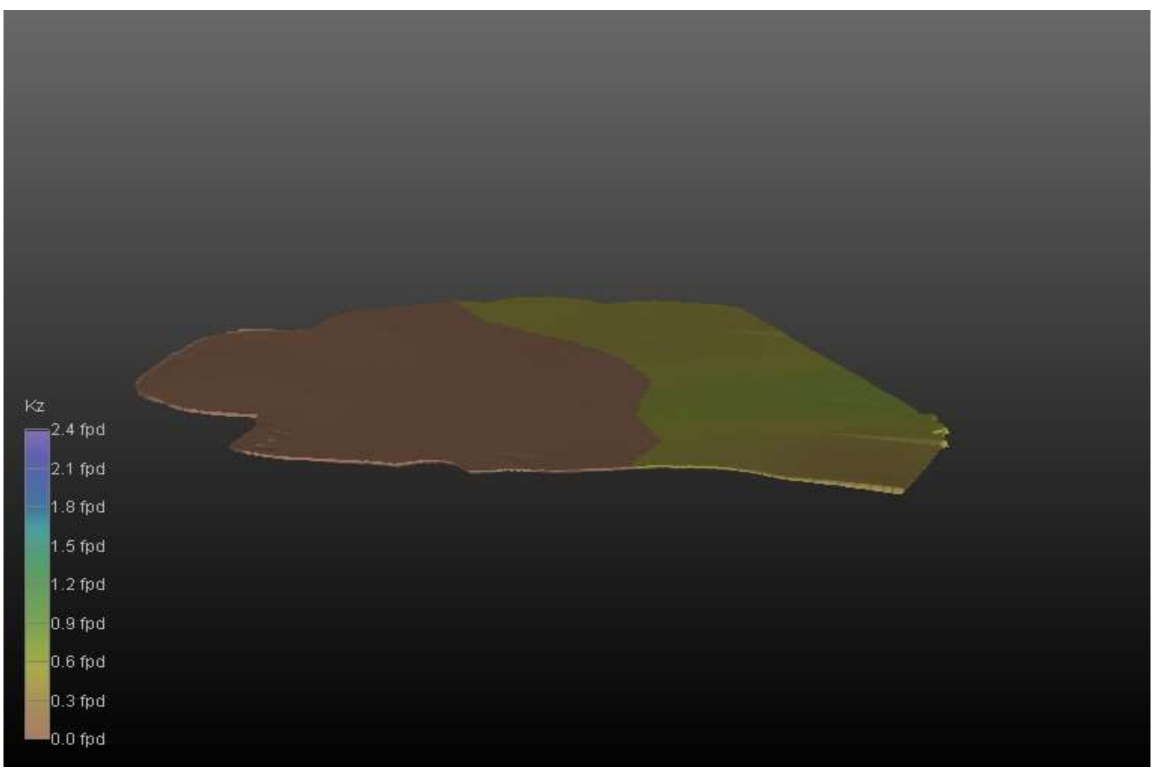
All Layers - Vertical Hydraulic Conductivity Distribution by Layer (Kz)



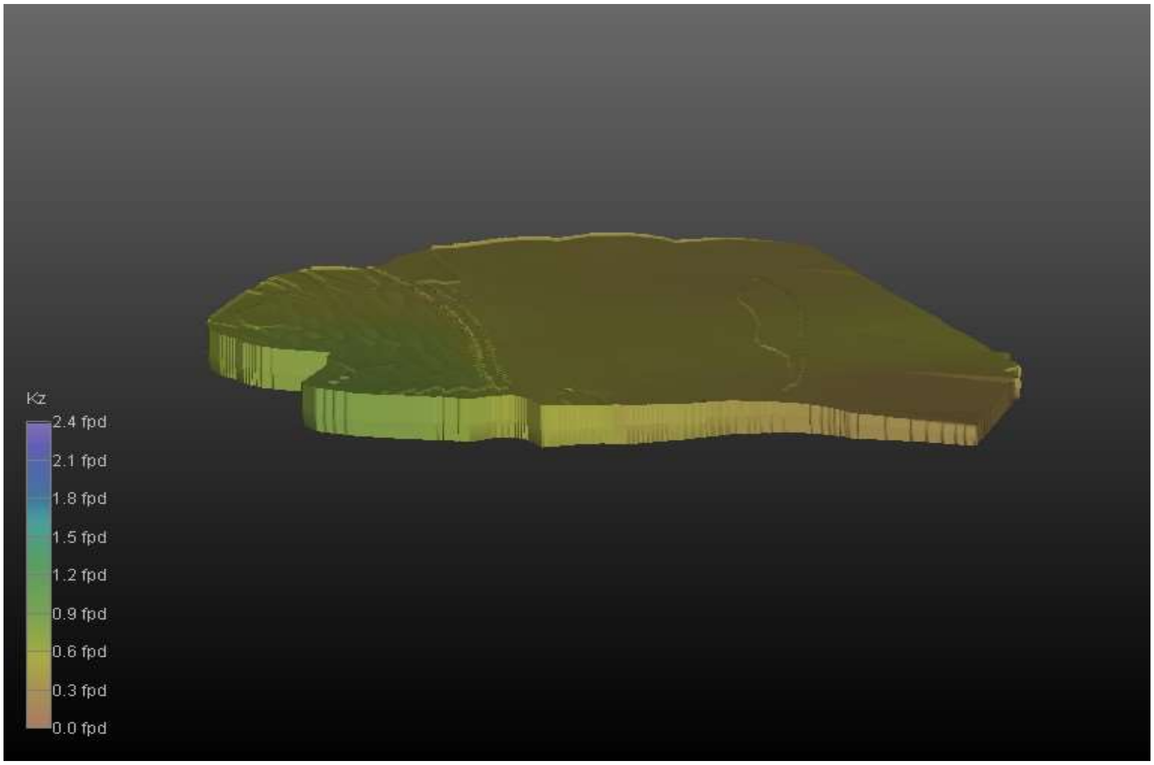
Layer 1 - Vertical Hydraulic Conductivity Distribution by Layer (Kz)



Layer 2 - Vertical Hydraulic Conductivity Distribution by Layer (Kz)



Layer 3 - Vertical Hydraulic Conductivity Distribution by Layer (Kz)



Process of Model Verification

1. The groundwater modeling team performed verifications model runs from 1999 to 2017. The purpose of these simulations was to verify the accuracy of the model to match the new water budget and observed groundwater elevations throughout expanded grid area.
2. The modeling team adjusted the vertical hydraulic conductivity in all three layers to improve the match.
3. Storage values from the previous model were unchanged.

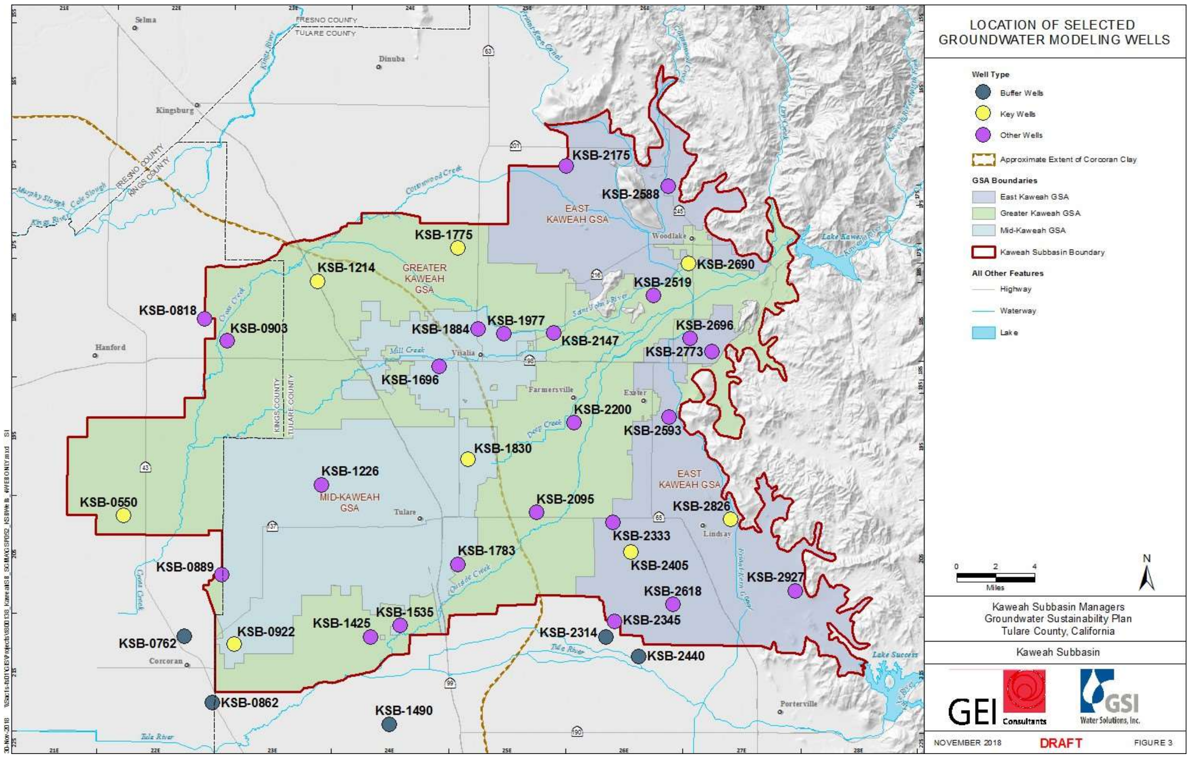
Results of Verification

The groundwater modeling team increased the number of calibrated targets from 30 in the 2012 update to over 900 in the KSHM. All 900 of these targets have been included in the calibration statistics that follow the presentation of key well hydrographs.

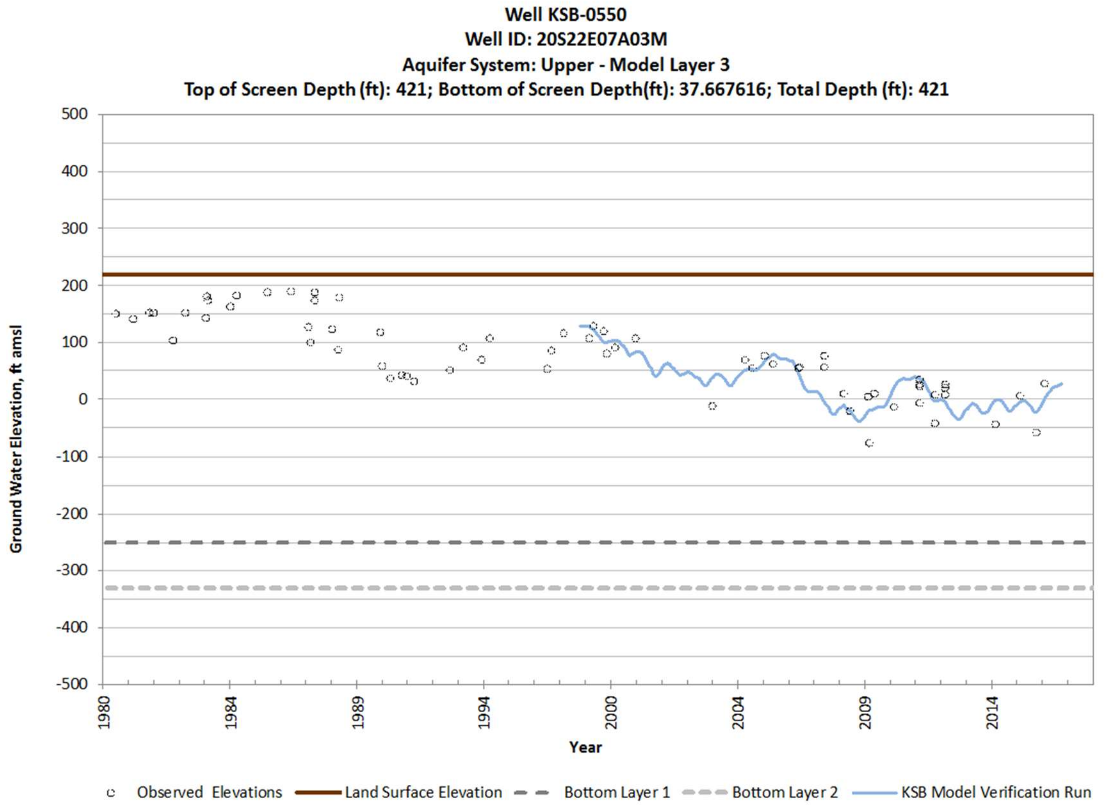
Included below is a map showing the locations of a group of key wells throughout the basin showing the match between observed and model simulated groundwater levels.

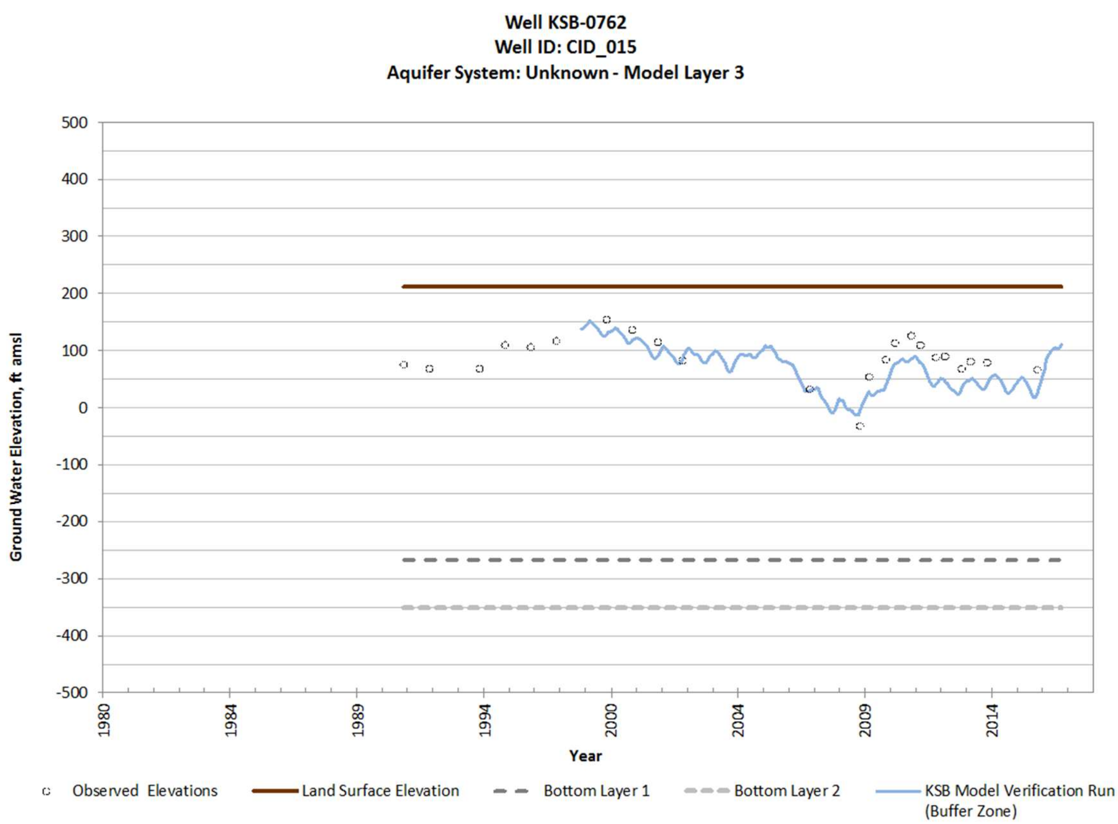
Hydrograph Wells

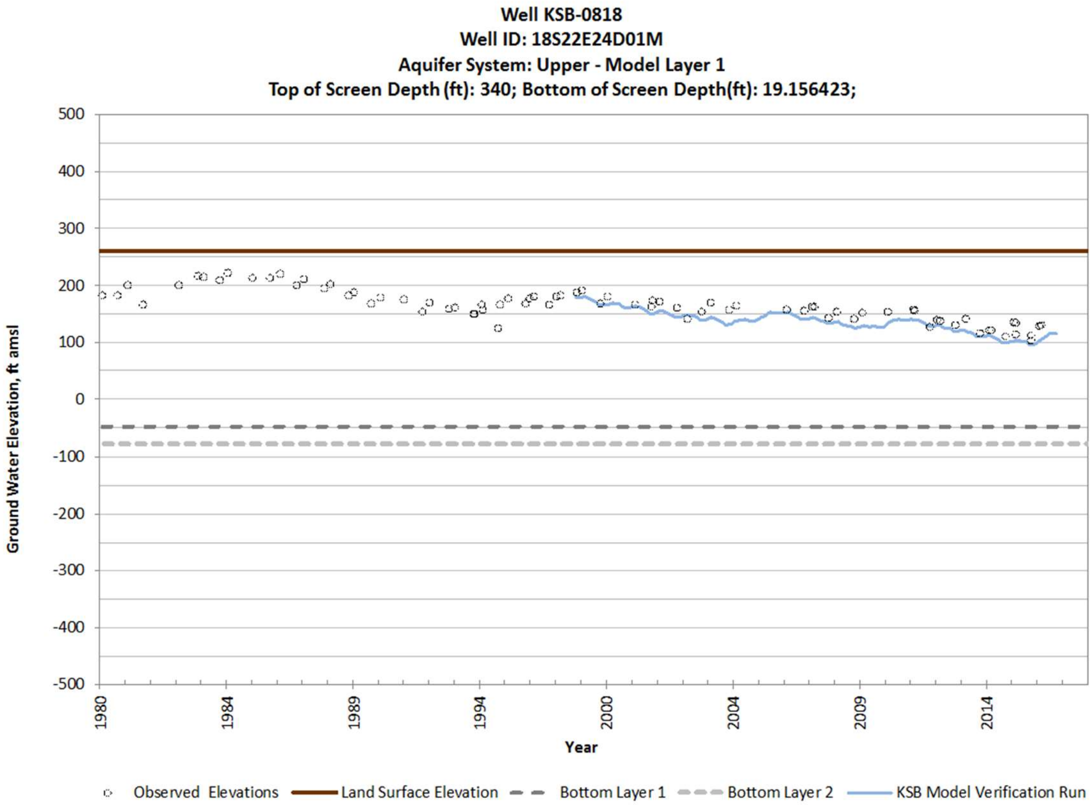
WELL LOCATIONS

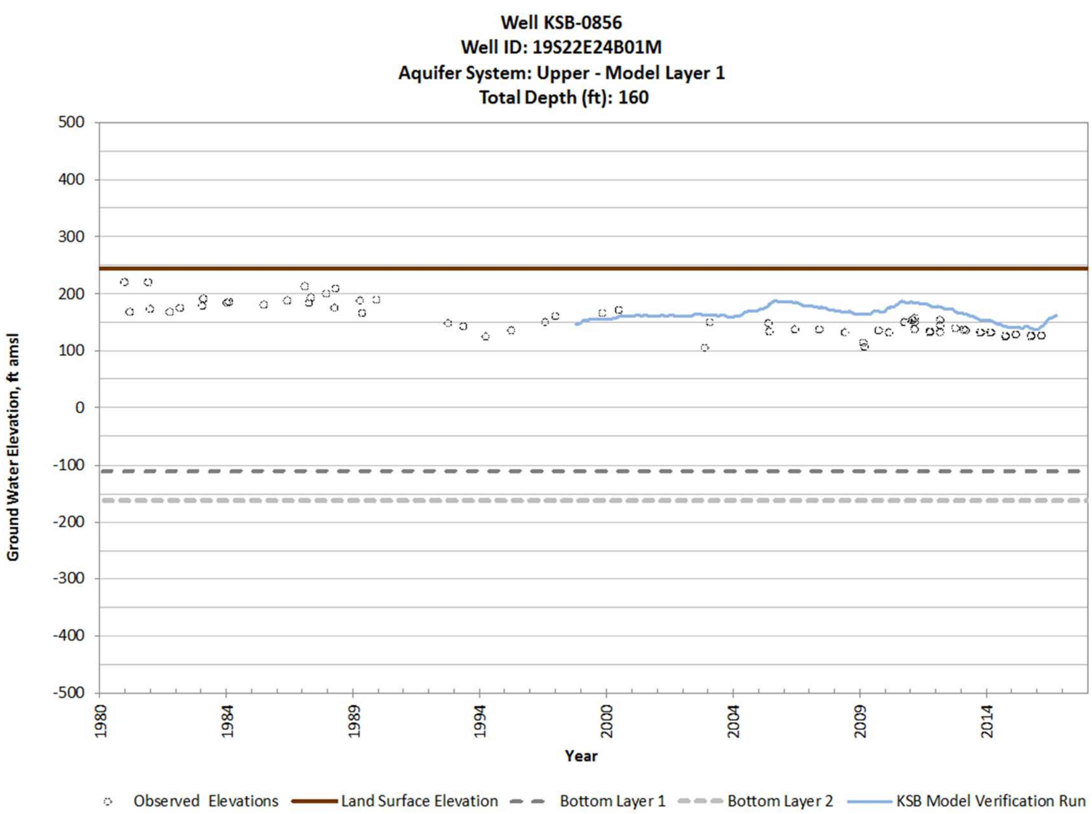


Hydrographs showing the match between observed and modeled groundwater elevations are presented for 37 key wells in the Kaweah Subbasin. Similar hydrographs have also been computed for over 900 wells within the subbasin and 200 wells within the model domain outside the subbasin. These additional hydrographs are available on demand but have been excluded from the report for brevity.

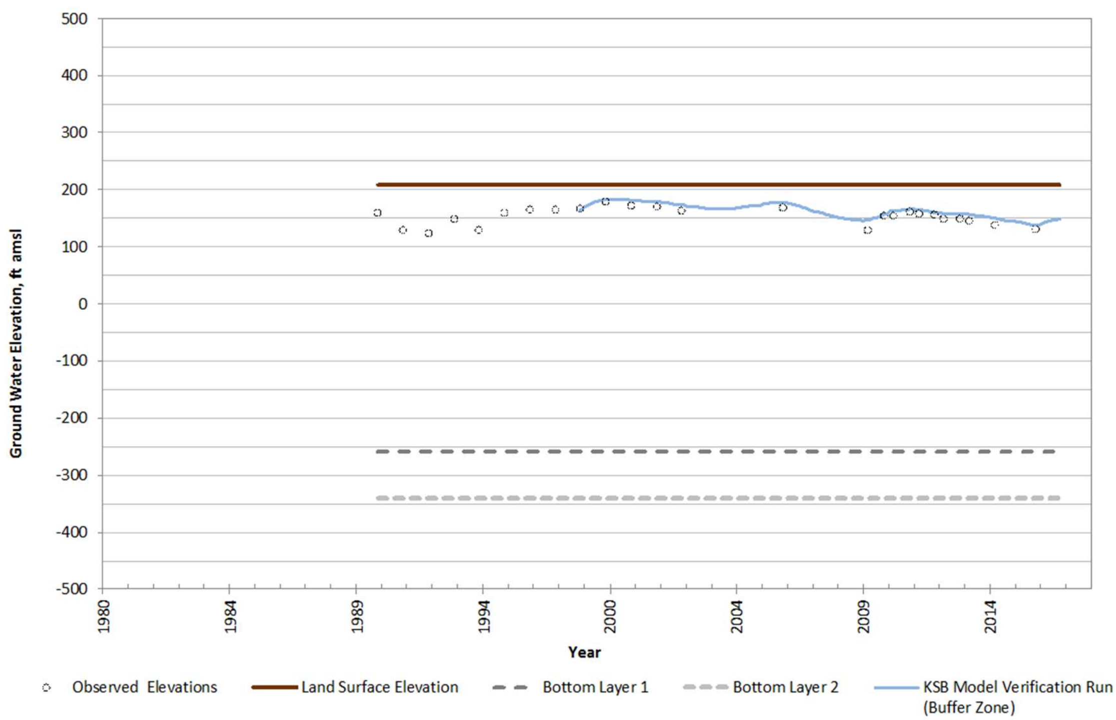

Well KSB-0550
Well ID: 20S22E07A03M
Aquifer System: Upper - Model Layer 3
Top of Screen Depth (ft): 421; Bottom of Screen Depth(ft): 37.667616; Total Depth (ft): 421
Ground Water Elevation, ft amsl
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run


Well KSB-0762
Well ID: CID_015
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run (Buffer Zone)

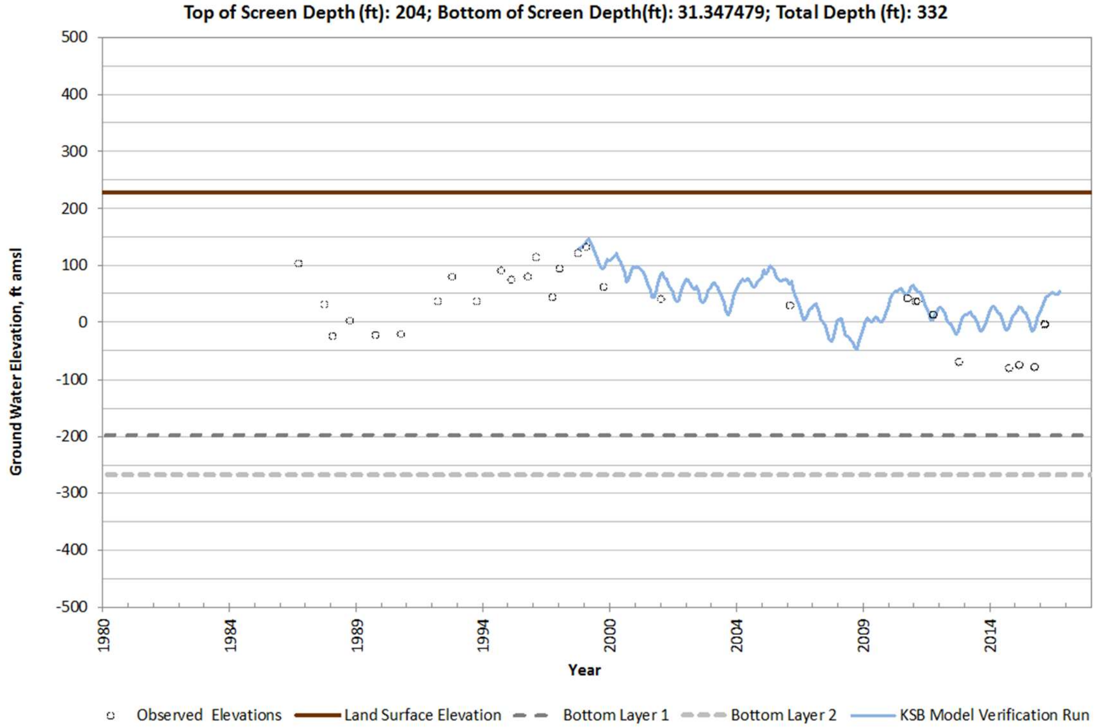

Well KSB-0818
Well ID: 18S22E24D01M
Aquifer System: Upper - Model Layer 1
Top of Screen Depth (ft): 340; Bottom of Screen Depth(ft): 19.156423;
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

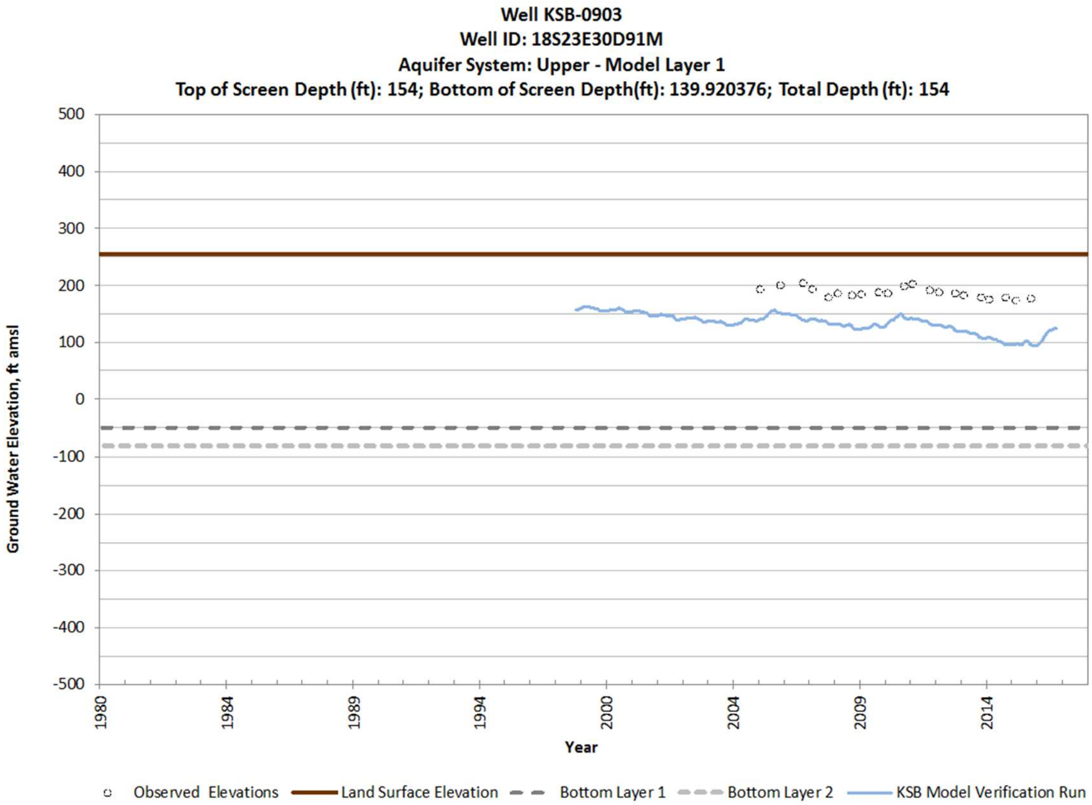

Well KSB-0856
Well ID: 19S22E24B01M
Aquifer System: Upper - Model Layer 1
Total Depth (ft): 160
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

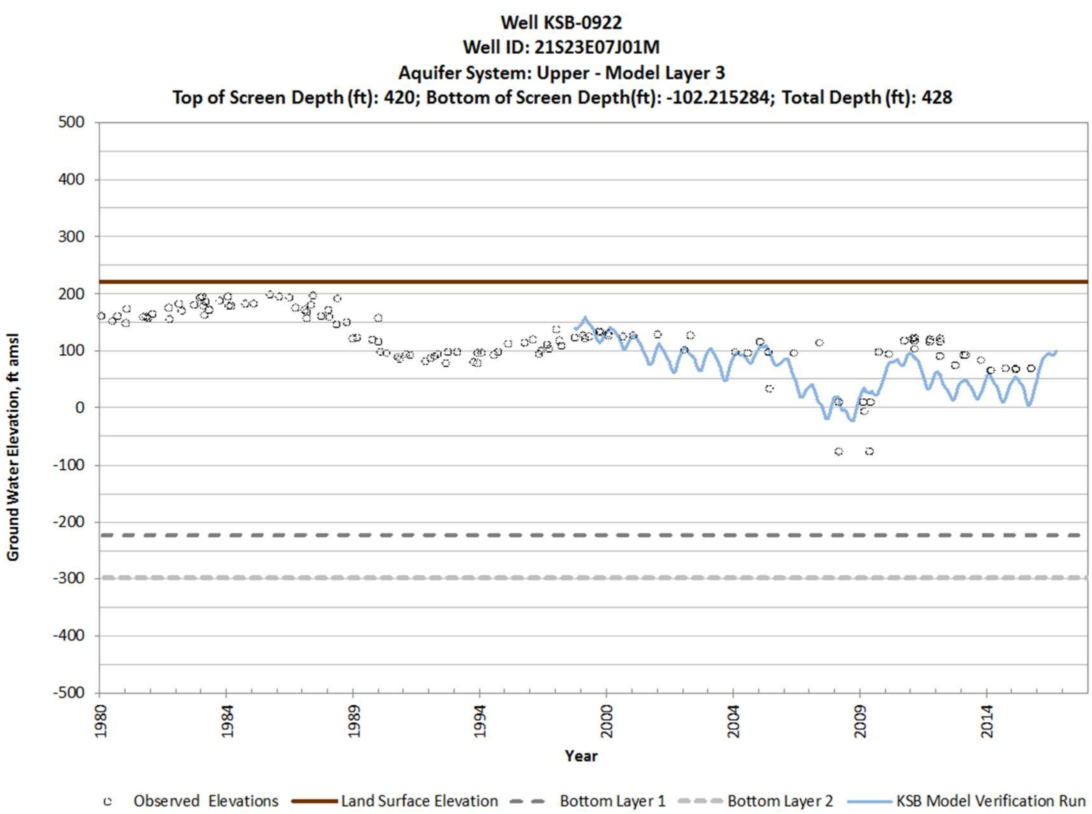
Well KSB-0862
Well ID: CID_070
Aquifer System: Unknown - Model Layer 1

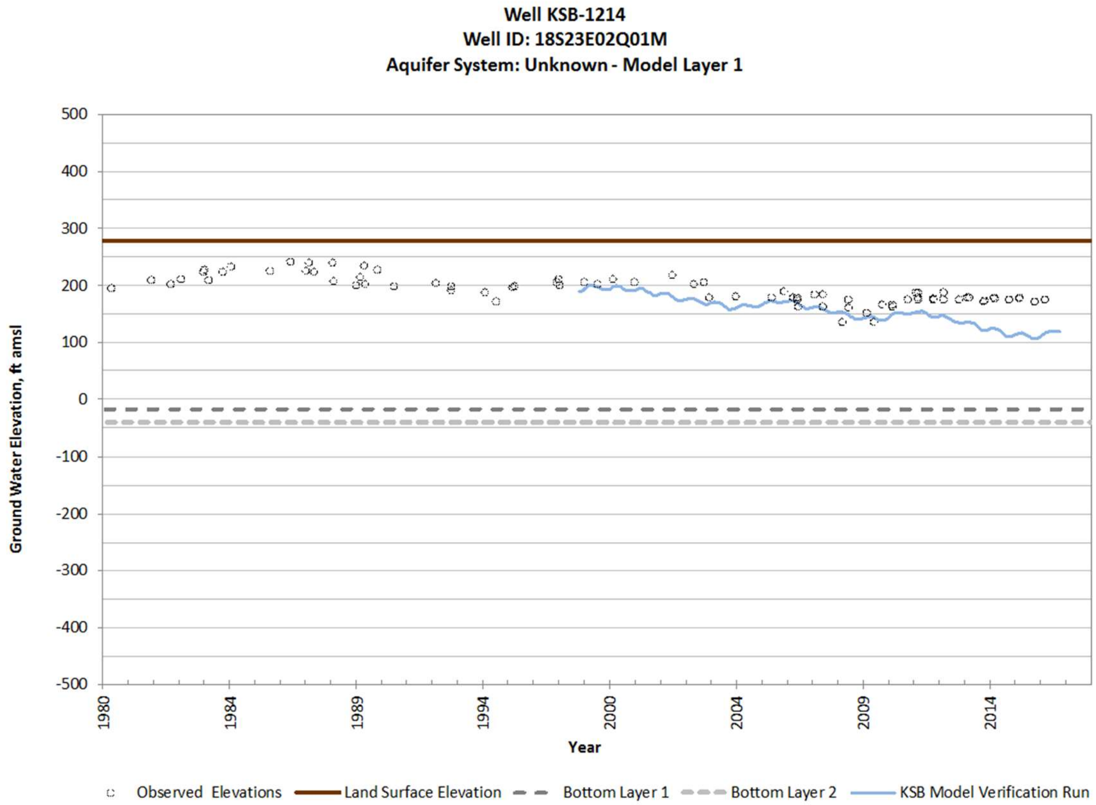


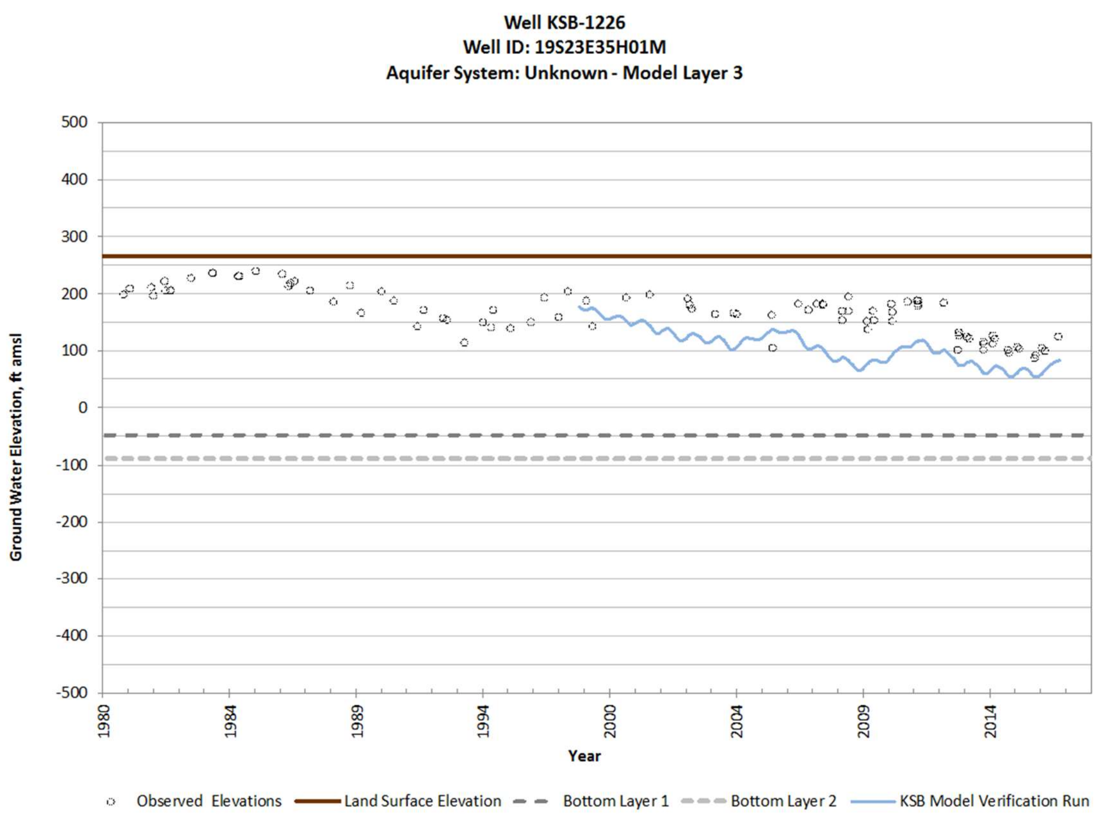
Well KSB-0889
Well ID: 20S22E24R01M
Aquifer System: Upper - Model Layer 3
Top of Screen Depth (ft): 204; Bottom of Screen Depth(ft): 31.347479; Total Depth (ft): 332

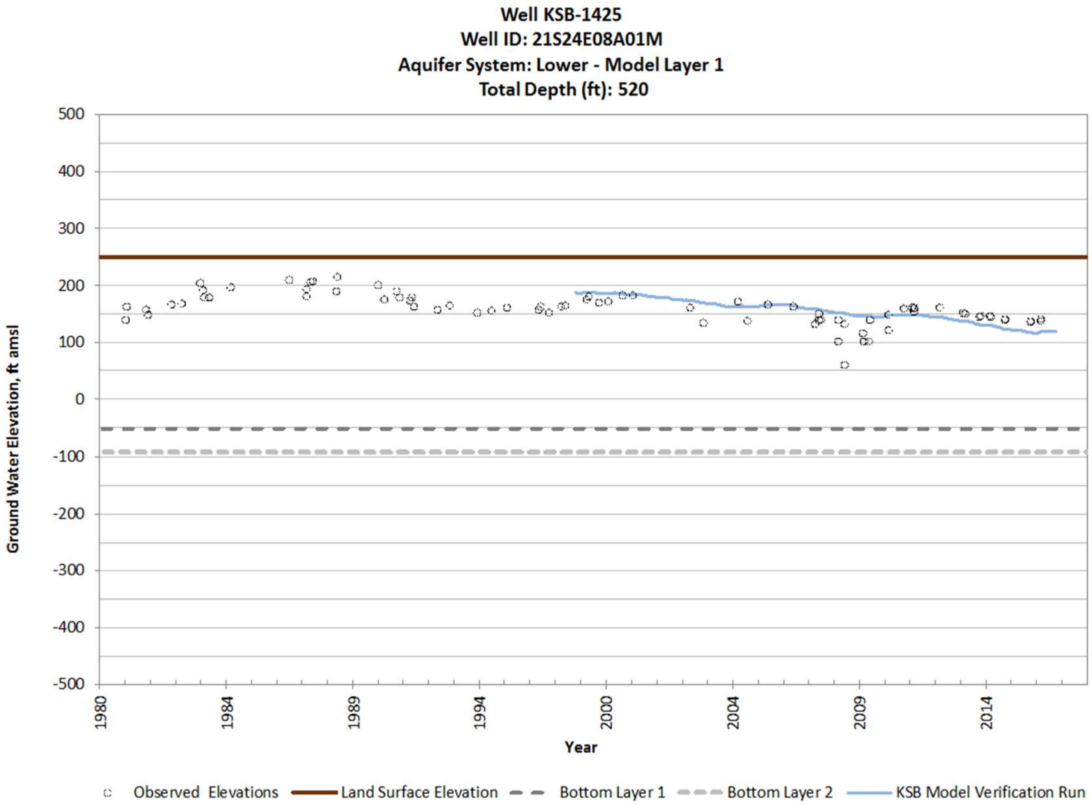


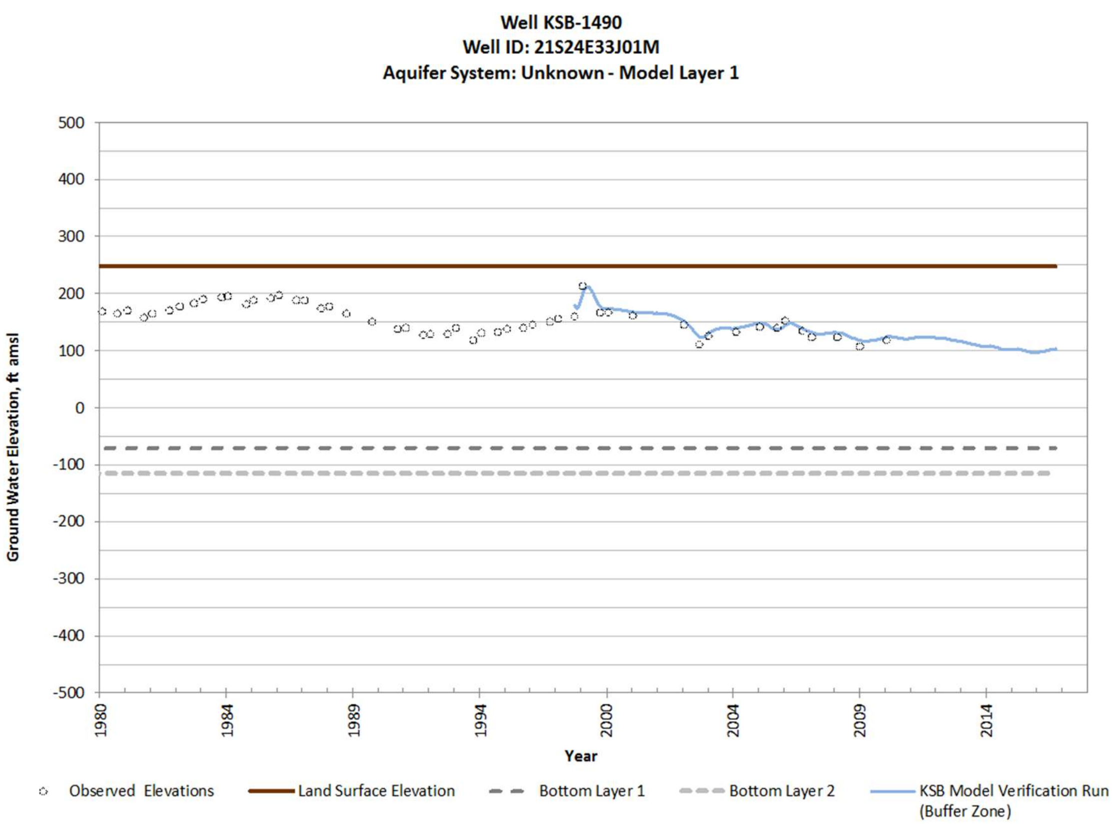

Well KSB-0903
Well ID: 18S23E30D91M
Aquifer System: Upper - Model Layer 1
Top of Screen Depth (ft): 154; Bottom of Screen Depth(ft): 139.920376; Total Depth (ft): 154
Ground Water Elevation, ft amsl
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

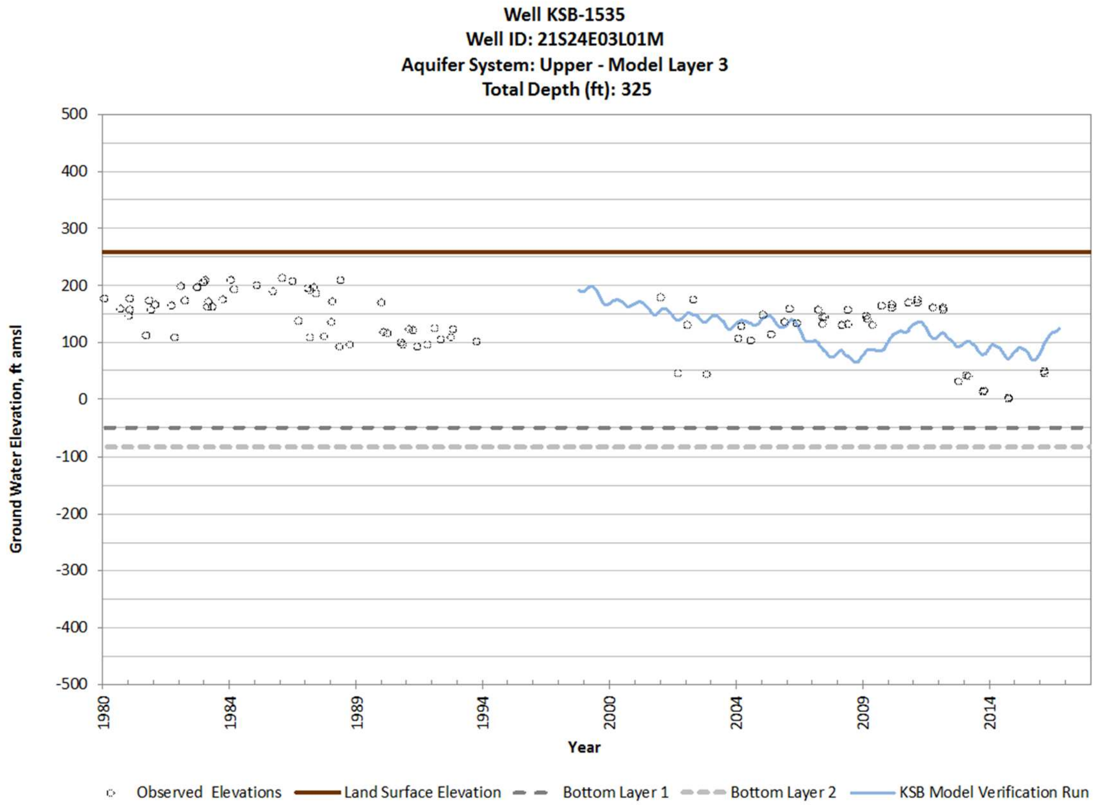

Well KSB-0922
Well ID: 21S23E07J01M
Aquifer System: Upper - Model Layer 3
Top of Screen Depth (ft): 420; Bottom of Screen Depth(ft): -102.215284; Total Depth (ft): 428
Ground Water Elevation, ft amsl
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

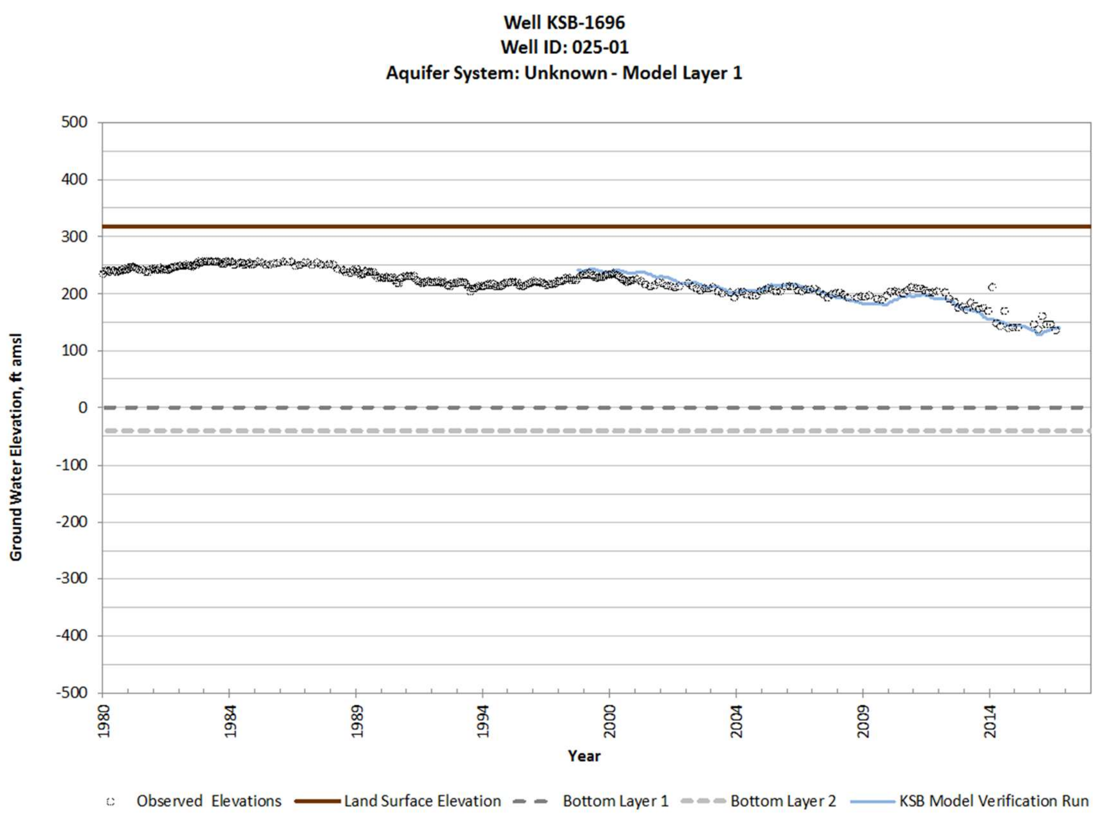

Well KSB-1214
Well ID: 18S23E02Q01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

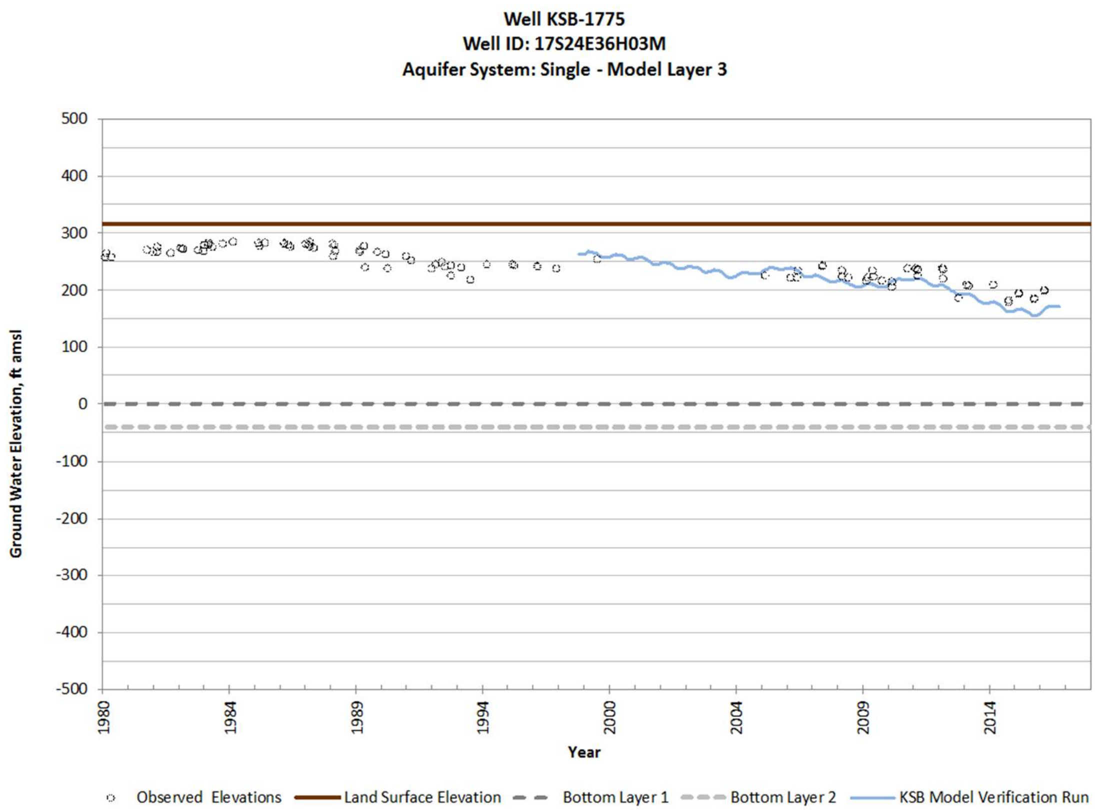

Well KSB-1226
Well ID: 19S23E35H01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

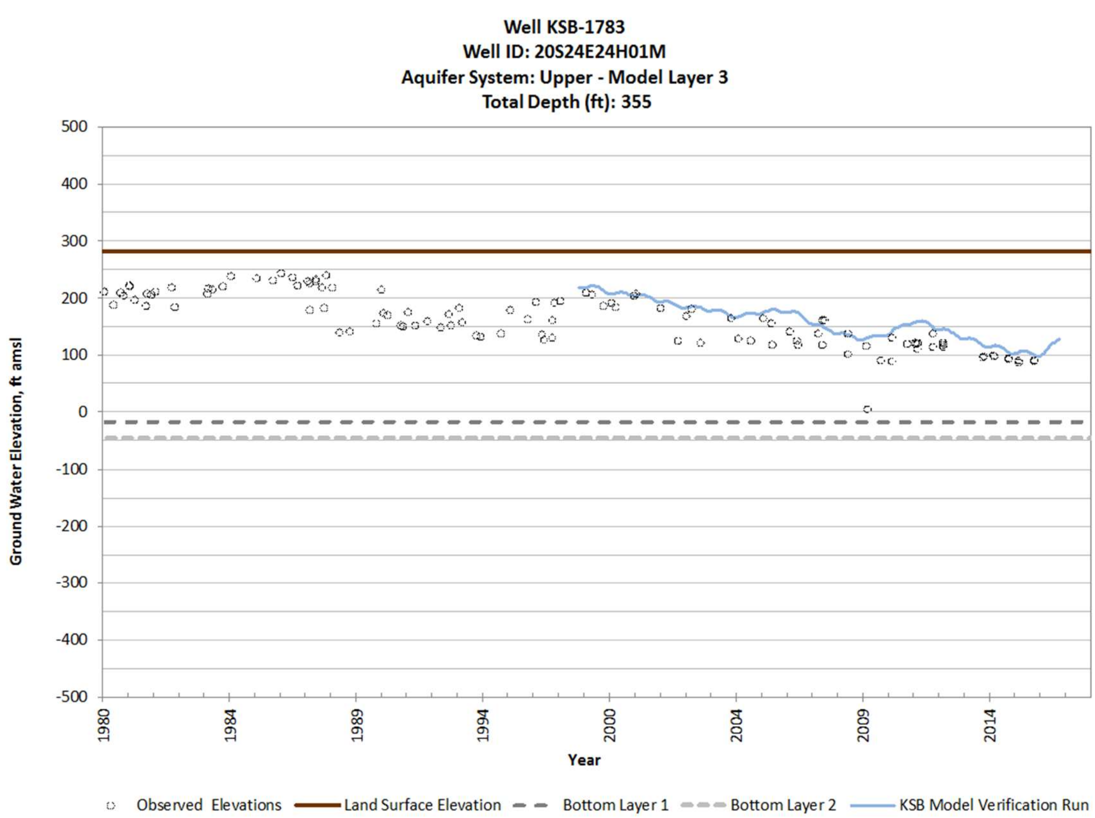

Well KSB-1425
Well ID: 21S24E08A01M
Aquifer System: Lower - Model Layer 1
Total Depth (ft): 520
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

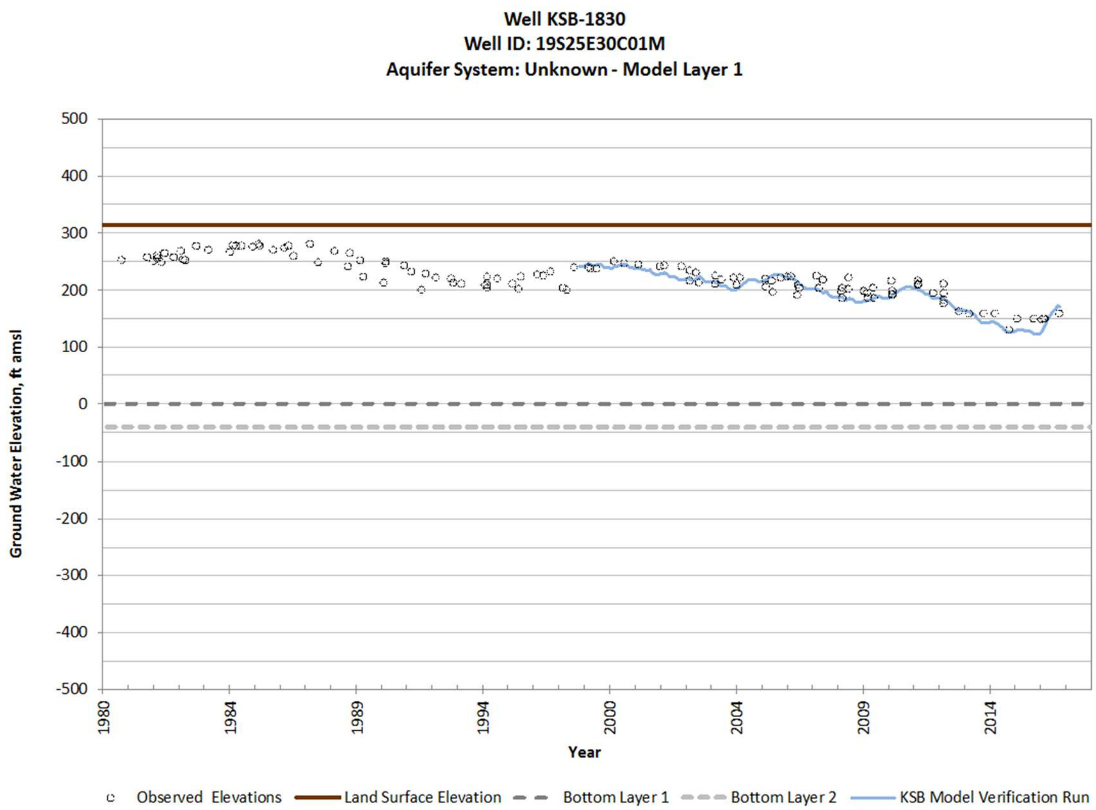

Well KSB-1490
Well ID: 21S24E33J01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run (Buffer Zone)

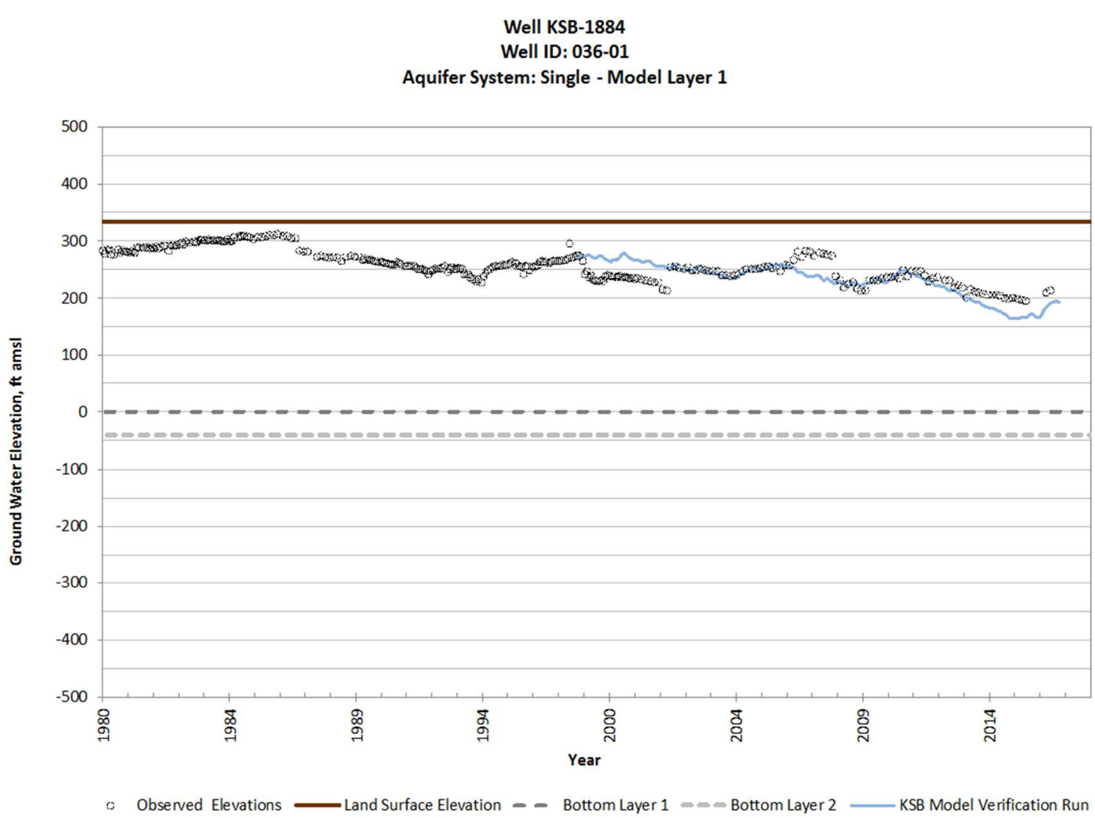

Well KSB-1535
Well ID: 21S24E03L01M
Aquifer System: Upper - Model Layer 3
Total Depth (ft): 325
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run


Well KSB-1696
Well ID: 025-01
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

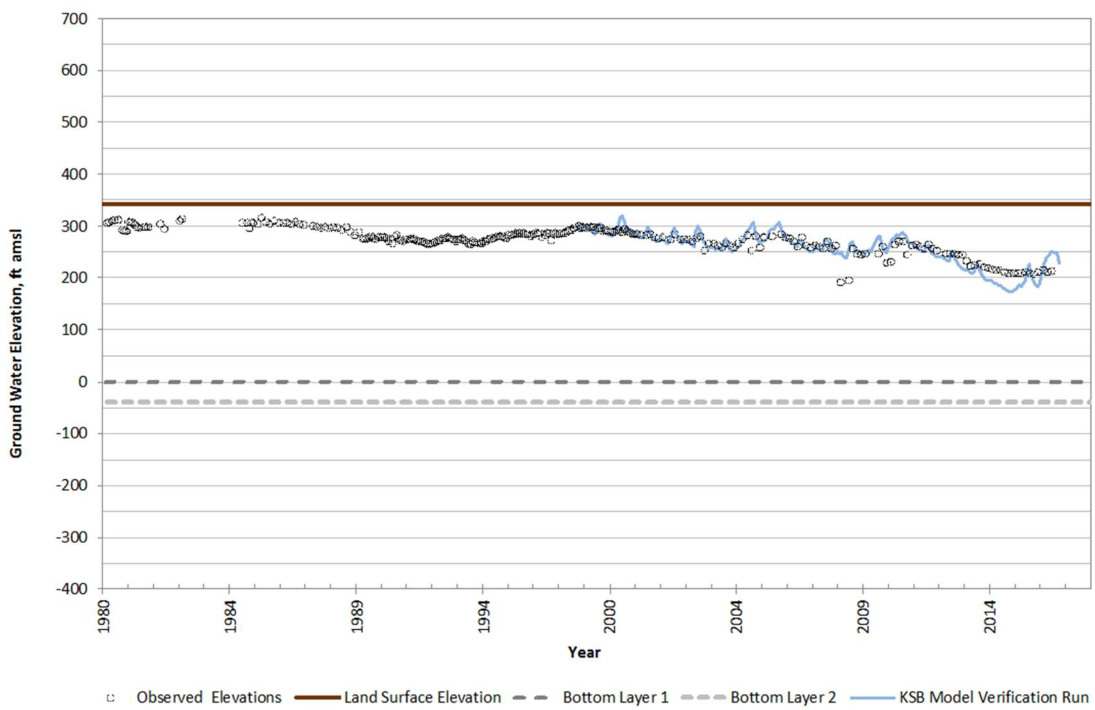

Well KSB-1775
Well ID: 17S24E36H03M
Aquifer System: Single - Model Layer 3
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run


Well KSB-1783
Well ID: 20S24E24H01M
Aquifer System: Upper - Model Layer 3
Total Depth (ft): 355
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

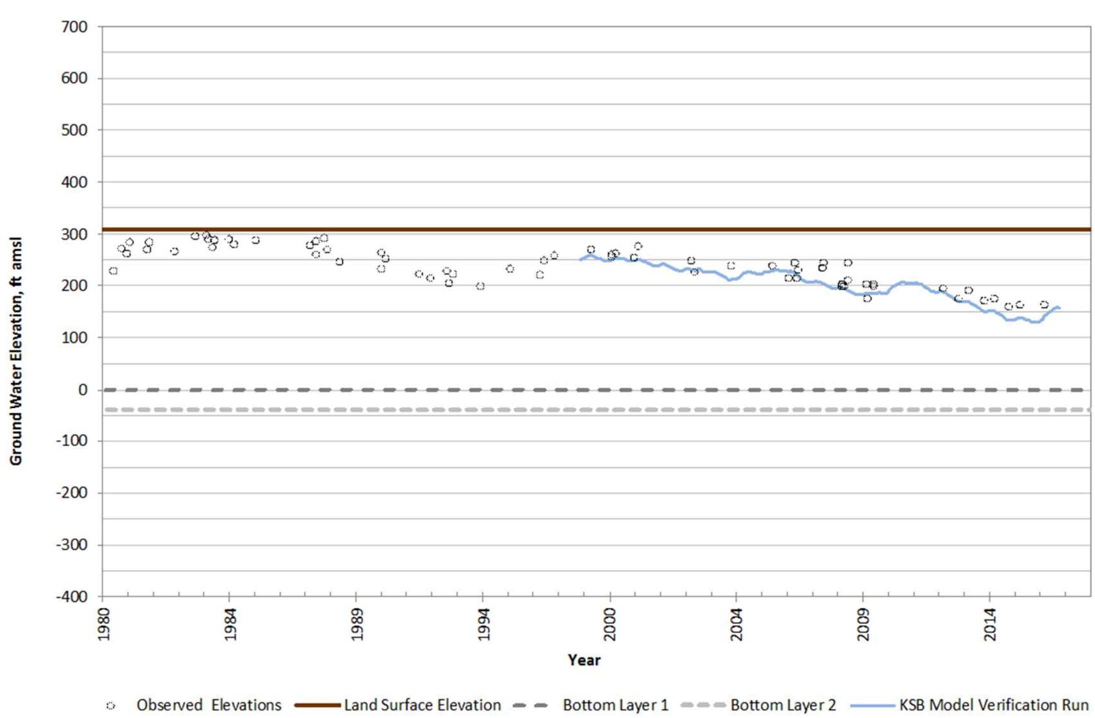

Well KSB-1830
Well ID: 19S25E30C01M
Aquifer System: Unknown - Model Layer 1
500
400
300
200
100
0
-100
-200
-300
-400
-500
Ground Water Elevation, ft amsl
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

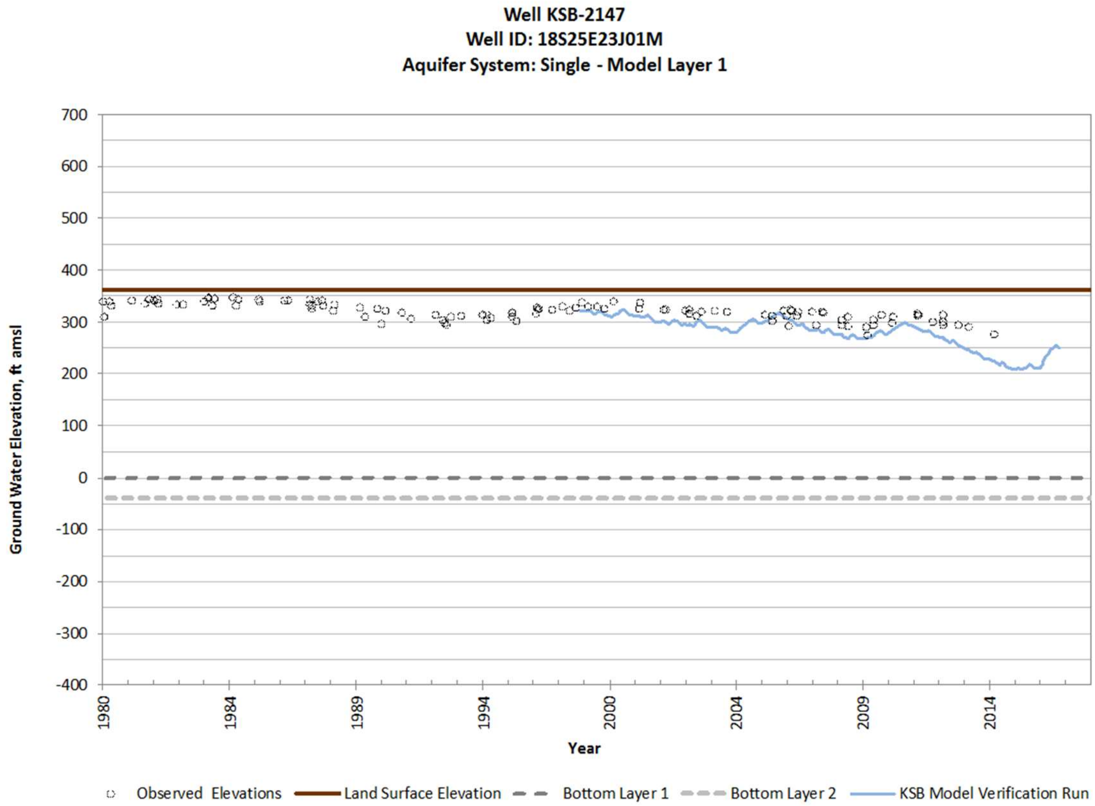

Well KSB-1884
Well ID: 036-01
Aquifer System: Single - Model Layer 1
500
400
300
200
100
0
-100
-200
-300
-400
-500
Ground Water Elevation, ft amsl
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

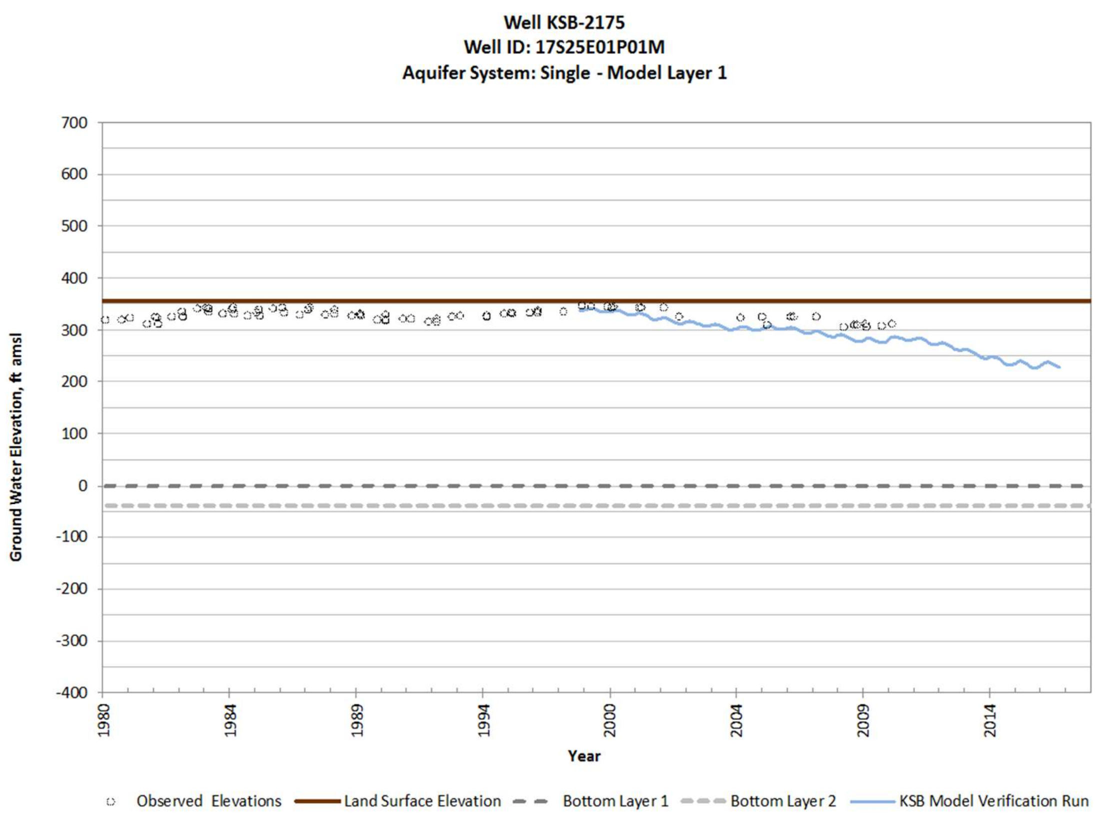
Well KSB-1977
Well ID: 053-01
Aquifer System: Single - Model Layer 1

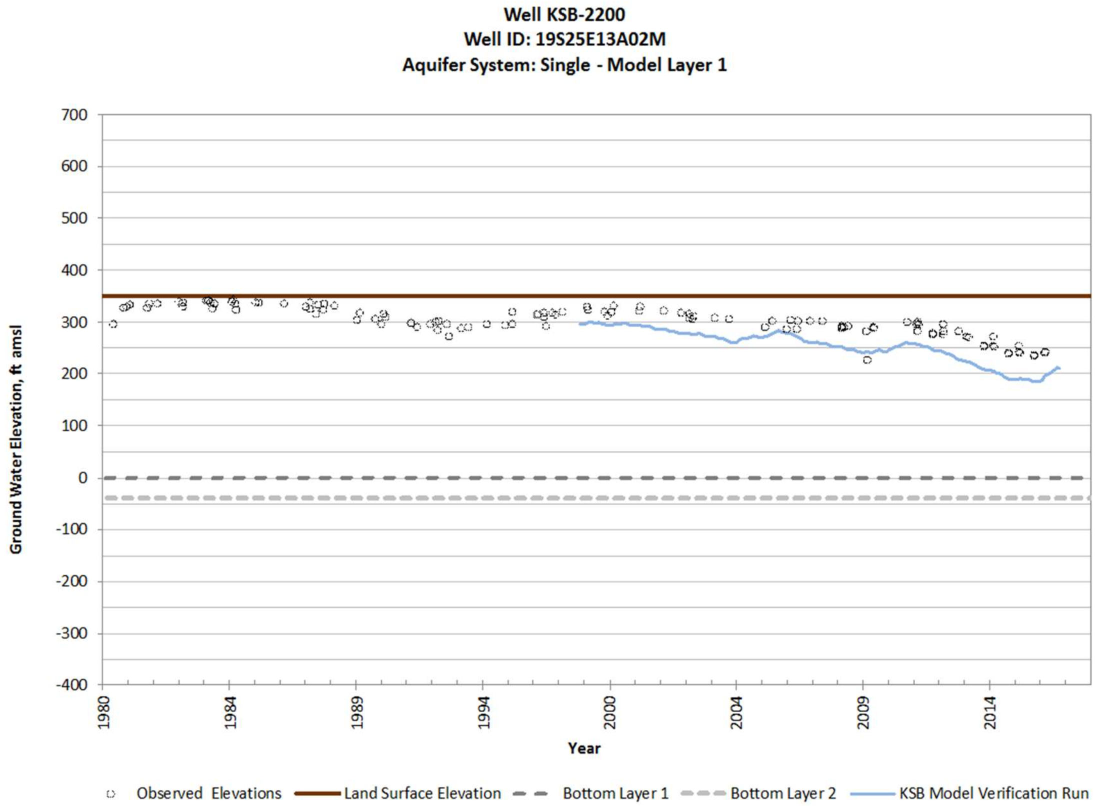


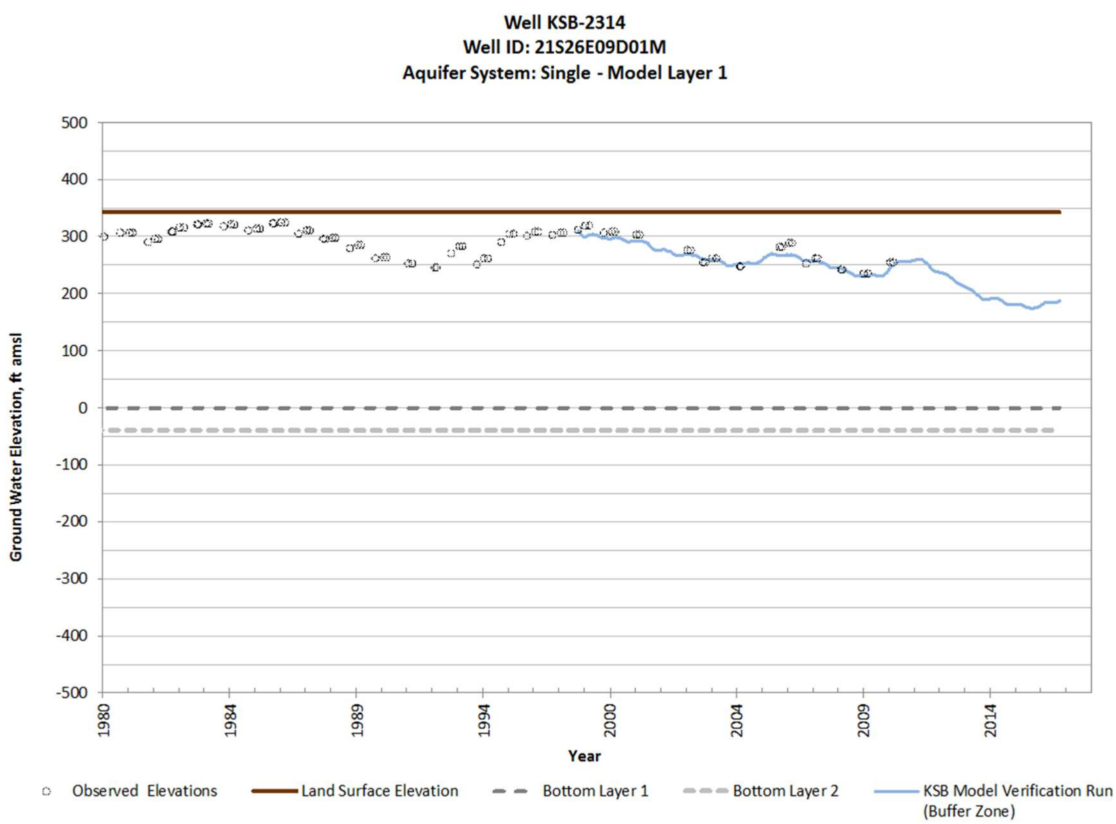
Well KSB-2095
Well ID: 20S25E03R01M
Aquifer System: Single - Model Layer 1

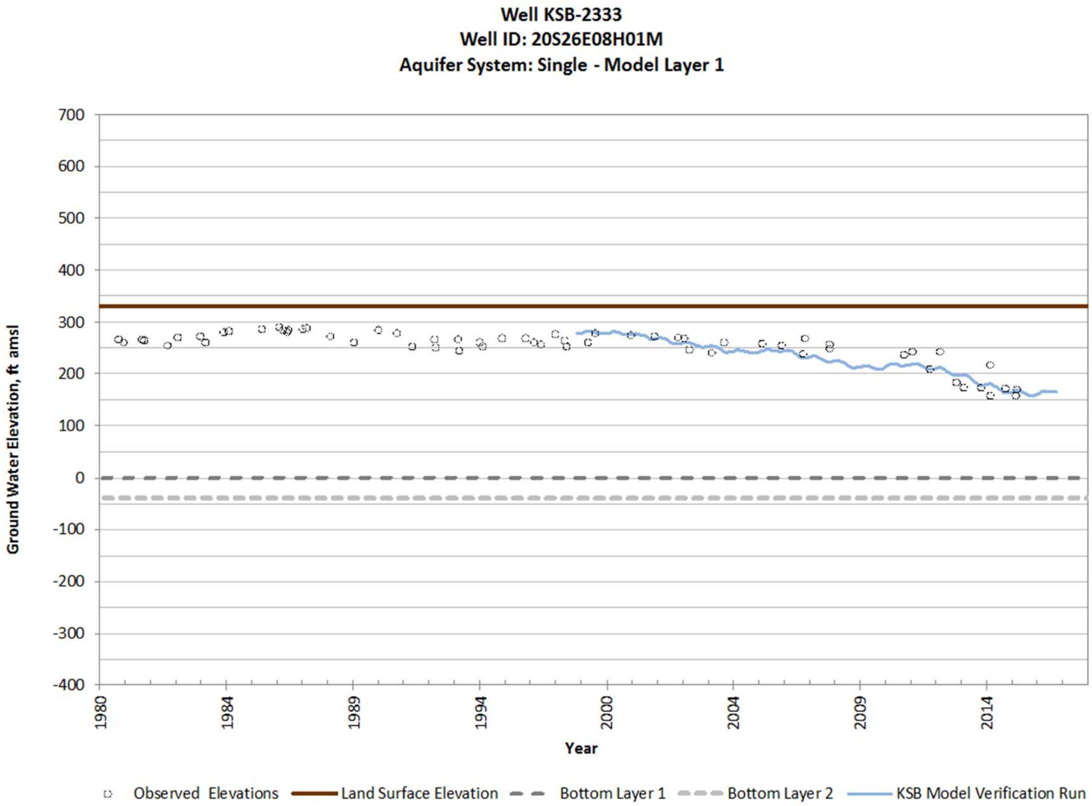


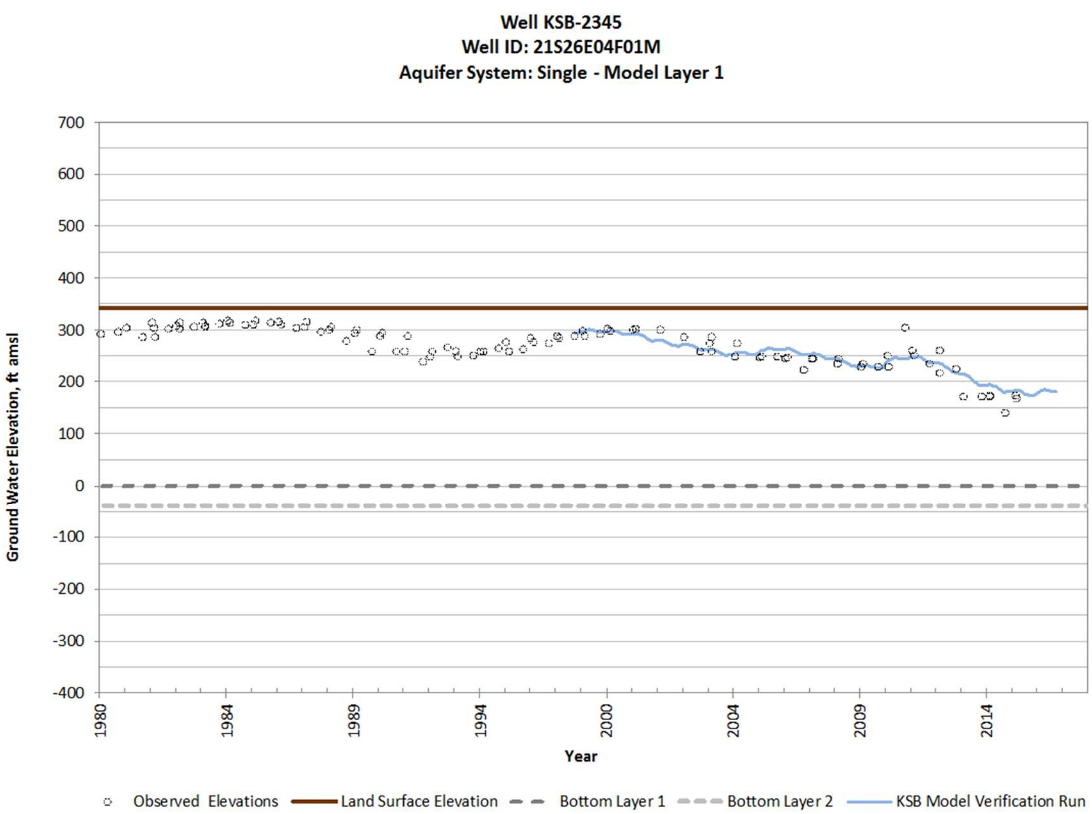

Well KSB-2147
Well ID: 18S25E23J01M
Aquifer System: Single - Model Layer 1
Ground Water Elevation, ft amsl
700
600
500
400
300
200
100
0
-100
-200
-300
-400
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

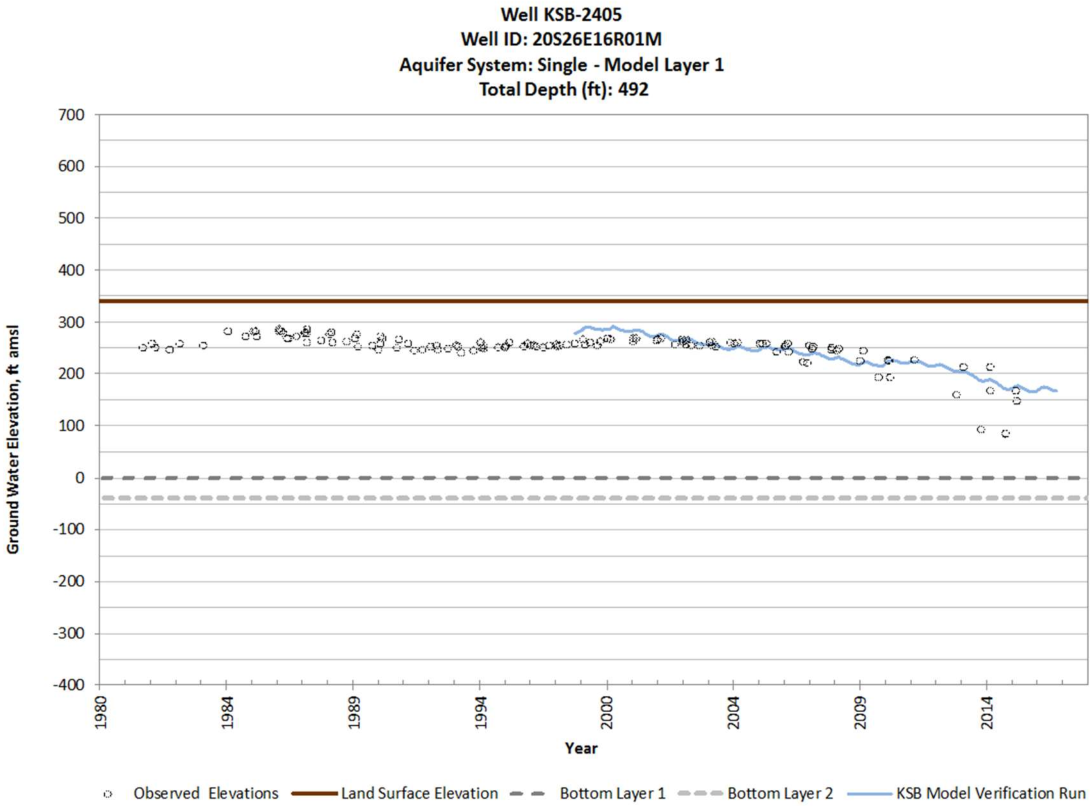

Well KSB-2175
Well ID: 17S25E01P01M
Aquifer System: Single - Model Layer 1
Ground Water Elevation, ft amsl
700
600
500
400
300
200
100
0
-100
-200
-300
-400
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

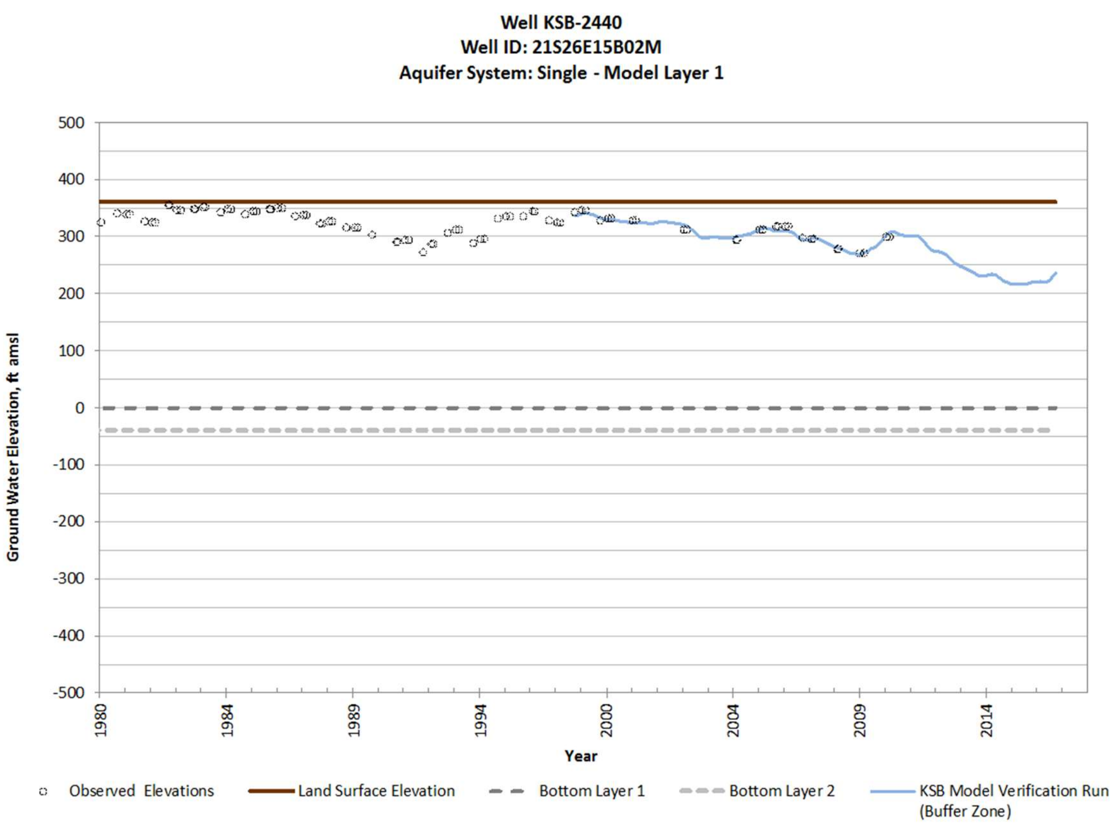

Well KSB-2200
Well ID: 19S25E13A02M
Aquifer System: Single - Model Layer 1
Ground Water Elevation, ft amsl
700
600
500
400
300
200
100
0
-100
-200
-300
-400
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

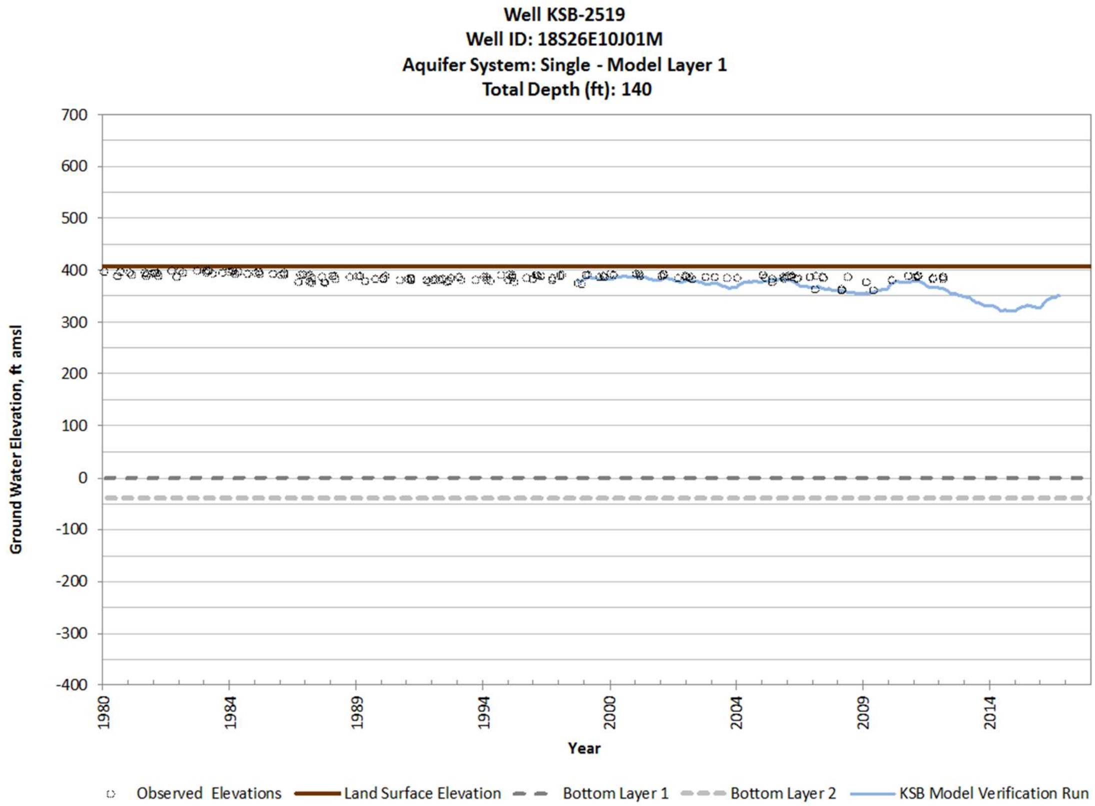

Well KSB-2314
Well ID: 21S26E09D01M
Aquifer System: Single - Model Layer 1
Ground Water Elevation, ft amsl
500
400
300
200
100
0
-100
-200
-300
-400
-500
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run (Buffer Zone)

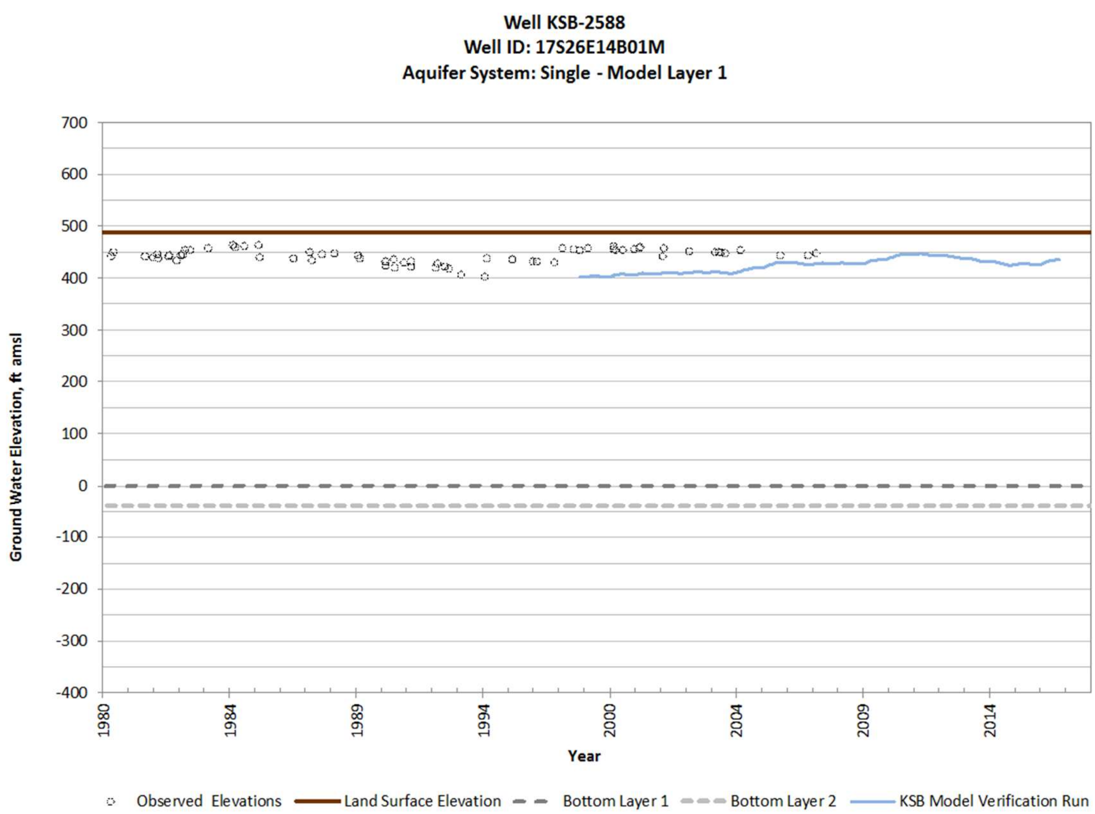

Well KSB-2333
Well ID: 20S26E08H01M
Aquifer System: Single - Model Layer 1
Ground Water Elevation, ft amsl
700
600
500
400
300
200
100
0
-100
-200
-300
-400
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run


Well KSB-2345
Well ID: 21S26E04F01M
Aquifer System: Single - Model Layer 1
Ground Water Elevation, ft amsl
700
600
500
400
300
200
100
0
-100
-200
-300
-400
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

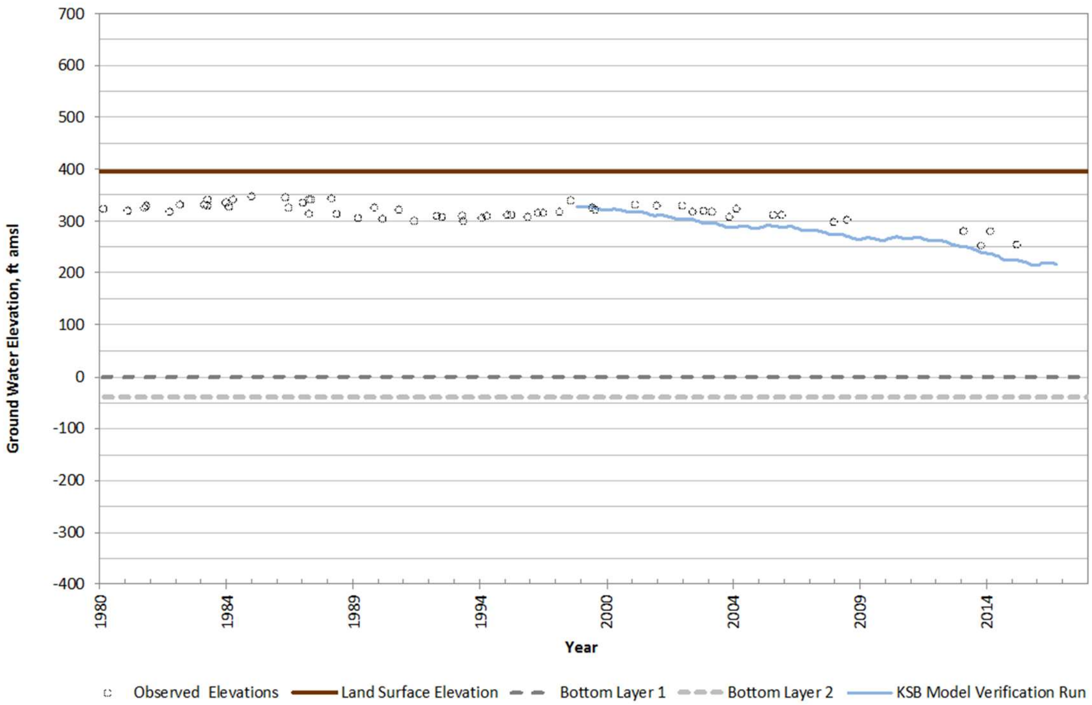

Well KSB-2405
Well ID: 20S26E16R01M
Aquifer System: Single - Model Layer 1
Total Depth (ft): 492
Ground Water Elevation, ft amsl
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run


Well KSB-2440
Well ID: 21S26E15B02M
Aquifer System: Single - Model Layer 1
Ground Water Elevation, ft amsl
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run (Buffer Zone)

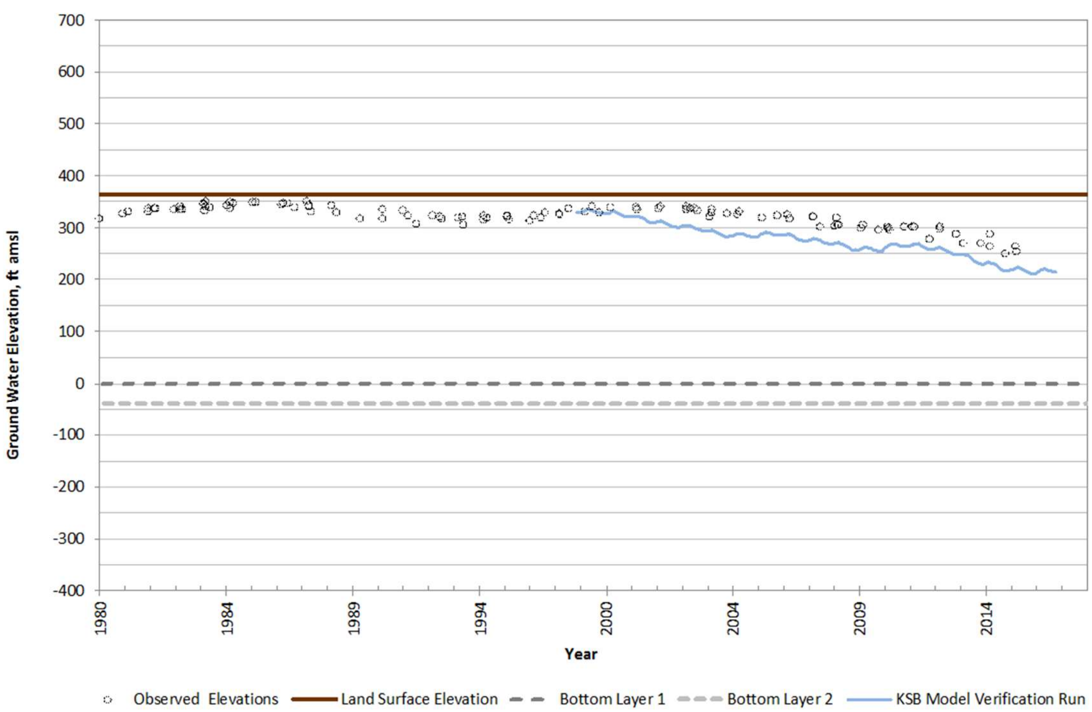

Well KSB-2519
Well ID: 18S26E10J01M
Aquifer System: Single - Model Layer 1
Total Depth (ft): 140
Ground Water Elevation, ft amsl
700
600
500
400
300
200
100
0
-100
-200
-300
-400
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

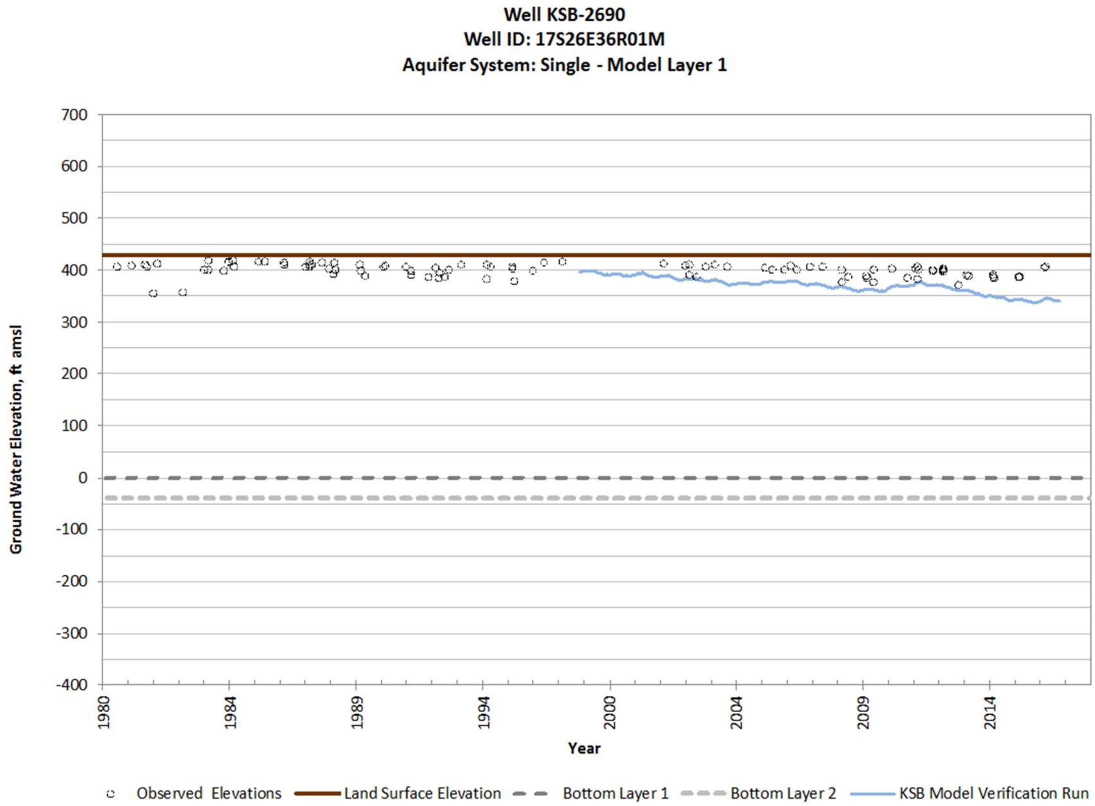

Well KSB-2588
Well ID: 17S26E14B01M
Aquifer System: Single - Model Layer 1
Ground Water Elevation, ft amsl
700
600
500
400
300
200
100
0
-100
-200
-300
-400
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

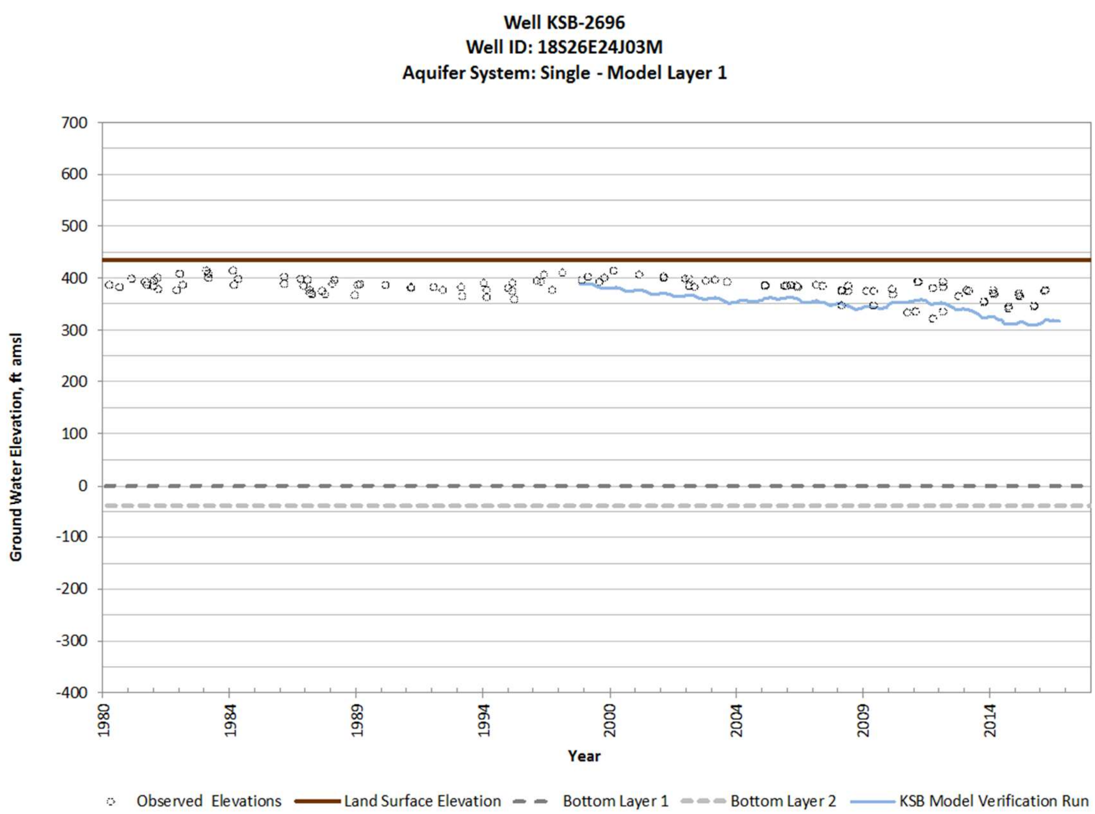
Well KSB-2593
Well ID: 19S26E11R01M
Aquifer System: Single - Model Layer 1



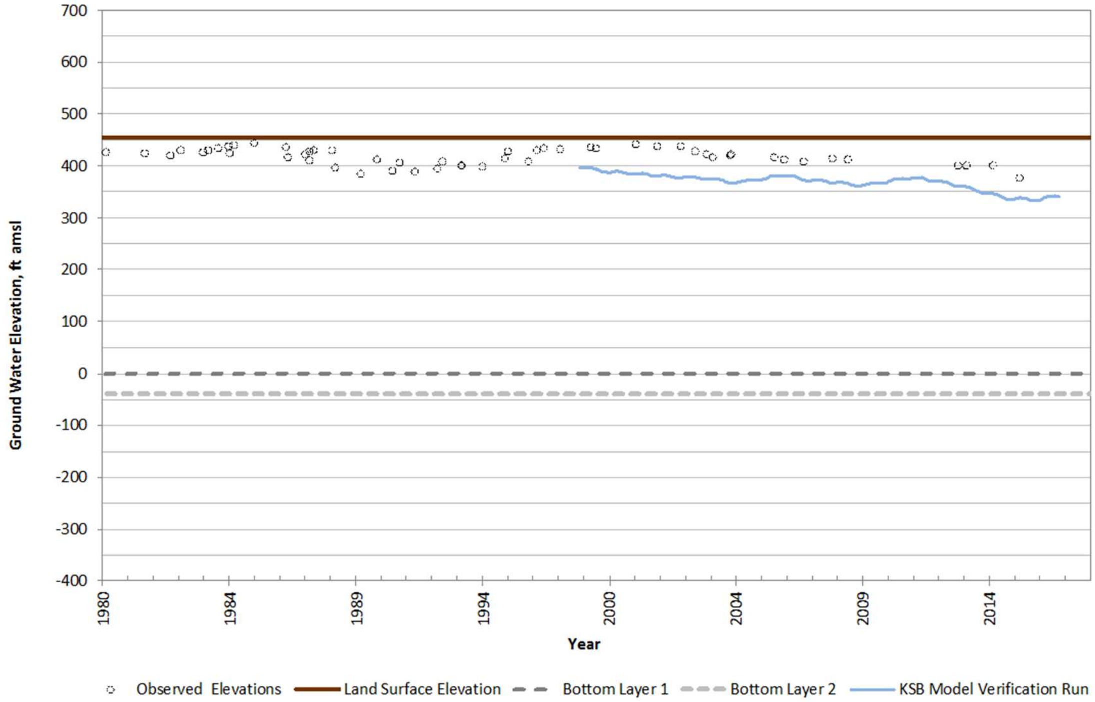
Well KSB-2618
Well ID: 20S26E35H01M
Aquifer System: Single - Model Layer 1



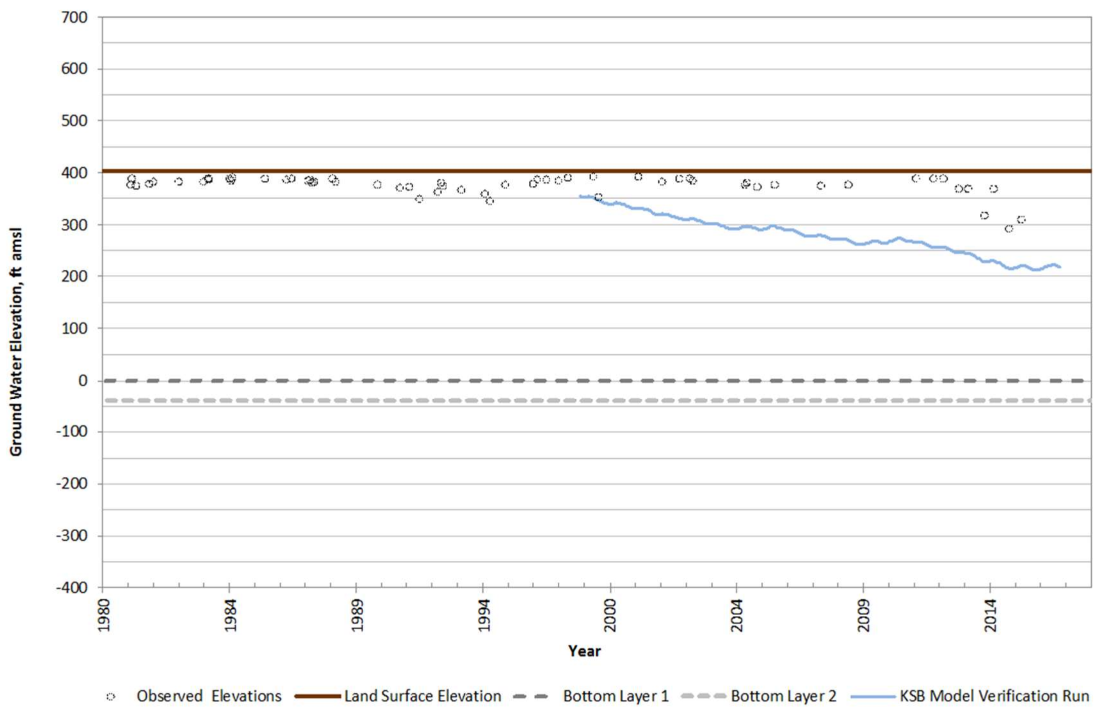

Well KSB-2690
Well ID: 17S26E36R01M
Aquifer System: Single - Model Layer 1
Ground Water Elevation, ft amsl
700
600
500
400
300
200
100
0
-100
-200
-300
-400
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

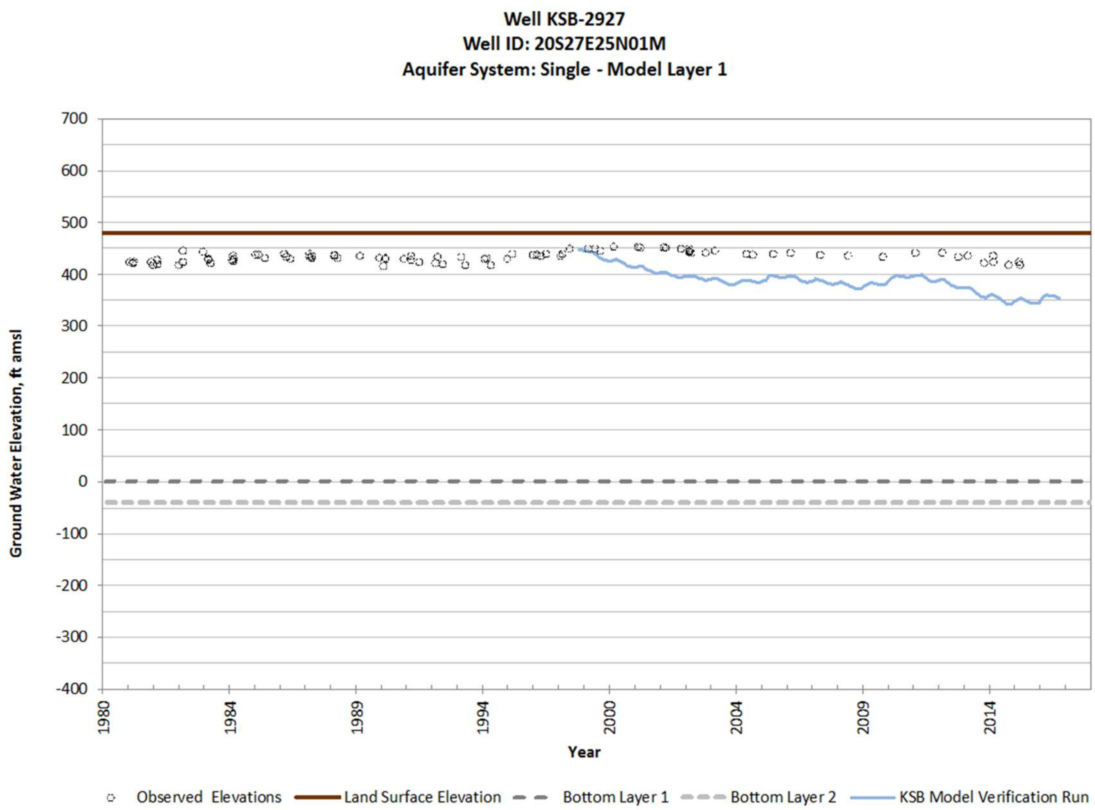

Well KSB-2696
Well ID: 18S26E24J03M
Aquifer System: Single - Model Layer 1
Ground Water Elevation, ft amsl
700
600
500
400
300
200
100
0
-100
-200
-300
-400
1980
1984
1989
1994
2000
2004
2009
2014
Year
Observed Elevations
Land Surface Elevation
Bottom Layer 1
Bottom Layer 2
KSB Model Verification Run

Well KSB-2773
Well ID: 18S27E30H01M
Aquifer System: Single - Model Layer 1
Total Depth (ft): 213



Well KSB-2826
Well ID: 20S27E08A01M
Aquifer System: Single - Model Layer 1





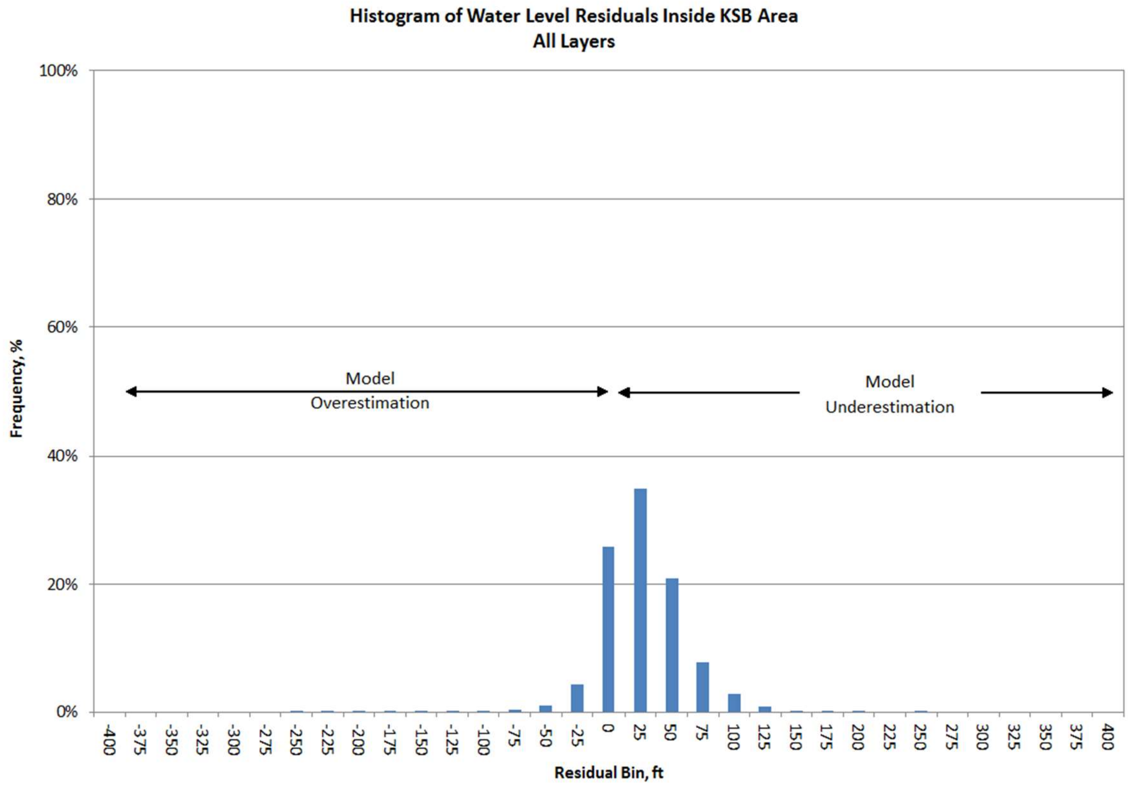
Model Statistics

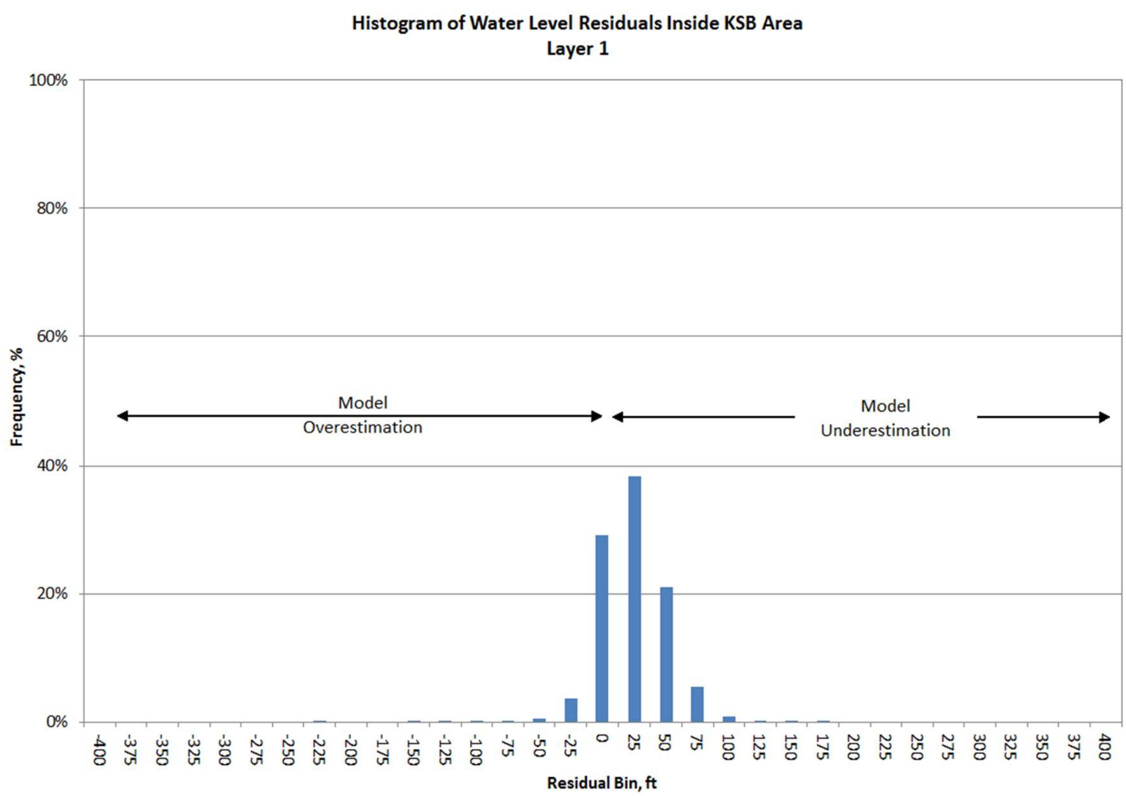
Wells in Kaweah Subbasin

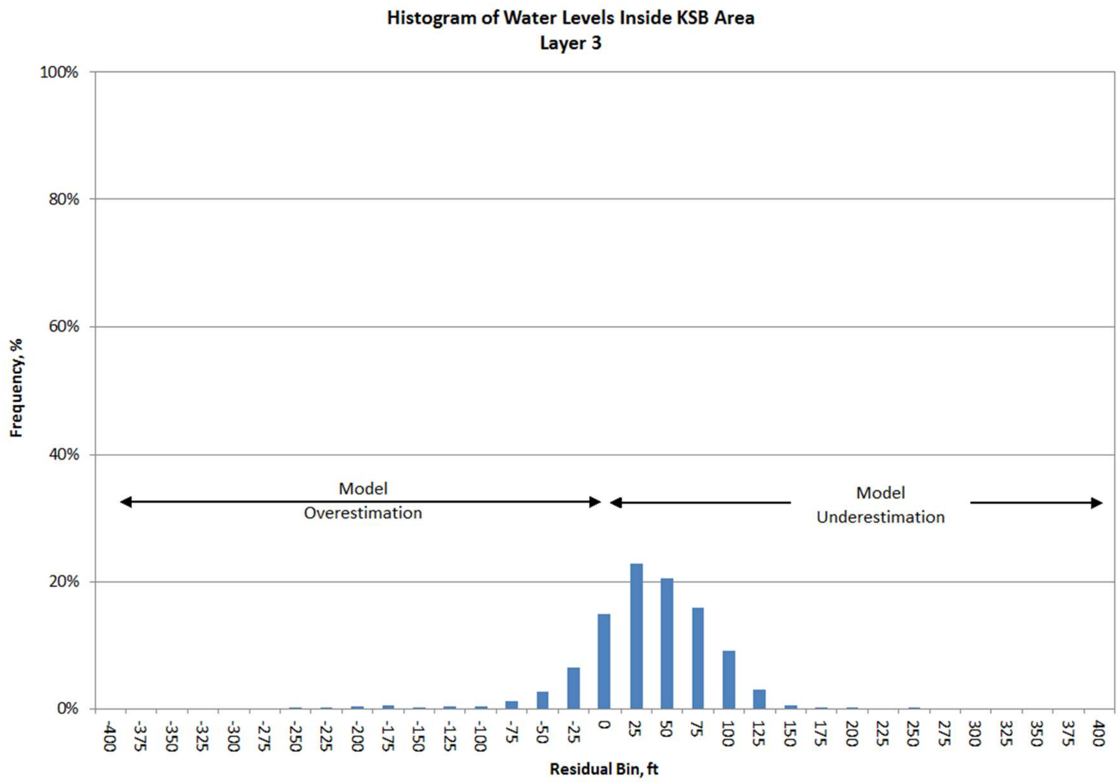
The graphs below show trends and comparisons of the groundwater model data. The data is shown for All Layers (all wells), Layer 1 (wells in layer 1), and Layer 3 (wells in Layer 3). The three main graphs in each section are as follows:

1. Histogram of Water Level Residuals
2. Temporal Distribution of Water Level Residuals
3. Measured vs Model- Calculated Water Levels

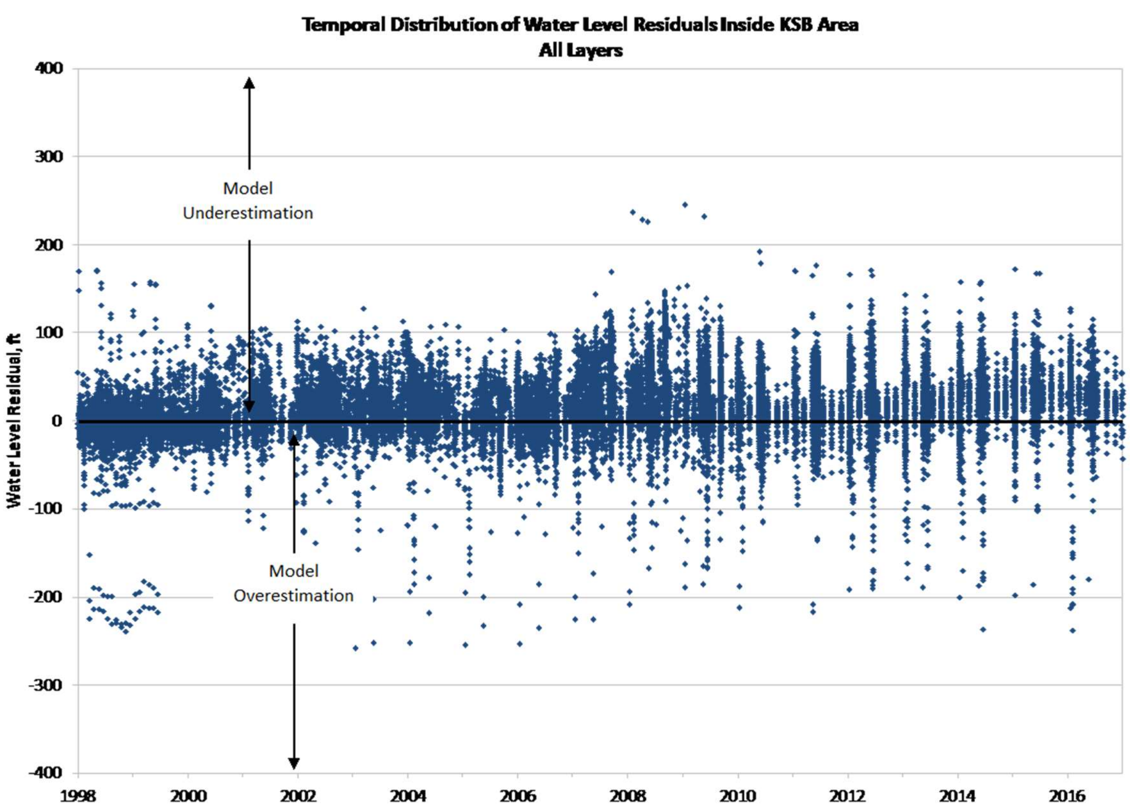
Histogram of Water Level Residual

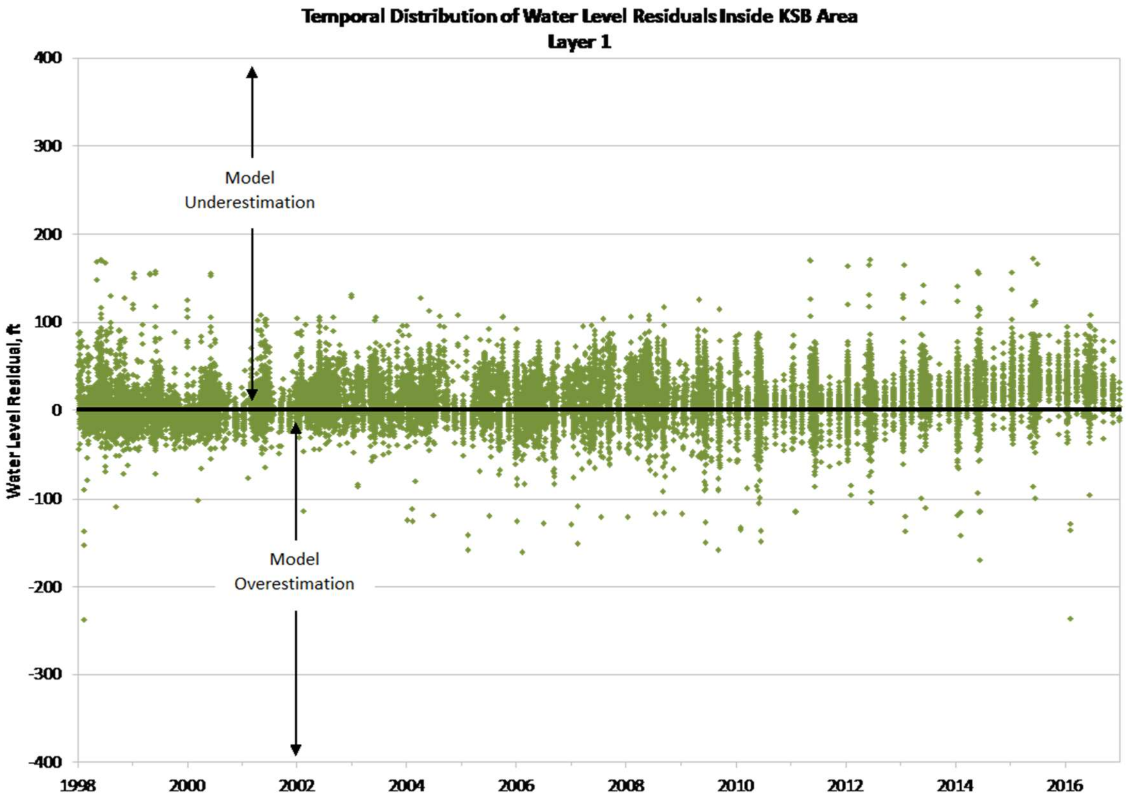


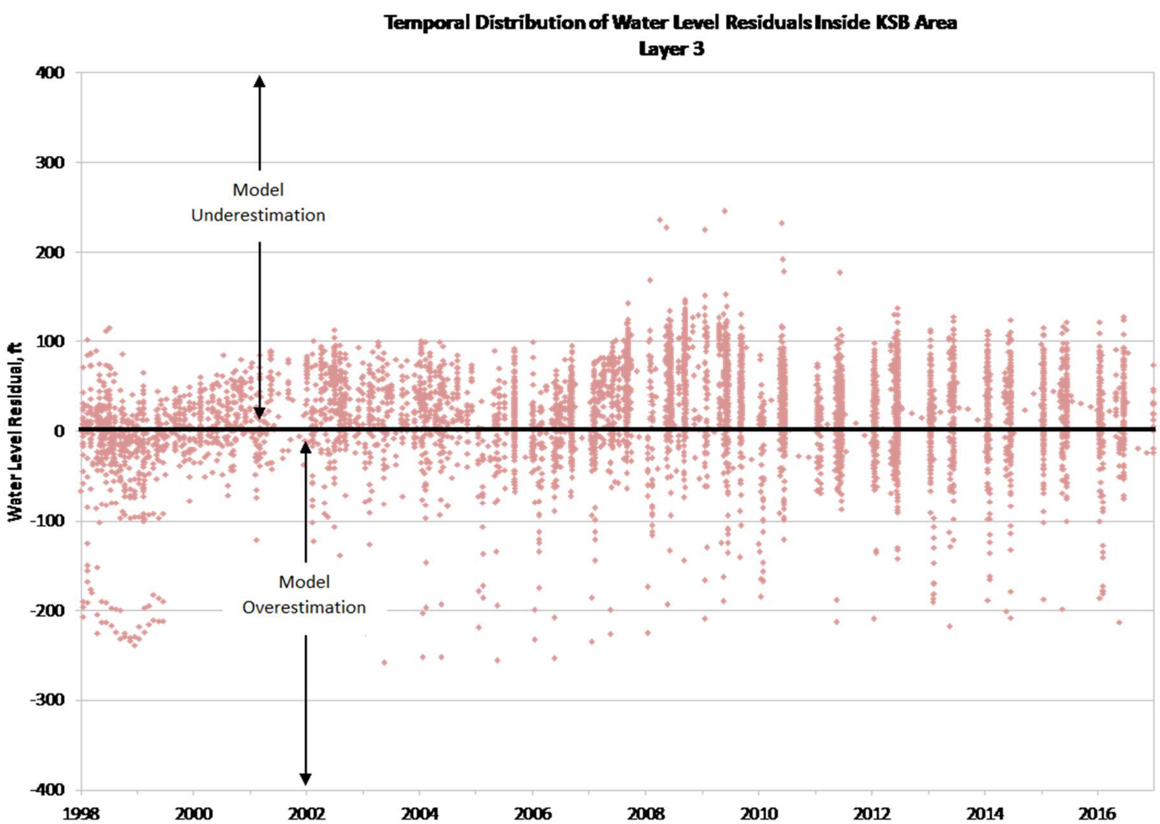




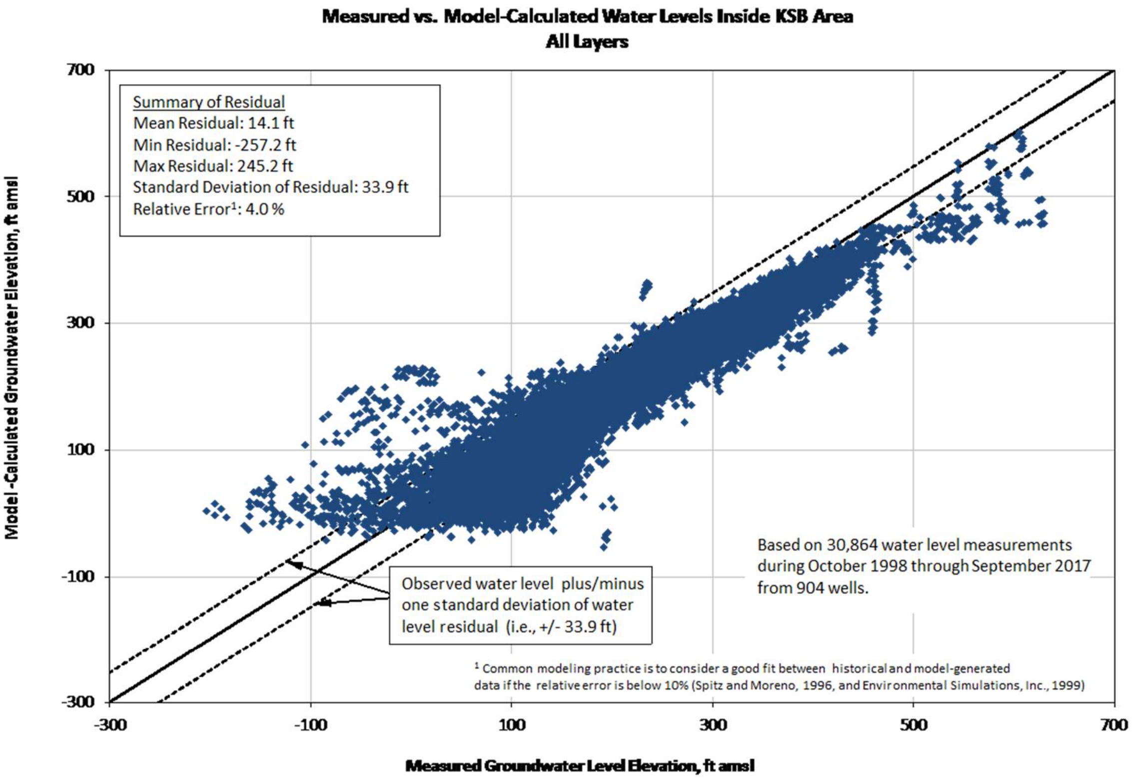
Temporal Distribution of Water Level Residuals

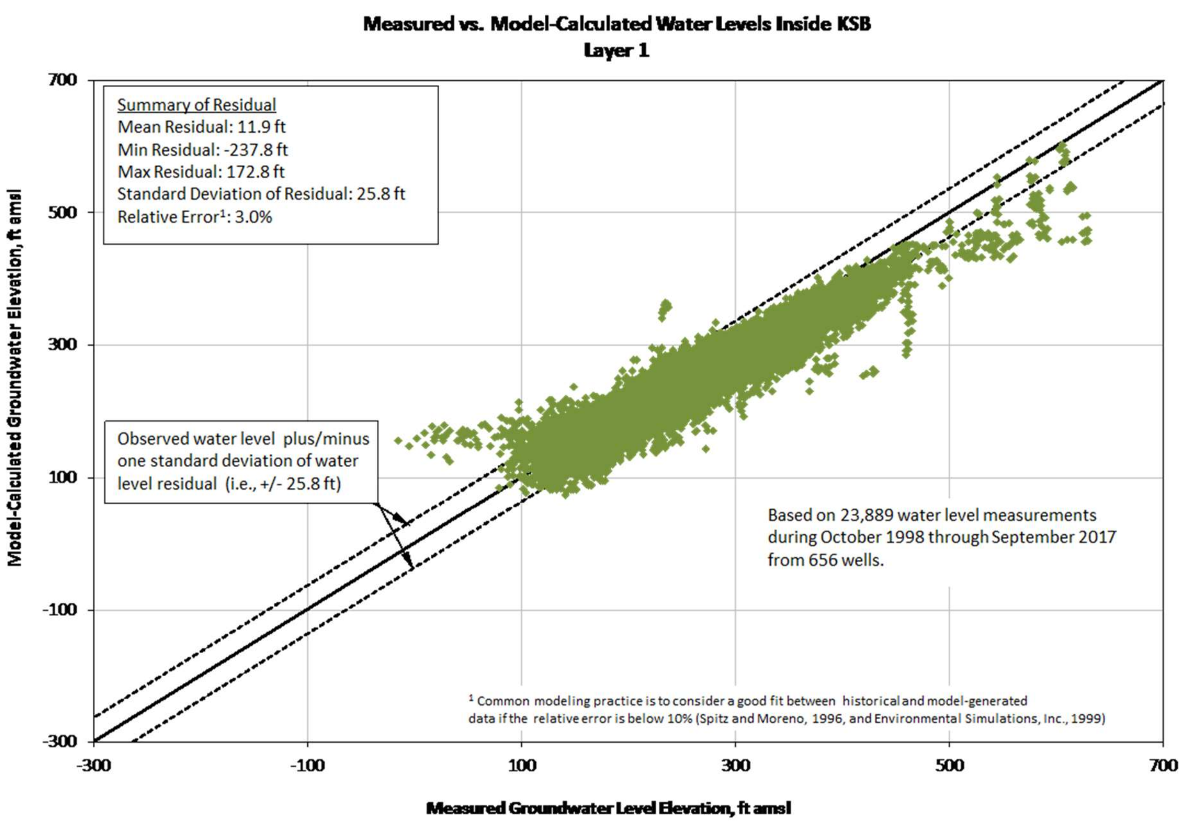


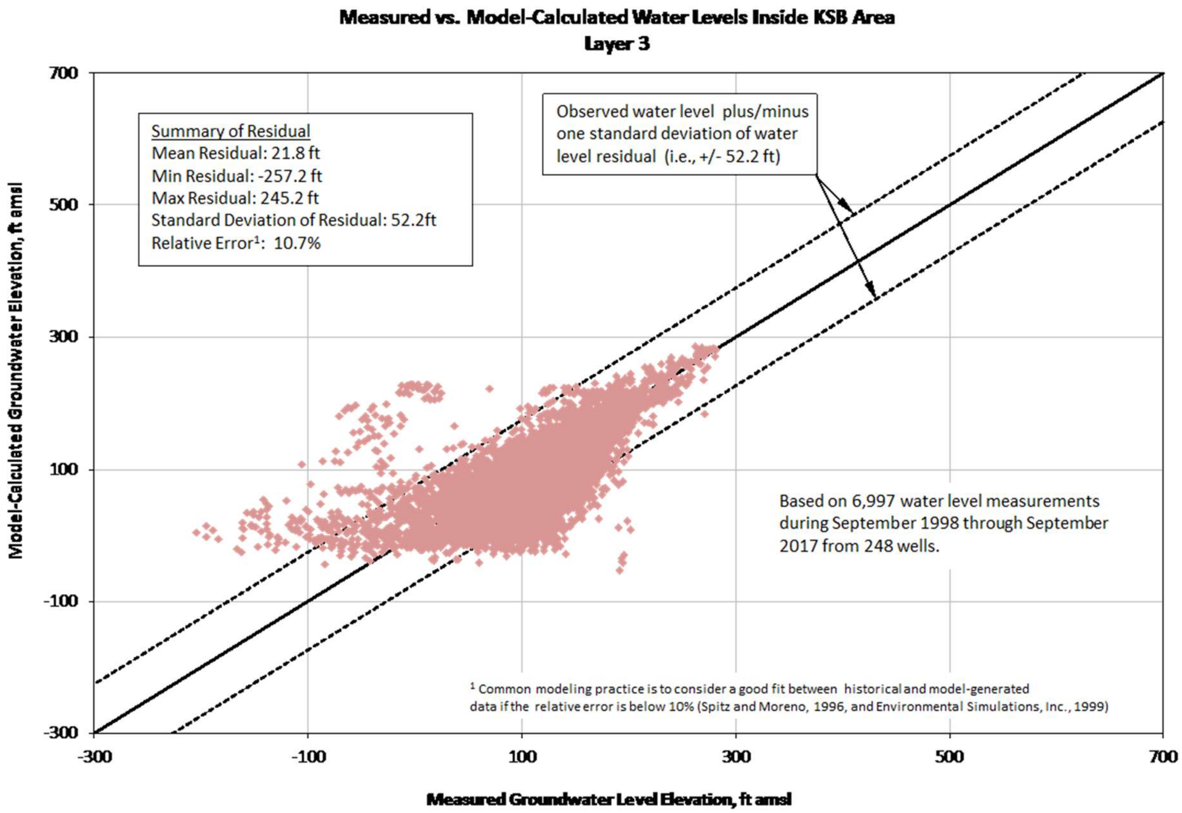

Temporal Distribution of Water Level Residuals Inside KSB Area
Layer 1
Water Level Residual, ft
400
300
200
100
0
-100
-200
-300
-400
Model
Underestimation
Model
Overestimation
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


Temporal Distribution of Water Level Residuals Inside KSB Area
Layer 3
Water Level Residual, ft
400
300
200
100
0
-100
-200
-300
-400
Model
Underestimation
Model
Overestimation
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

Measured vs Model-Calculated Water Levels







Comparing the Residual Layers

The residual from measured and modeling results are computed for 23,889 water level measurements from 656 wells between October 1998 through September 2017. Based on the values of relative error, we can conclude that there is a good fit between measured and model-generated data since the relative error is 3% in layer 1 and just over 10% in layer 3.

Summary of Residual	KSB Layer 1	KSB Layer 3	All Layers
Mean Residual (ft)	11.9	21.8	
Min Residual (ft)	-237.8	-257.2	
Max Residual (ft)	172.8	245.2	
Standard Dev. of Residual (ft)	25.8	52.2	
Relative Error (%)	3.0	10.7	

**Note common modeling practice is to consider a good fit between historical and model-generated data if the relative error is below 10%. (Spitz and Moreno, 1996, and Environmental Simulation, Inc., 1999)*

Appendix 2: Full Kaweah Subbasin Results

Full Results for Case 1: Base Case of Future with Averaged Conditions and No Projects

Water Year	Inflow (Acre-Feet/Year)			Outflow (Acre-Feet/Year)					Storage	
	Recharge	Underflow Buffer to KSB	Total Inflow	Ag Pumping	Aquifer Discharge to Streams	Non-Ag Pumping	Underflow KSB to Buffer	Total Outflow	Change in Storage (Acre-Feet/Year)	Cumulative Change in Storage (Acre-Feet)
2020	676,105	185,429	861,534	726,105	0	101,360	60,420	887,886	-26,352	-26,352
2021	673,620	203,678	877,298	732,860	0	103,682	59,393	895,935	-18,637	-44,989
2022	673,620	205,414	879,035	739,458	0	106,216	61,291	906,965	-27,930	-72,920
2023	673,620	206,638	880,258	747,097	0	108,525	62,616	918,238	-37,980	-110,900
2024	676,105	208,646	884,751	755,303	0	110,849	63,749	929,901	-45,151	-156,050
2025	673,620	210,193	883,814	761,862	0	113,133	64,127	939,122	-55,309	-211,359
2026	673,620	212,602	886,222	768,886	0	115,649	64,536	949,071	-62,849	-274,208
2027	673,620	215,400	889,020	776,094	0	118,164	64,784	959,042	-70,022	-344,230
2028	676,105	218,919	895,024	782,900	0	120,927	65,156	968,984	-73,960	-418,189
2029	673,620	221,930	895,550	791,008	0	123,195	64,942	979,145	-83,595	-501,784
2030	673,620	225,496	899,117	797,556	0	125,708	64,967	988,231	-89,114	-590,899
2031	673,620	229,677	903,297	800,937	0	127,891	64,713	993,540	-90,244	-681,142
2032	676,099	233,290	909,388	801,646	0	130,418	65,071	997,136	-87,747	-768,890
2033	673,608	236,093	909,701	803,611	0	132,652	64,880	1,001,142	-91,441	-860,330
2034	673,606	239,534	913,140	806,077	0	135,154	64,870	1,006,100	-92,960	-953,291
2035	673,599	242,693	916,292	806,308	0	137,524	64,955	1,008,787	-92,495	-1,045,786
2036	676,068	246,934	923,002	811,192	0	138,989	65,077	1,015,258	-92,256	-1,138,041
2037	673,581	249,855	923,436	812,030	0	139,192	64,817	1,016,039	-92,603	-1,230,644
2038	673,578	253,266	926,844	813,739	0	141,351	64,797	1,019,887	-93,044	-1,323,688
2039	673,572	256,382	929,954	813,325	0	143,285	64,862	1,021,472	-91,518	-1,415,206
2040	676,029	260,125	936,154	815,379	0	142,321	65,149	1,022,849	-86,695	-1,501,901
Average 2020-2040	**674,316**	**226,771**	**901,087**	**783,970**	**0**	**124,580**	**64,056**	**972,606**	**-71,519**	**-650,990**

Full Results for Case 2: Future with Interannual Variability and No Projects

Water Year	Inflow (Acre-Feet/Year)			Outflow (Acre-Feet/Year)					Storage	
	Recharge	Underflow Buffer to KSB	Total Inflow	Ag Pumping	Aquifer Discharge to Streams	Non-Ag Pumping	Underflow KSB to Buffer	Total Outflow	Change in Storage (Acre-Feet/Year)	Cumulative Change in Storage (Acre-Feet)
2020	927,137	157,959	1,085,096	503,909	0	94,915	68,183	667,008	418,089	418,089
2021	1,186,432	212,662	1,399,094	450,049	44	97,438	47,322	594,852	804,242	1,222,330
2022	602,179	212,753	814,933	635,499	1,805	92,423	37,741	767,469	47,464	1,269,794
2023	688,052	195,456	883,509	677,926	548	92,275	56,153	826,902	56,607	1,326,401
2024	509,897	198,662	708,559	800,353	205	104,082	76,157	980,797	-272,239	1,054,163
2025	563,000	210,854	773,854	838,657	2	112,096	72,617	1,023,371	-249,517	804,646
2026	596,378	211,899	808,276	762,498	74	113,199	86,234	962,005	-153,729	650,917
2027	474,937	220,772	695,709	913,175	282	127,425	80,387	1,121,269	-425,560	225,356
2028	914,170	208,284	1,122,455	549,253	0	113,285	49,995	712,533	409,922	635,278
2029	820,036	183,763	1,003,799	564,464	0	119,950	47,269	731,683	272,116	907,394
2030	462,915	193,897	656,812	1,039,718	791	145,966	96,036	1,282,511	-625,700	281,694
2031	597,824	195,972	793,796	894,045	0	149,384	107,367	1,150,796	-357,000	-75,306
2032	514,239	219,117	733,356	951,074	102	148,989	105,343	1,205,508	-472,152	-547,458
2033	774,102	230,418	1,004,520	658,256	3	140,618	82,814	881,690	122,830	-424,628
2034	950,150	240,907	1,191,058	573,989	0	131,217	53,043	758,248	432,809	8,181
2035	496,704	243,265	739,969	972,719	959	147,809	91,836	1,213,323	-473,354	-465,173
2036	569,699	264,392	834,091	1,106,537	120	151,409	101,256	1,359,323	-525,232	-990,405
2037	407,524	274,466	681,990	1,185,193	99	144,434	80,170	1,409,897	-727,907	-1,718,312
2038	390,111	279,092	669,202	1,110,319	0	130,837	74,606	1,315,762	-646,559	-2,364,871
2039	536,273	259,803	796,076	822,968	15	125,676	82,866	1,031,525	-235,449	-2,600,320
2040	1,190,394	292,662	1,483,056	502,512	43	126,799	69,085	698,439	784,616	-1,815,704
Average 2020-2040	**674,864**	**224,146**	**899,010**	**786,339**	**242**	**124,297**	**74,594**	**985,472**	**-86,462**	**-104,663**

Full Results for Case 3: Future with Interannual Variability Reversed and No Projects

Water Year	Inflow (Acre-Feet/Year)			Outflow (Acre-Feet/Year)					Storage	
	Recharge	Underflow Buffer to KSB	Total Inflow	Ag Pumping	Recharge	Non-Ag Pumping	Underflow KSB to Buffer	Total Outflow	Change in Storage (Acre-Feet/Year)	Cumulative Change in Storage (Acre-Feet)
2020	1,191,324	173,864	1,365,188	507,156	43	143,667	103,103	753,969	611,219	611,219
2021	536,675	139,383	676,058	825,712	15	138,916	128,162	1,092,805	-416,747	194,472
2022	390,020	204,314	594,334	1,111,323	0	134,171	86,604	1,332,097	-737,764	-543,292
2023	407,240	252,324	659,565	1,185,336	99	145,928	73,509	1,404,873	-745,308	-1,288,600
2024	569,142	293,988	863,131	1,106,310	120	152,440	77,974	1,336,844	-473,714	-1,762,313
2025	496,017	328,383	824,400	972,217	959	144,469	59,633	1,177,277	-352,877	-2,115,190
2026	949,363	307,692	1,257,054	573,330	0	127,457	40,626	741,413	515,641	-1,599,549
2027	773,345	238,922	1,012,267	657,424	3	135,945	85,382	878,754	133,513	-1,466,036
2028	513,644	247,525	761,169	949,938	102	142,955	91,055	1,184,050	-422,881	-1,888,917
2029	596,916	276,709	873,624	892,780	0	141,484	73,496	1,107,761	-234,136	-2,123,053
2030	462,063	335,951	798,013	1,036,097	791	140,731	53,233	1,230,852	-432,839	-2,555,892
2031	818,253	341,336	1,159,589	559,479	0	115,896	30,396	705,771	453,818	-2,102,074
2032	912,126	287,218	1,199,344	544,284	0	109,023	43,026	696,332	503,011	-1,599,063
2033	473,254	287,541	760,795	905,896	282	123,092	66,352	1,095,623	-334,828	-1,933,891
2034	594,562	305,782	900,344	755,785	74	109,375	61,840	927,074	-26,730	-1,960,621
2035	560,653	319,746	880,399	831,448	2	110,548	48,648	990,645	-110,247	-2,070,868
2036	507,841	332,929	840,771	792,976	205	103,656	50,825	947,661	-106,890	-2,177,758
2037	684,705	338,231	1,022,937	670,552	548	91,453	36,860	799,412	223,524	-1,954,233
2038	600,005	328,445	928,450	628,835	1,805	91,473	26,874	748,988	179,462	-1,774,771
2039	1,183,943	215,572	1,399,515	443,711	44	94,145	75,152	613,051	786,464	-988,307
2040	924,327	165,600	1,089,927	498,108	0	91,431	100,732	690,270	399,657	-588,650
Average 2020-2040	**673,591**	**272,450**	**946,042**	**783,271**	**242**	**123,250**	**67,309**	**974,073**	**-28,031**	**-1,508,923**

Full Results for Case 4: Altered Future with Management Actions

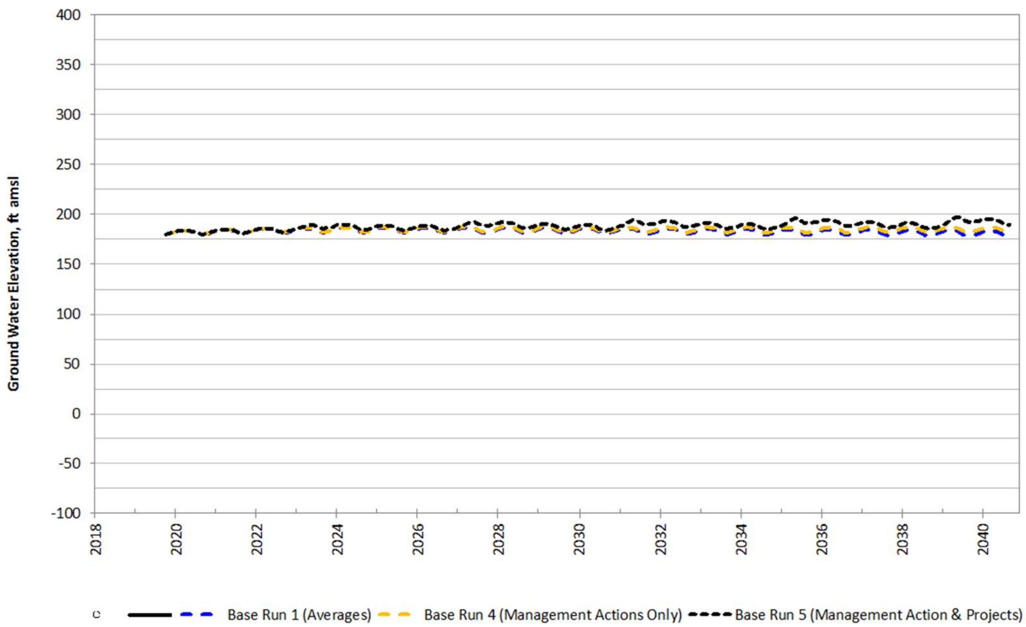
Water Year	Inflow (Acre-Feet/Year)			Outflow (Acre-Feet/Year)					Change in Storage	
	Recharge	Underflow Buffer to KSB	Total Inflow	Ag Pumping	Recharge	Non-Ag Pumping	Underflow KSB to Buffer	Total Outflow	Change in Storage (Acre-Feet/Year)	Cumulative Change in Storage (Acre-Feet
2020	681,104	184,922	866,026	722,860	0	101,360	60,625	884,845	-18,819	-18,819
2021	678,620	202,314	880,934	726,854	0	103,682	59,930	890,466	-9,533	-28,351
2022	678,620	203,514	882,134	733,956	0	106,216	62,002	902,174	-20,041	-48,392
2023	678,620	203,884	882,504	737,608	0	108,525	63,549	909,682	-27,178	-75,570
2024	681,103	205,774	886,877	749,801	0	110,849	64,740	925,390	-38,513	-114,083
2025	678,619	206,575	885,194	749,246	0	113,133	65,350	927,730	-42,536	-156,619
2026	678,619	206,752	885,371	743,893	0	115,649	66,298	925,840	-40,469	-197,088
2027	678,619	208,208	886,826	750,498	0	118,164	66,838	935,499	-48,673	-245,761
2028	681,103	210,711	891,814	756,665	0	120,927	67,448	945,041	-53,226	-298,988
2029	678,619	212,763	891,381	764,160	0	123,195	67,480	954,835	-63,454	-362,441
2030	678,619	215,014	893,632	761,110	0	125,708	67,757	954,574	-60,942	-423,384
2031	678,619	215,454	894,073	744,144	0	128,224	68,307	940,675	-46,602	-469,986
2032	681,103	216,576	897,680	744,268	0	130,665	69,183	944,117	-46,437	-516,423
2033	678,619	217,589	896,208	745,654	0	132,652	69,351	947,657	-51,450	-567,872
2034	678,619	219,522	898,140	747,494	0	135,154	69,585	952,233	-54,092	-621,965
2035	678,619	220,782	899,400	735,676	0	137,654	69,988	943,317	-43,917	-665,881
2036	681,103	219,464	900,567	711,641	0	140,439	71,296	923,376	-22,809	-688,691
2037	678,617	218,732	897,349	711,957	0	142,655	71,750	926,363	-29,014	-717,705
2038	678,617	219,591	898,208	712,953	0	144,381	72,133	929,467	-31,259	-748,964
2039	678,617	220,552	899,169	711,698	0	145,124	72,518	929,340	-30,171	-779,135
2040	681,102	222,282	903,384	713,679	0	147,871	73,135	934,686	-31,301	-810,436
Average 2020-2040	**679,328**	**211,951**	**891,280**	**736,944**	**0**	**125,344**	**67,584**	**929,872**	**-38,592**	**-407,455**

Full Results for Case 5: Altered Future with Management Actions and Projects

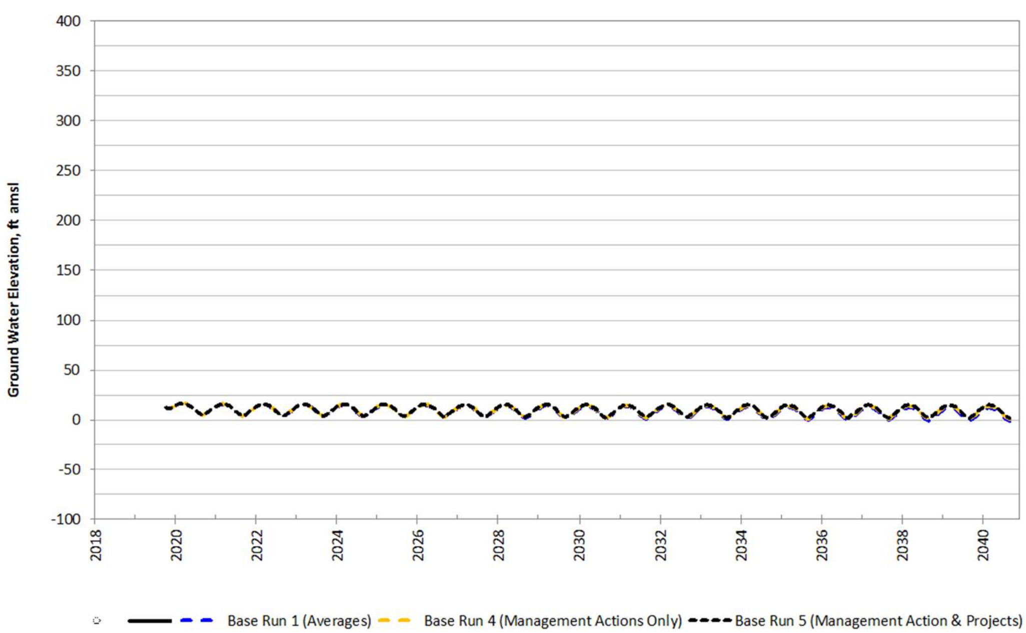
Water Year	Inflow (Acre-Feet/Year)			Outflow (Acre-Feet/Year)				Change in Storage (Acre-Feet/Year)	
	Recharge	Underflow Buffer to KSB	Total Inflow	Ag Pumping	Non-Ag Pumping	Underflow KSB to Buffer	Total Outflow	Change In Storage (Acre-Feet/Year)	Cumulative Change in Storage (Acre-Feet)
2020	693,019	184,909	877,928	722,860	102,029	60,664	885,553	-7,625	-7,625
2021	692,081	201,840	893,921	726,854	103,847	60,091	890,792	3,129	-4,496
2022	695,135	202,679	897,814	733,956	106,285	62,280	902,522	-4,708	-9,203
2023	754,786	195,768	950,555	737,608	108,573	66,823	913,005	37,550	28,347
2024	700,811	197,706	898,518	749,801	110,894	66,641	927,335	-28,817	-470
2025	703,322	200,034	903,356	752,178	113,174	66,866	932,218	-28,862	-29,332
2026	712,321	200,571	912,892	747,271	115,688	67,844	930,802	-17,911	-47,243
2027	785,165	194,160	979,325	754,312	118,204	73,946	946,461	32,864	-14,379
2028	714,945	196,846	911,791	760,919	120,970	71,326	953,215	-41,424	-55,803
2029	712,463	201,420	913,883	768,855	123,239	70,436	962,530	-48,646	-104,449
2030	717,464	204,861	922,324	771,713	125,753	70,521	967,988	-45,663	-150,112
2031	801,229	197,492	998,722	755,179	128,271	78,944	962,394	36,328	-113,784
2032	720,097	198,739	918,836	755,733	131,062	74,994	961,789	-42,952	-156,737
2033	717,619	202,972	920,591	757,560	133,316	73,816	964,691	-44,100	-200,837
2034	717,626	206,231	923,858	759,855	135,482	73,658	968,996	-45,138	-245,975
2035	811,166	200,103	1,011,270	756,425	137,733	83,881	978,039	33,231	-212,744
2036	720,276	199,062	919,338	732,921	140,537	78,918	952,376	-33,038	-245,782
2037	717,812	202,242	920,054	733,653	142,773	77,386	953,812	-33,758	-279,540
2038	717,828	204,926	922,753	735,098	145,291	77,091	957,480	-34,727	-314,267
2039	814,808	199,028	1,013,835	734,198	147,012	88,871	970,081	43,754	-270,513
2040	720,268	200,596	920,864	736,631	147,962	82,129	966,721	-45,857	-316,370
Average 2020-2040	**730,488**	**199,628**	**930,116**	**746,837**	**125,624**	**72,720**	**945,181**	**-15,065**	**-131,015**

Appendix 3: Modeling Results for Monitoring Wells

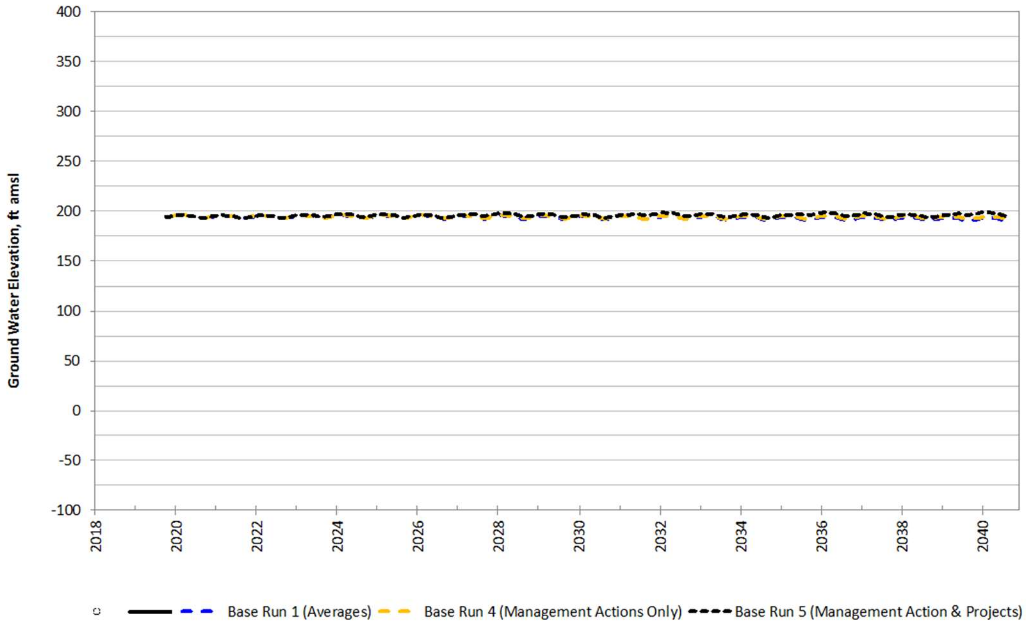
Well KSB-0388
Greater Kaweah GSA
Well ID: 19S22E07K01M
Aquifer System: Upper - Model Layer 3
Top of Screen Depth (ft): 380; Bottom of Screen Depth(ft): 77.940855;



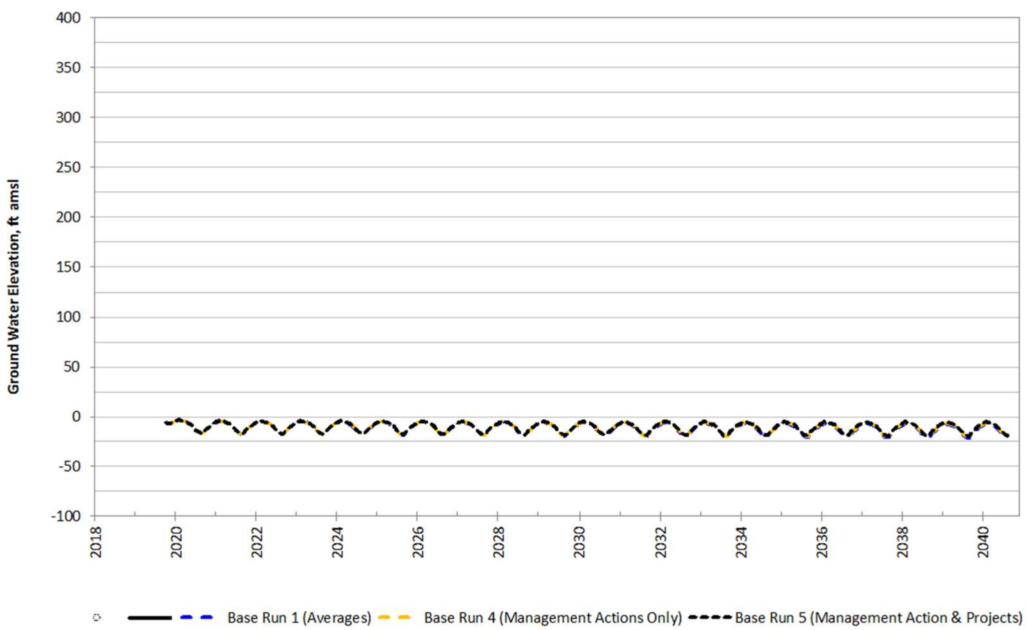
Well KSB-0399
Greater Kaweah GSA
Well ID: 20S22E07A02M
Aquifer System: Unknown - Model Layer 3

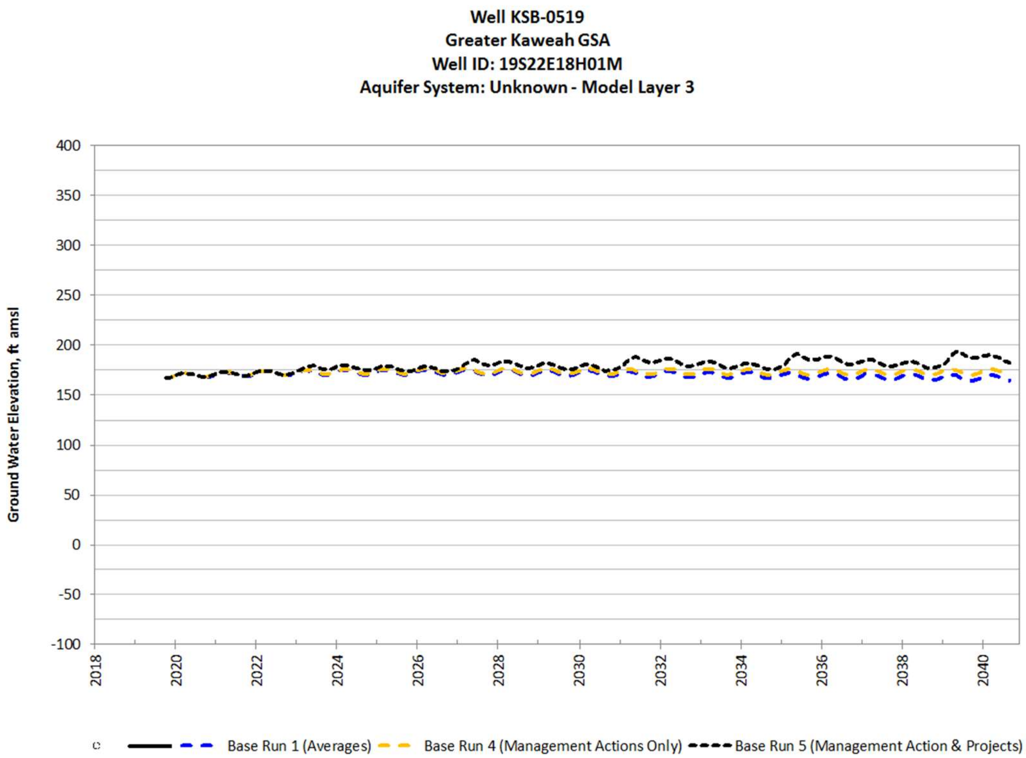


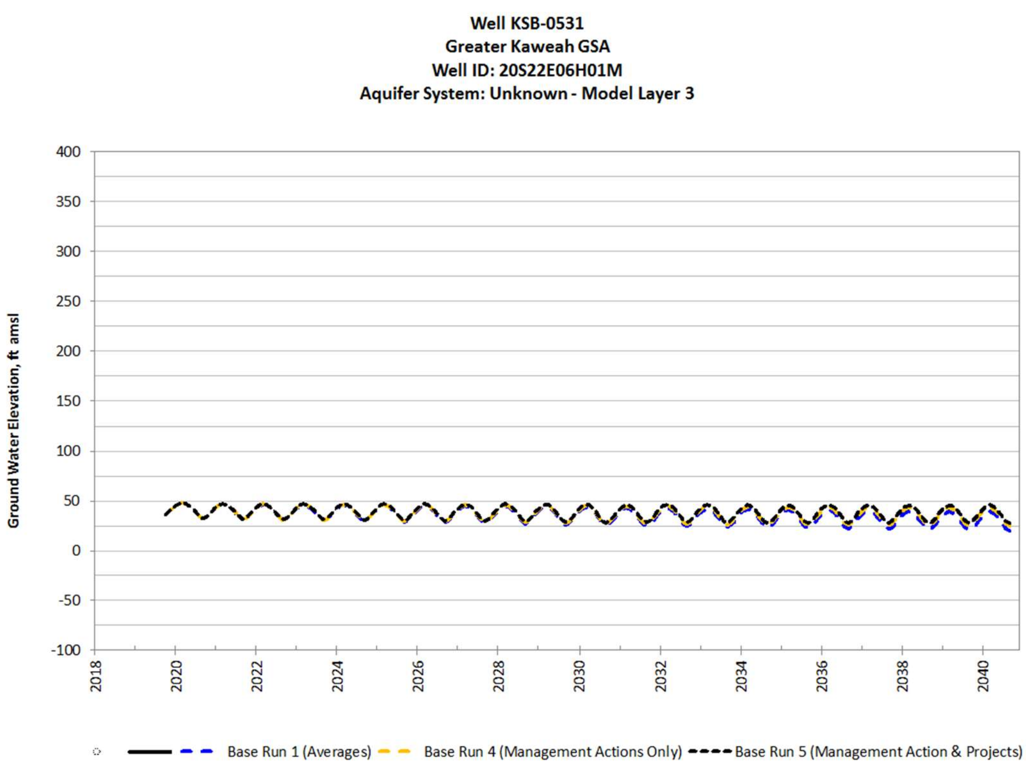
Well KSB-0446
Greater Kaweah GSA
Well ID: 20S22E07A03M
Aquifer System: Upper - Model Layer 3
Top of Screen Depth (ft): 421; Bottom of Screen Depth(ft): 37.667616; Total Depth (ft): 421

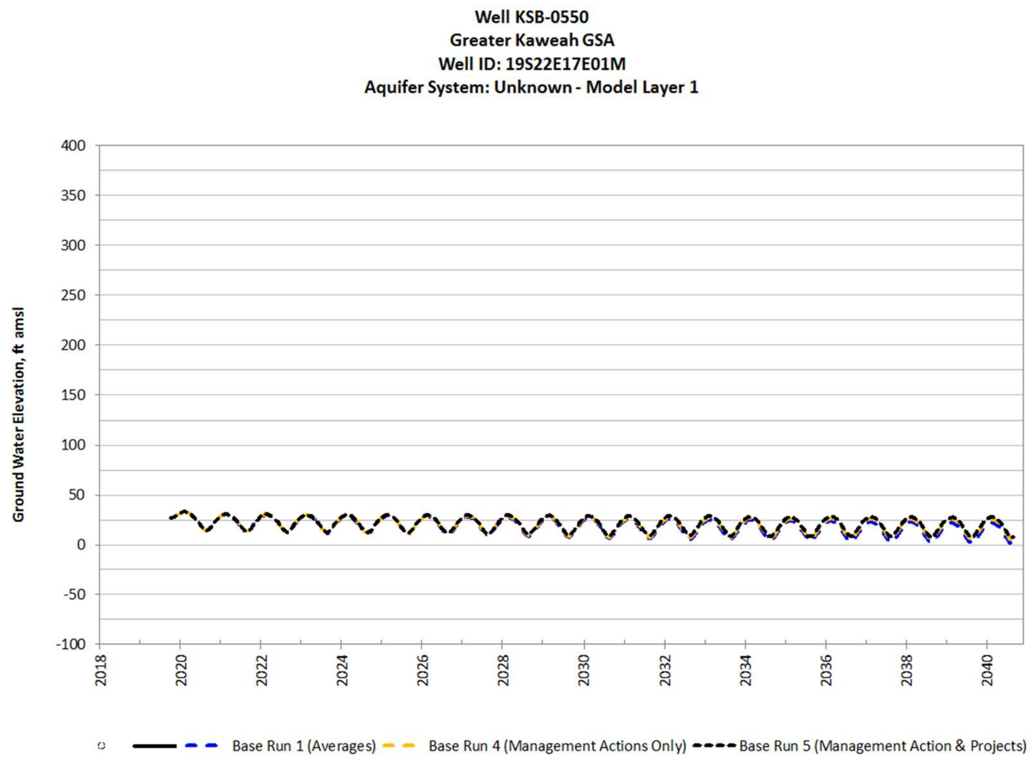


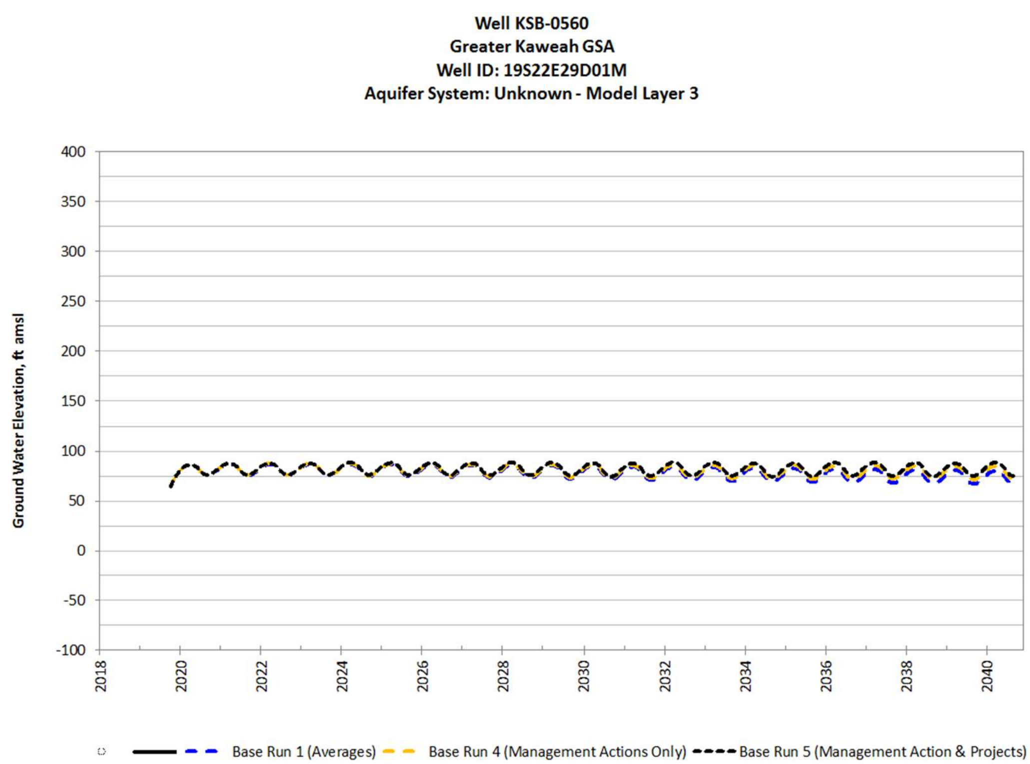
Well KSB-0459
Greater Kaweah GSA
Well ID: 20S22E07A04M
Aquifer System: Unknown - Model Layer 3

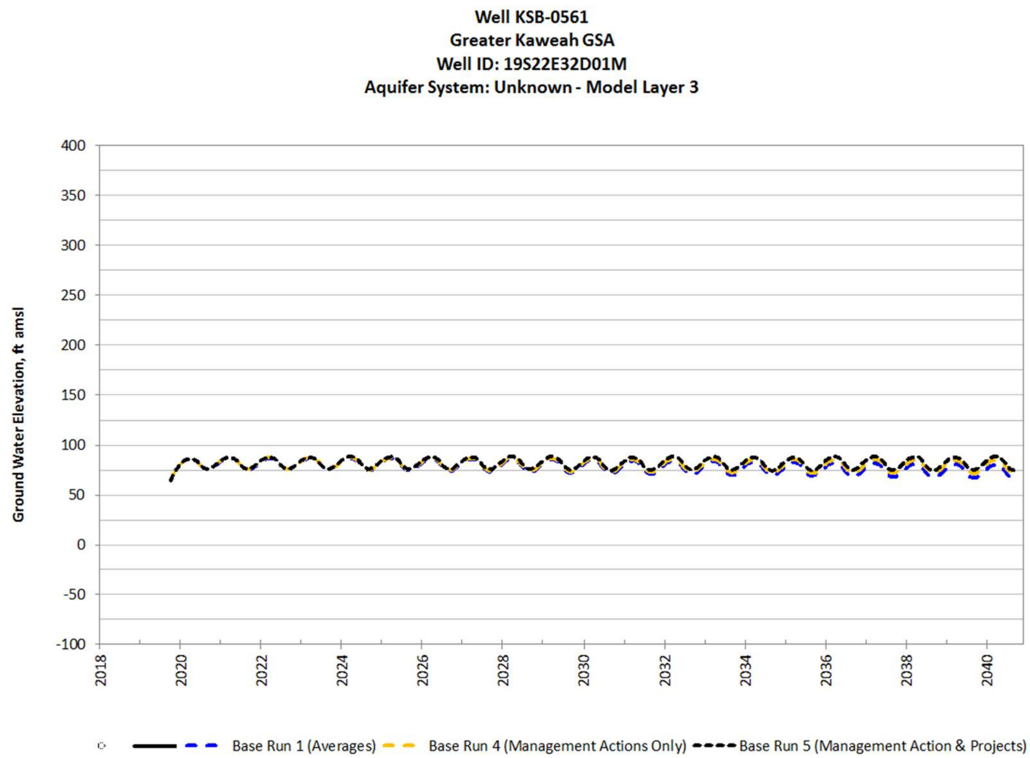


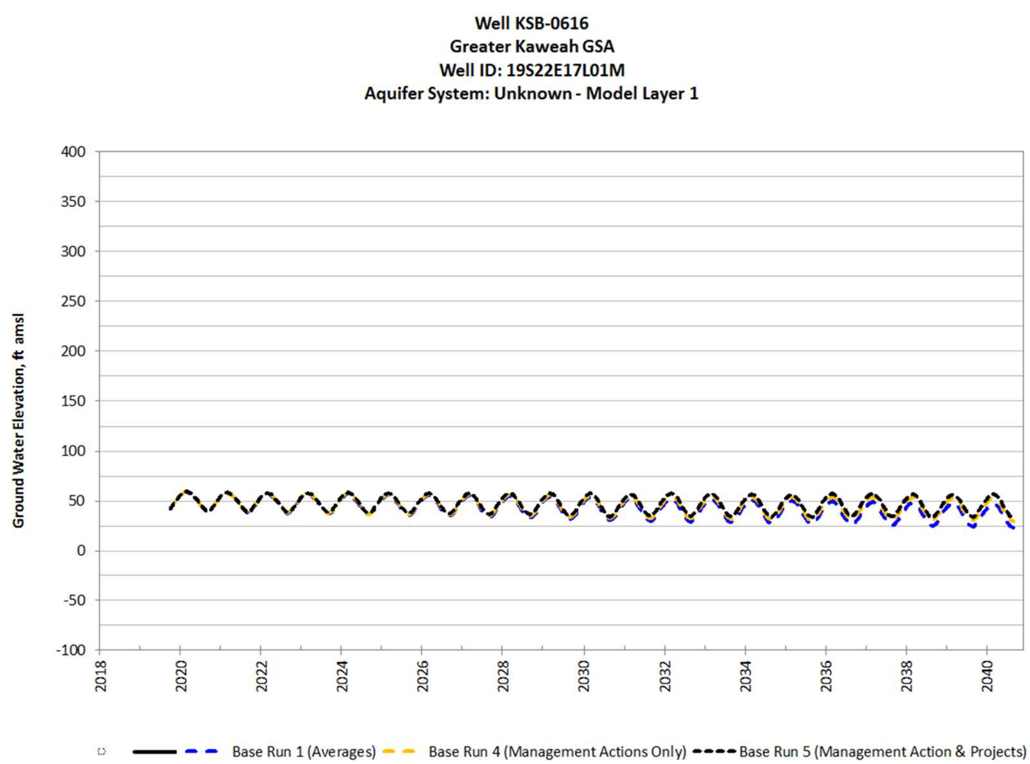

Well KSB-0519
Greater Kaweah GSA
Well ID: 19S22E18H01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

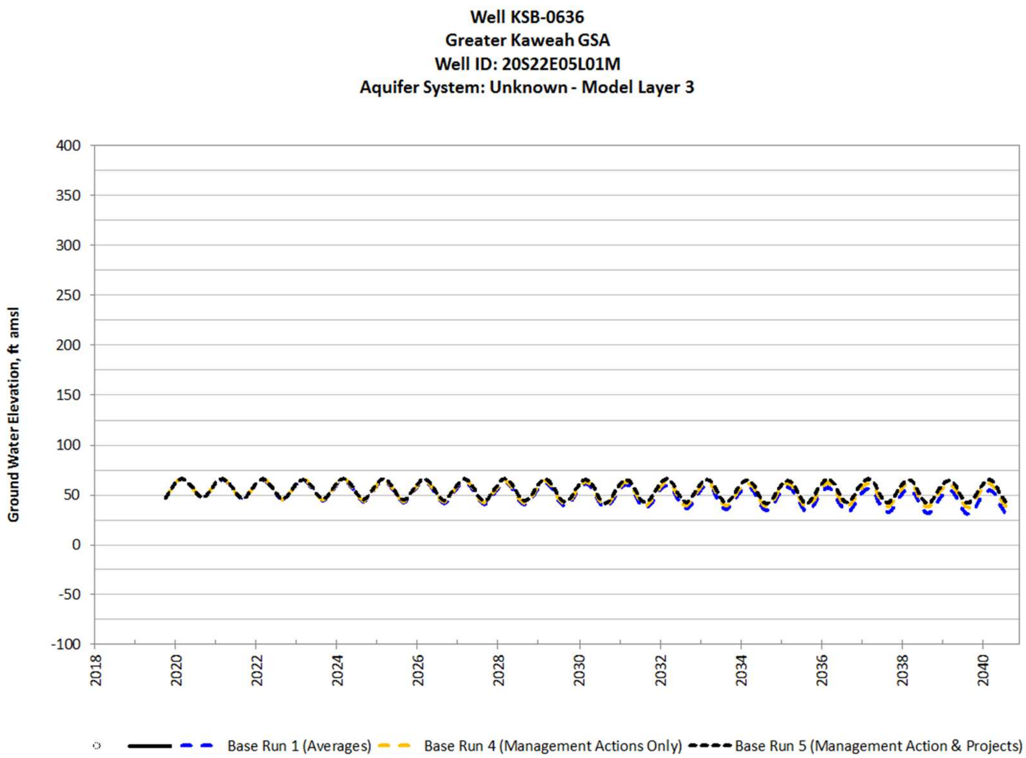

Well KSB-0531
Greater Kaweah GSA
Well ID: 20S22E06H01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

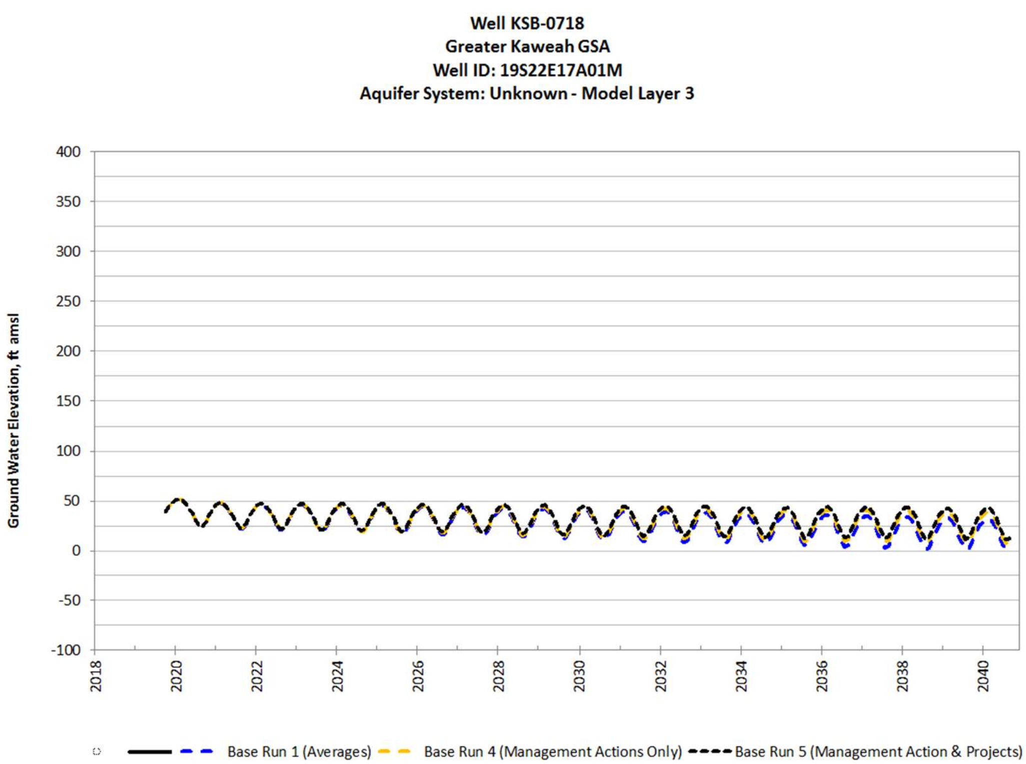

Well KSB-0550
Greater Kaweah GSA
Well ID: 19S22E17E01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

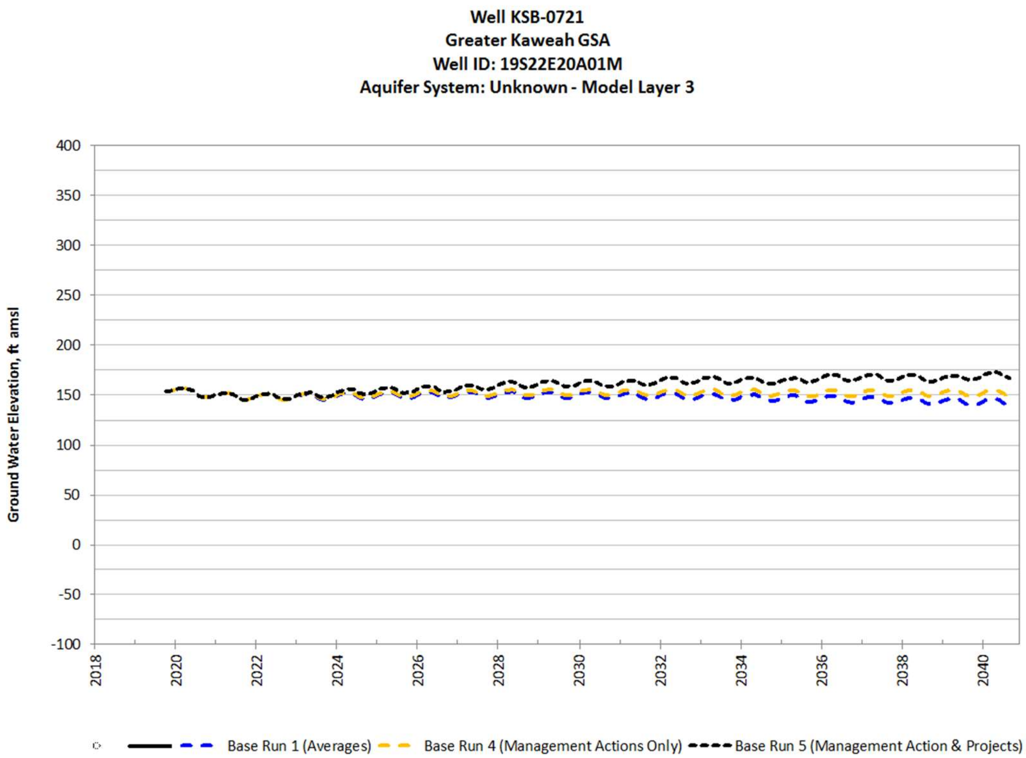

Well KSB-0560
Greater Kaweah GSA
Well ID: 19S22E29D01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

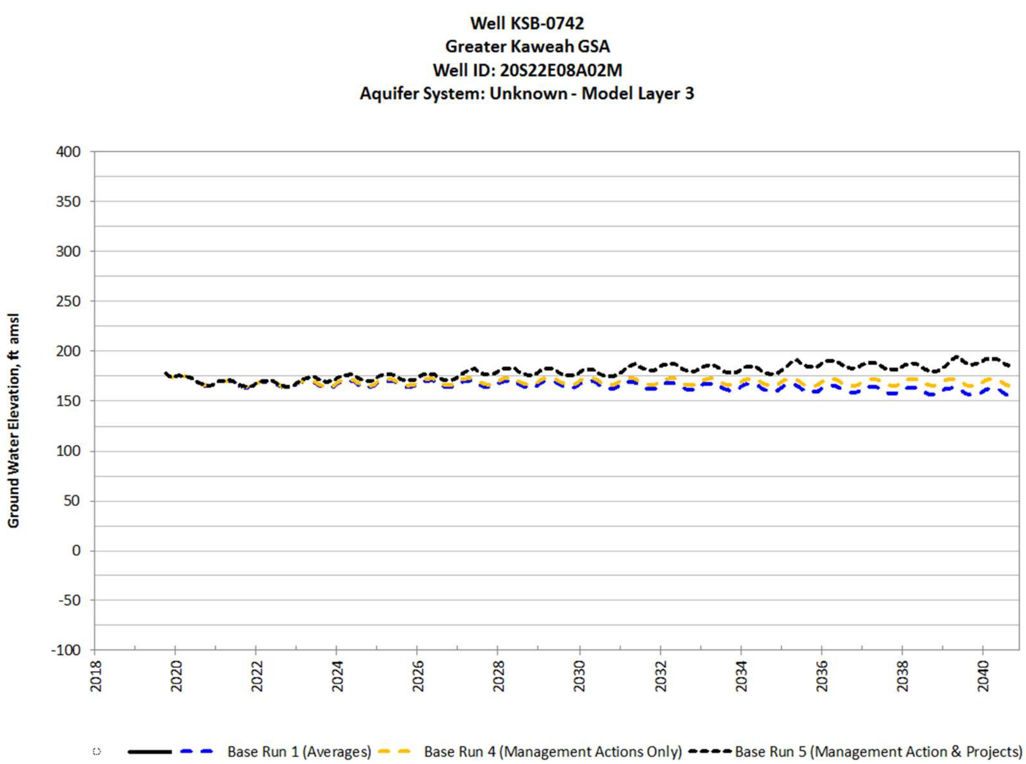

Well KSB-0561
Greater Kaweah GSA
Well ID: 19S22E32D01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

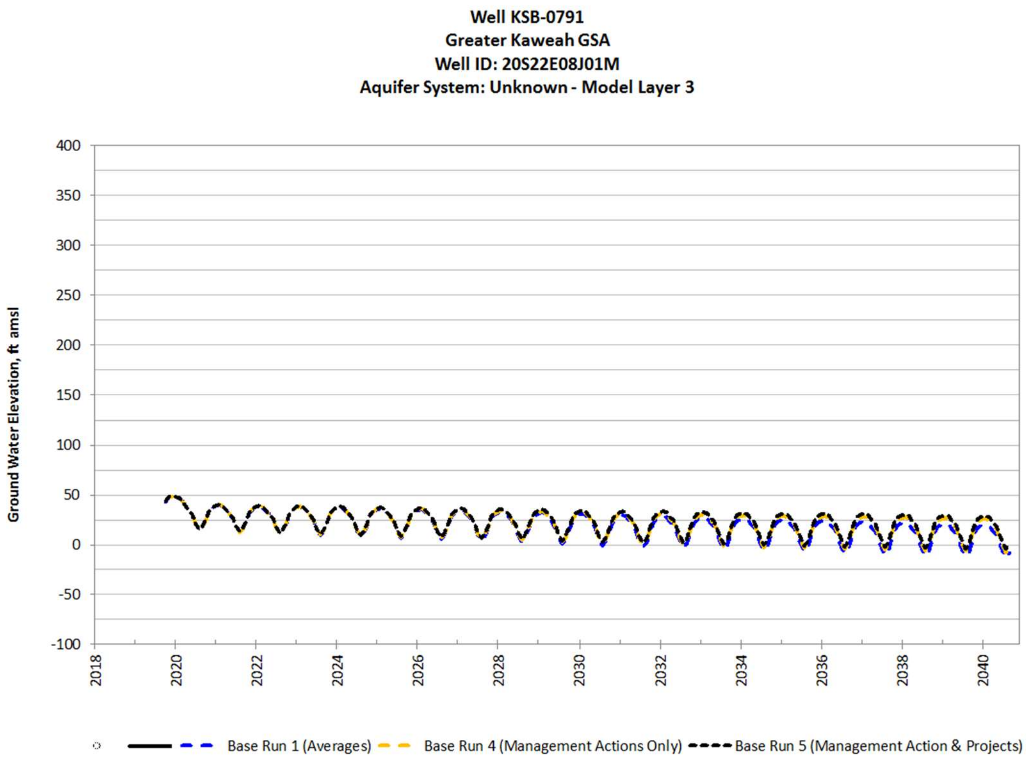

Well KSB-0616
Greater Kaweah GSA
Well ID: 19S22E17L01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

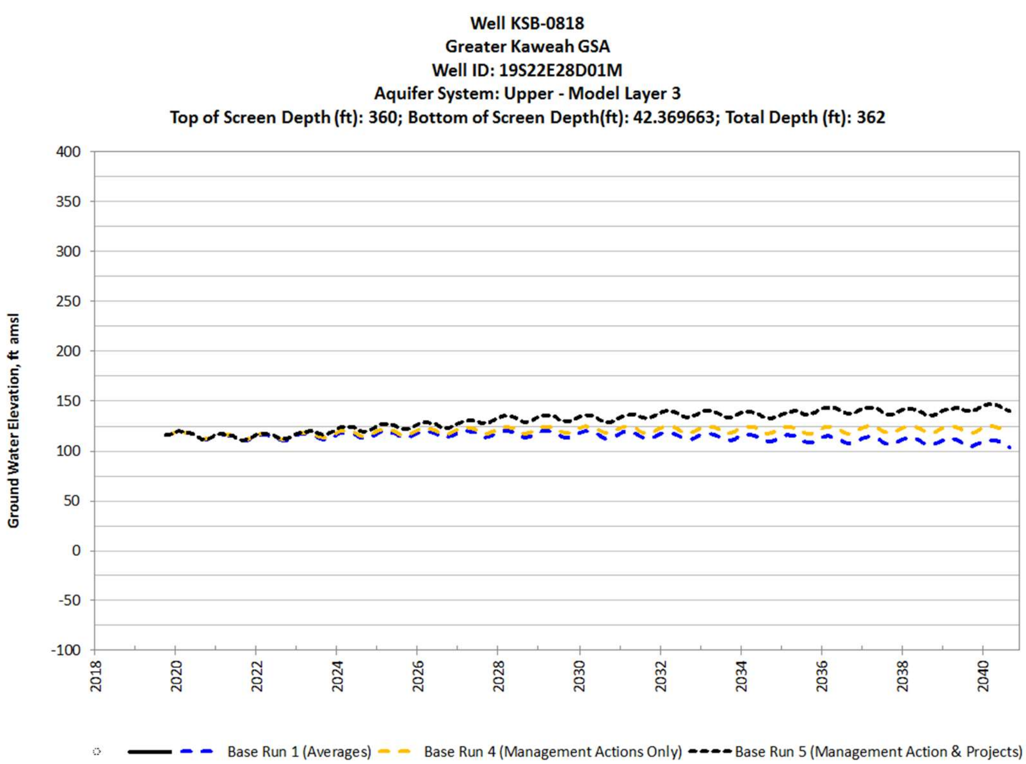

Well KSB-0636
Greater Kaweah GSA
Well ID: 20S22E05L01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-0718
Greater Kaweah GSA
Well ID: 19S22E17A01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

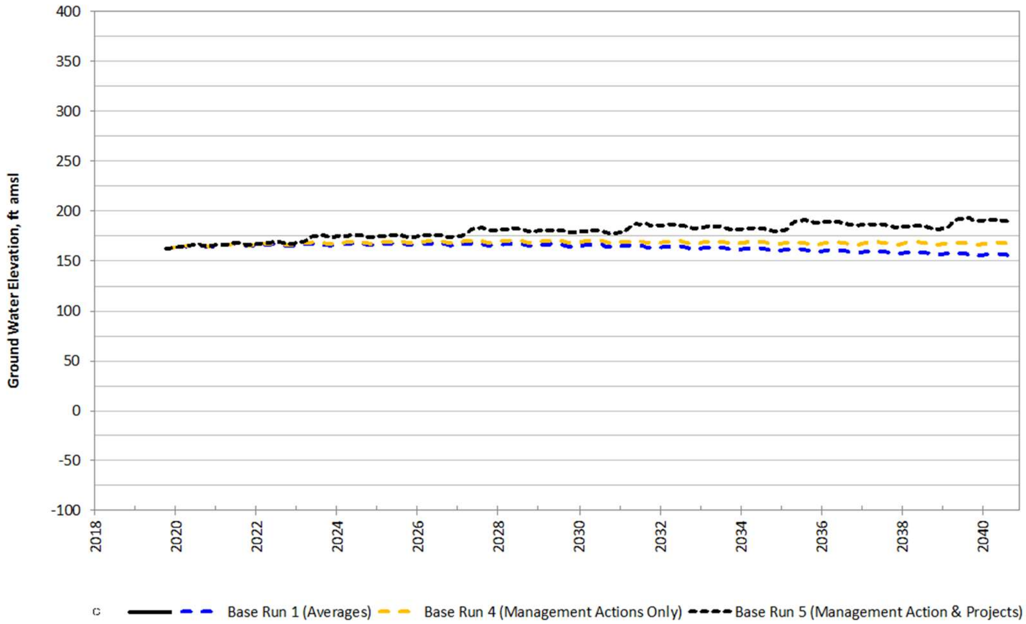

Well KSB-0721
Greater Kaweah GSA
Well ID: 19S22E20A01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-0742
Greater Kaweah GSA
Well ID: 20S22E08A02M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

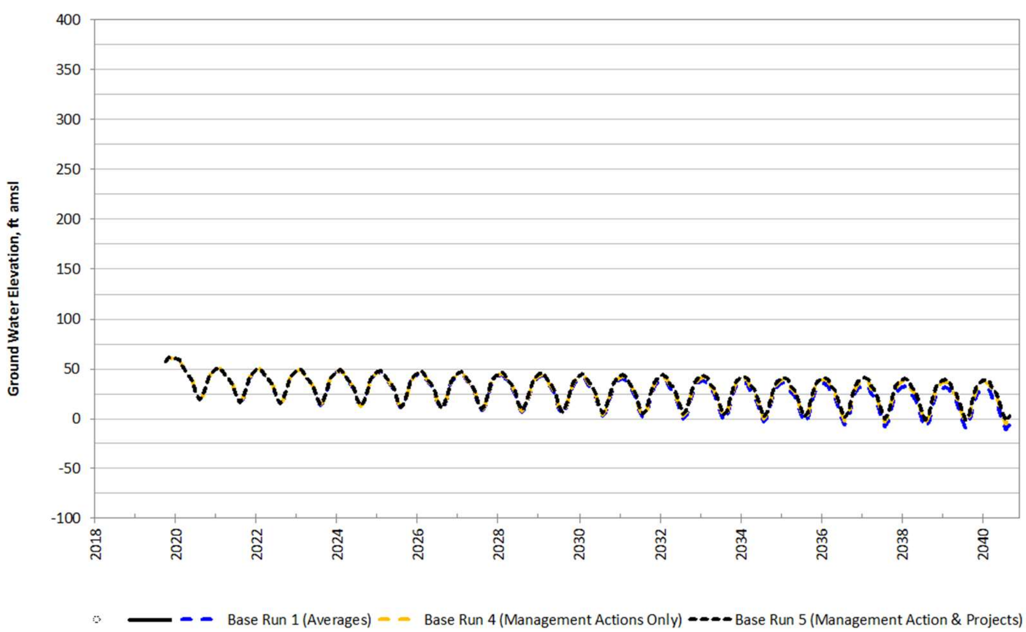

Well KSB-0791
Greater Kaweah GSA
Well ID: 20S22E08J01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-0818
Greater Kaweah GSA
Well ID: 19S22E28D01M
Aquifer System: Upper - Model Layer 3
Top of Screen Depth (ft): 360; Bottom of Screen Depth(ft): 42.369663; Total Depth (ft): 362
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

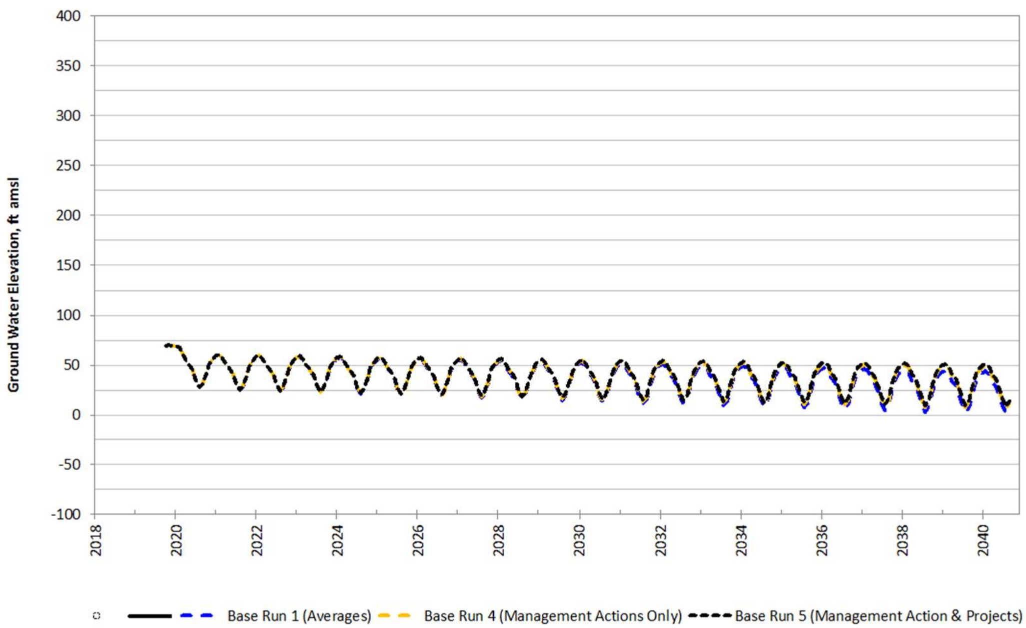
Well KSB-0856
Greater Kaweah GSA
Well ID: 20S22E04D02M
Aquifer System: Unknown - Model Layer 3



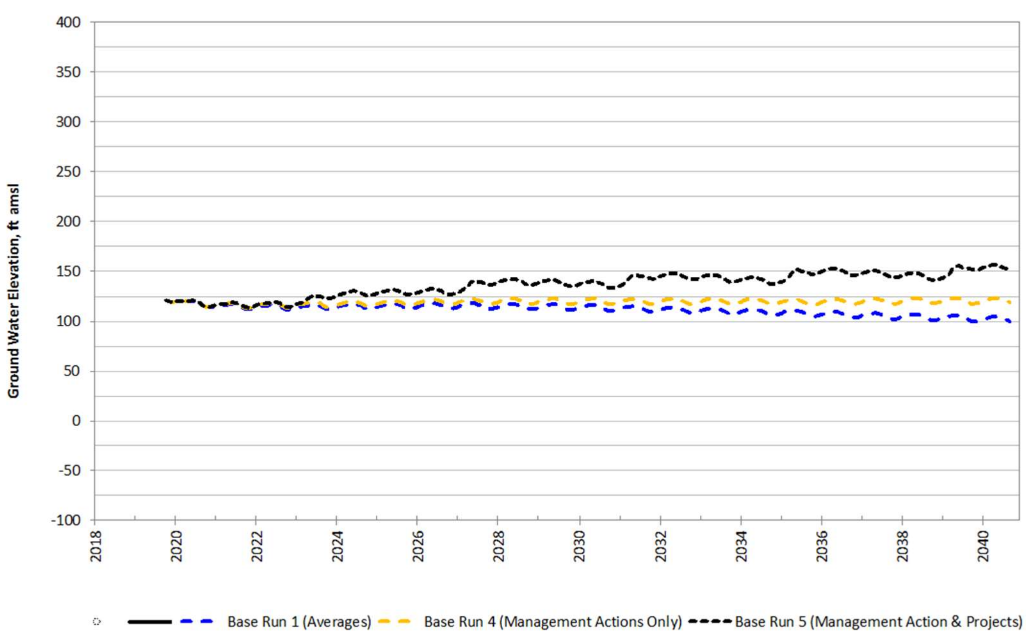
Well KSB-0889
Greater Kaweah GSA
Well ID: 20S22E04D01M
Aquifer System: Unknown - Model Layer 3

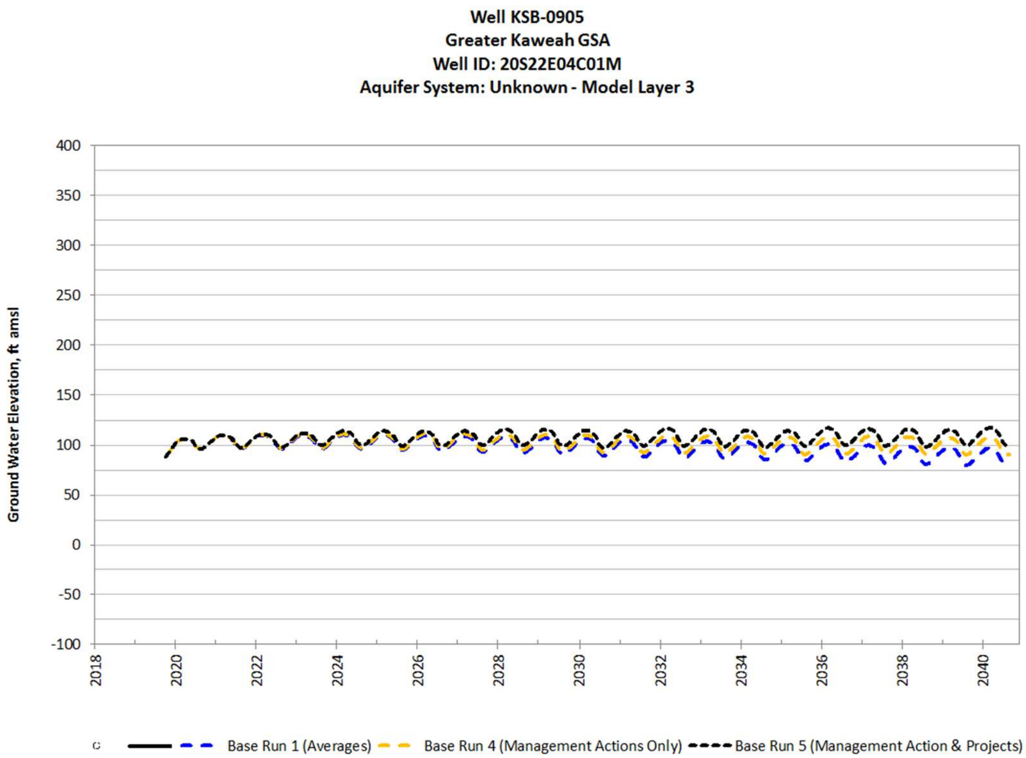


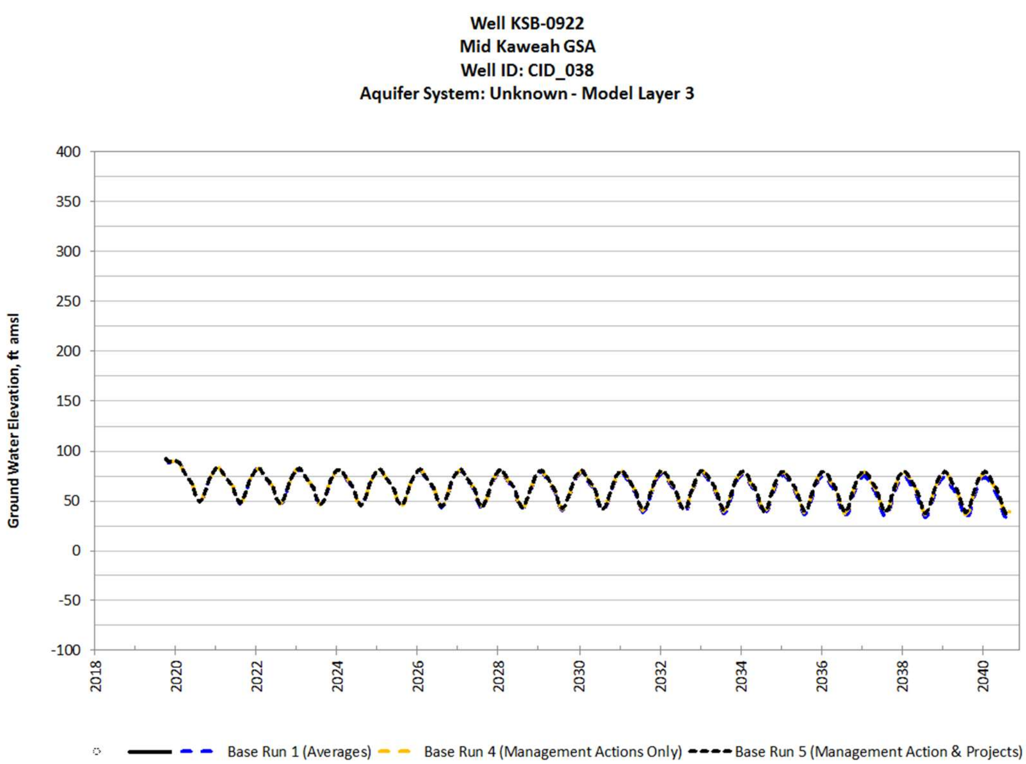
Well KSB-0890
Greater Kaweah GSA
Well ID: 19S22E28C01M
Aquifer System: Unknown - Model Layer 3



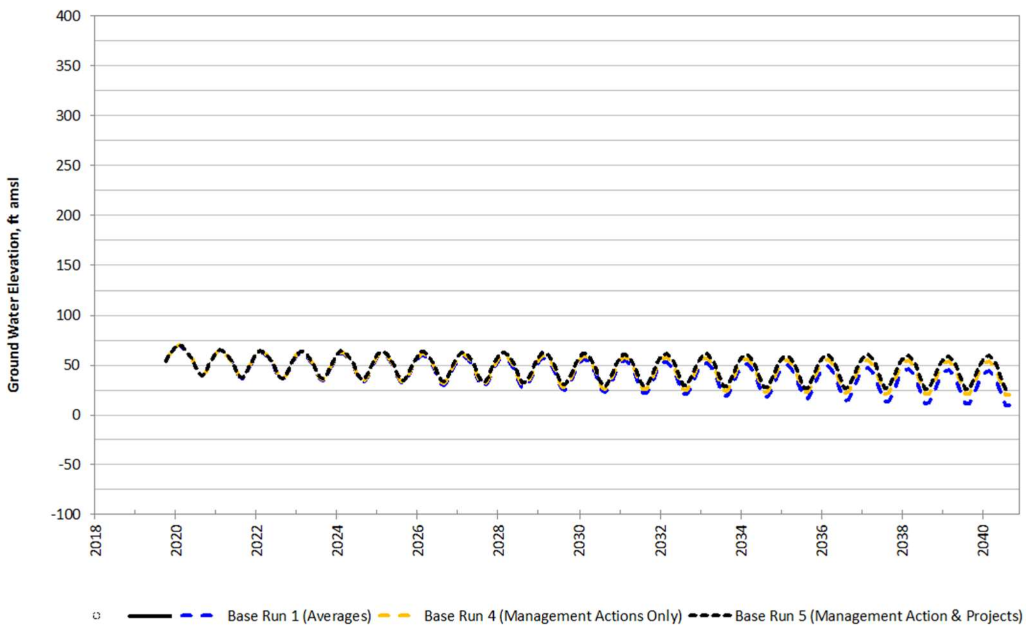
Well KSB-0903
Greater Kaweah GSA
Well ID: 19S22E21C01M
Aquifer System: Unknown - Model Layer 3



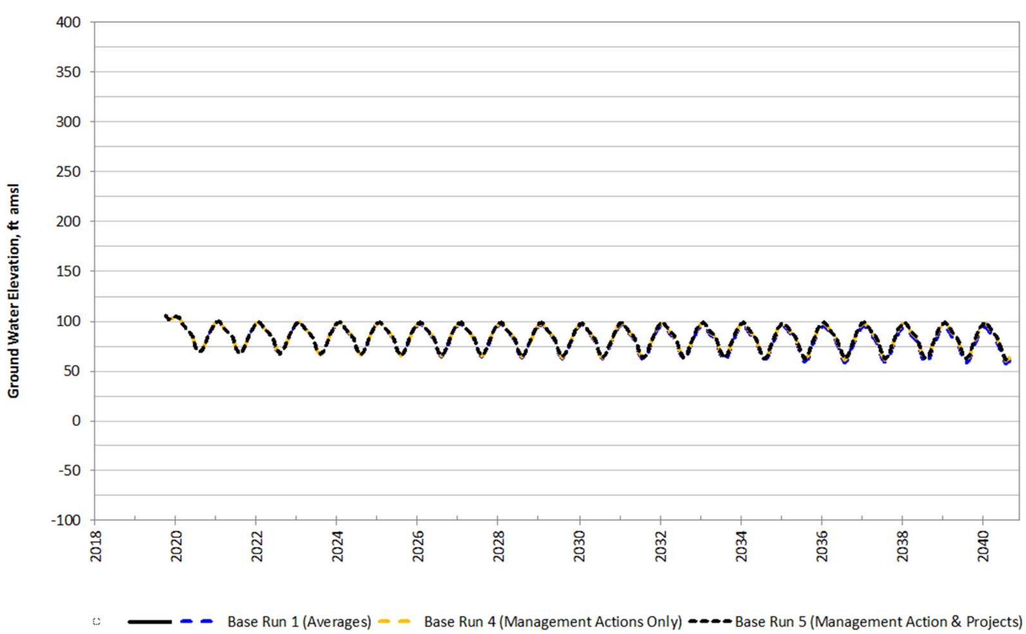

Well KSB-0905
Greater Kaweah GSA
Well ID: 20S22E04C01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

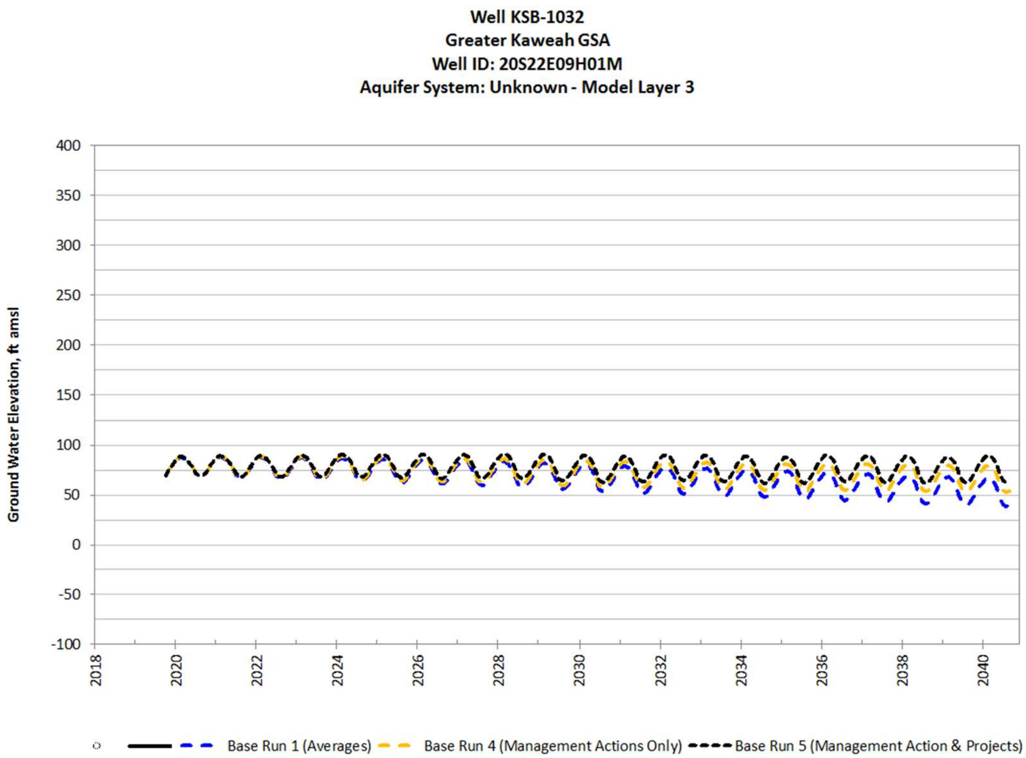

Well KSB-0922
Mid Kaweah GSA
Well ID: CID_038
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

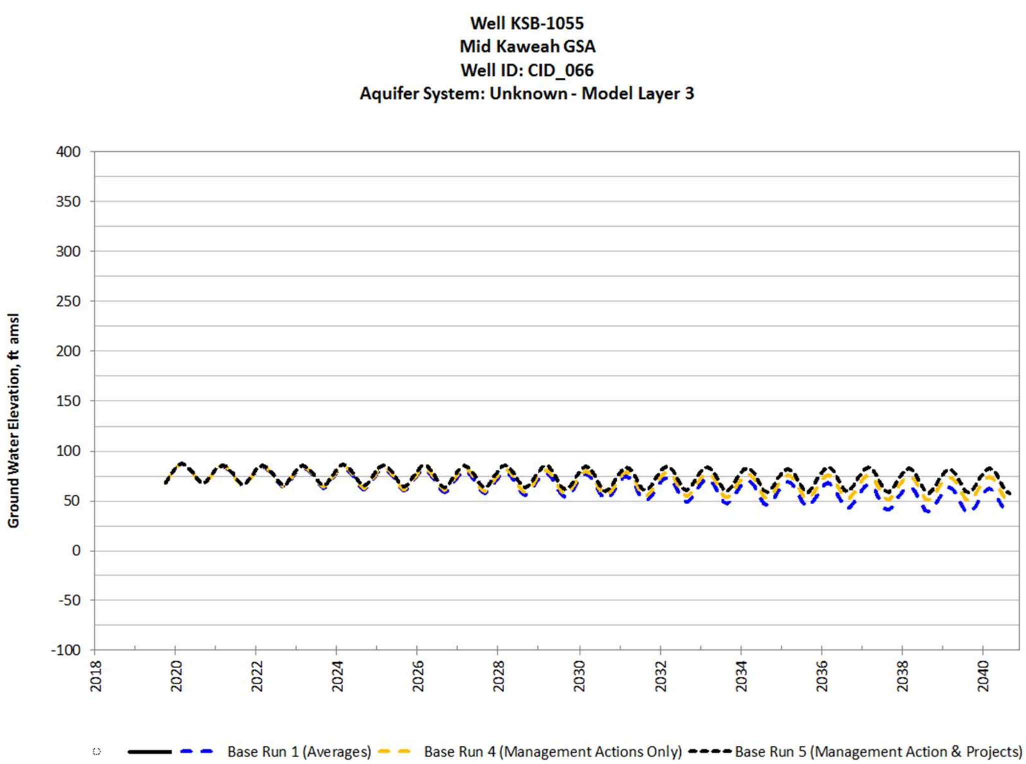
Well KSB-0946
Mid Kaweah GSA
Well ID: CID_053
Aquifer System: Unknown - Model Layer 3

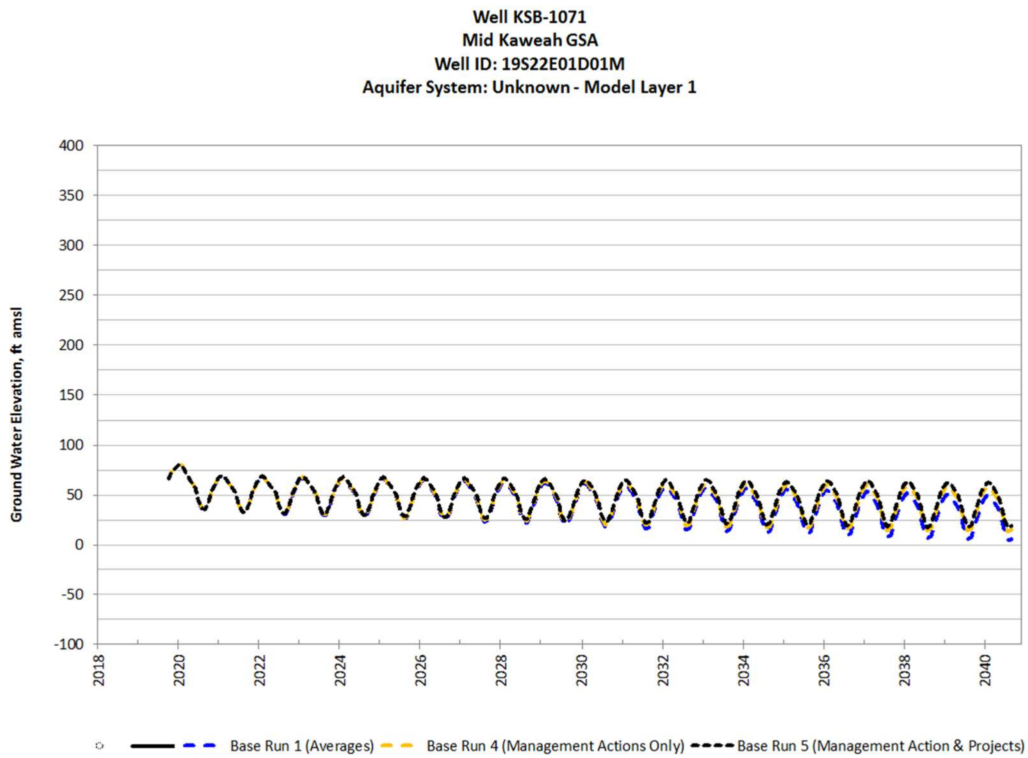


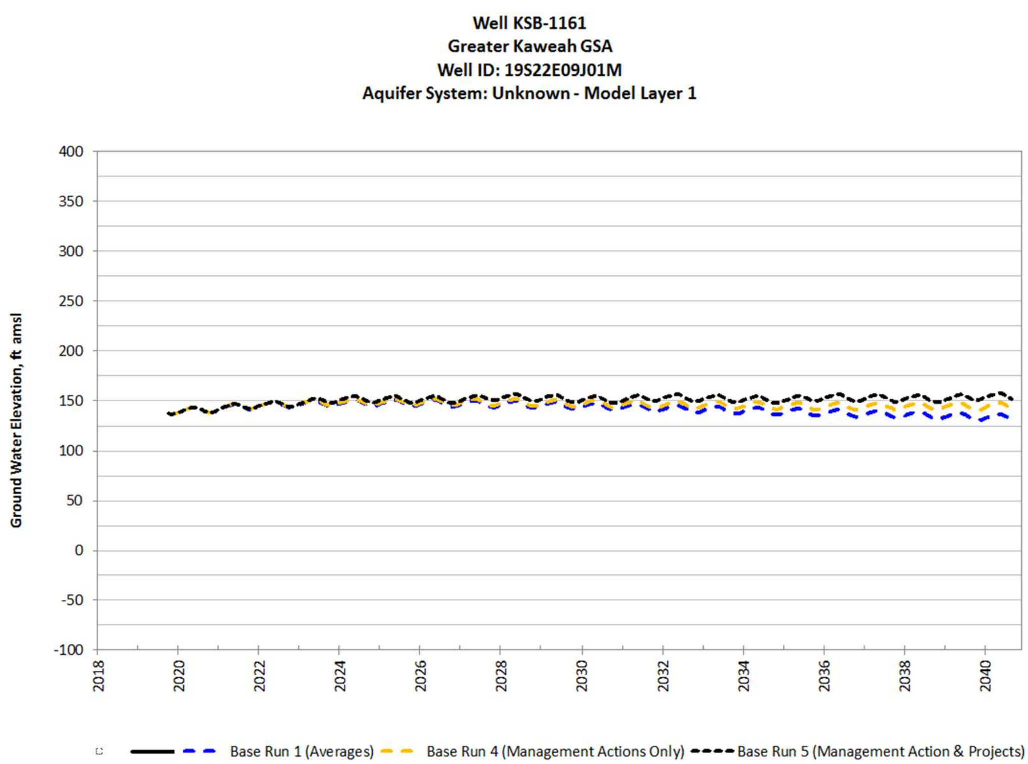
Well KSB-1031
Greater Kaweah GSA
Well ID: 19S22E33B01M
Aquifer System: Unknown - Model Layer 3



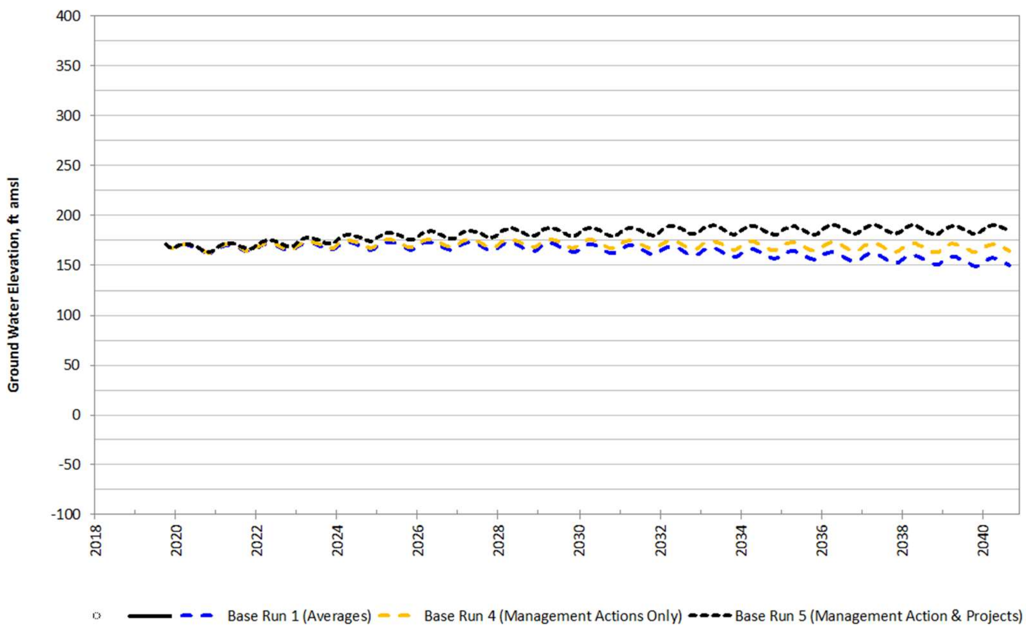

Well KSB-1032
Greater Kaweah GSA
Well ID: 20S22E09H01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-1055
Mid Kaweah GSA
Well ID: CID_066
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

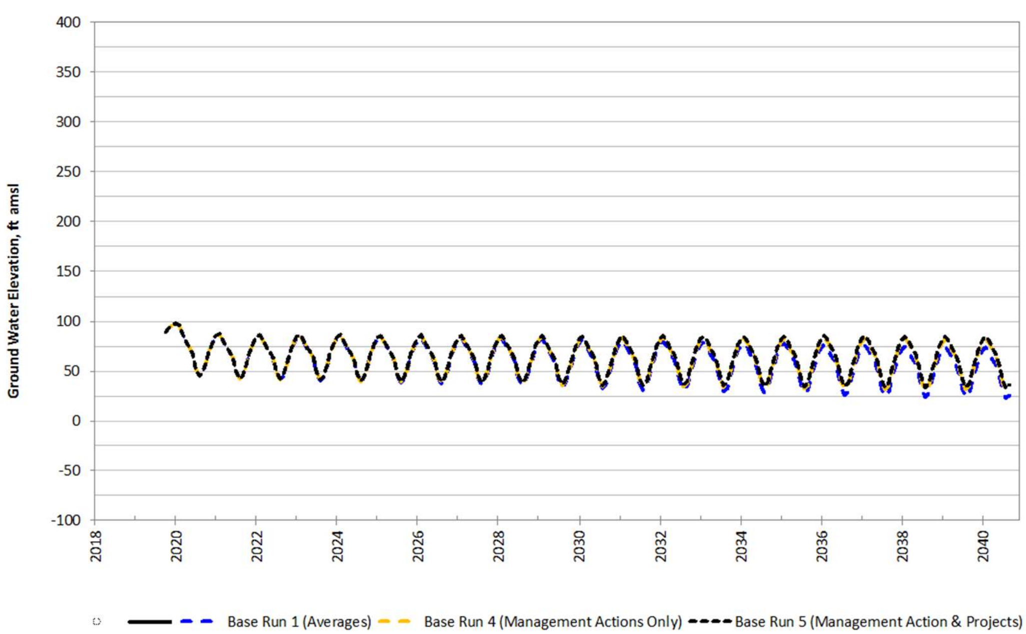

Well KSB-1071
Mid Kaweah GSA
Well ID: 19S22E01D01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-1161
Greater Kaweah GSA
Well ID: 19S22E09J01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

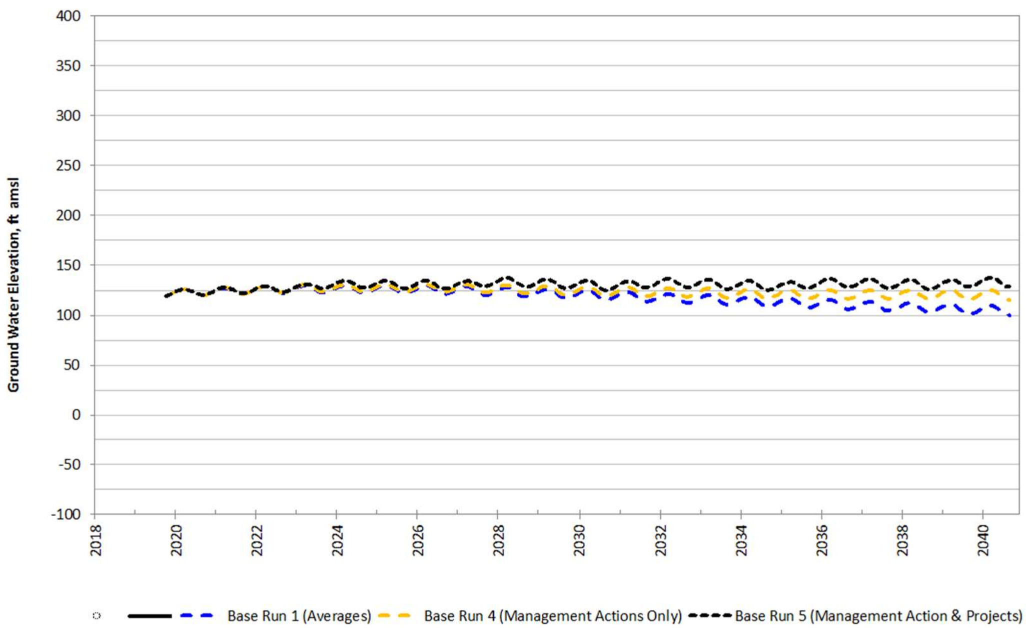
Well KSB-1168
Mid Kaweah GSA
Well ID: CID_007
Aquifer System: Unknown - Model Layer 3



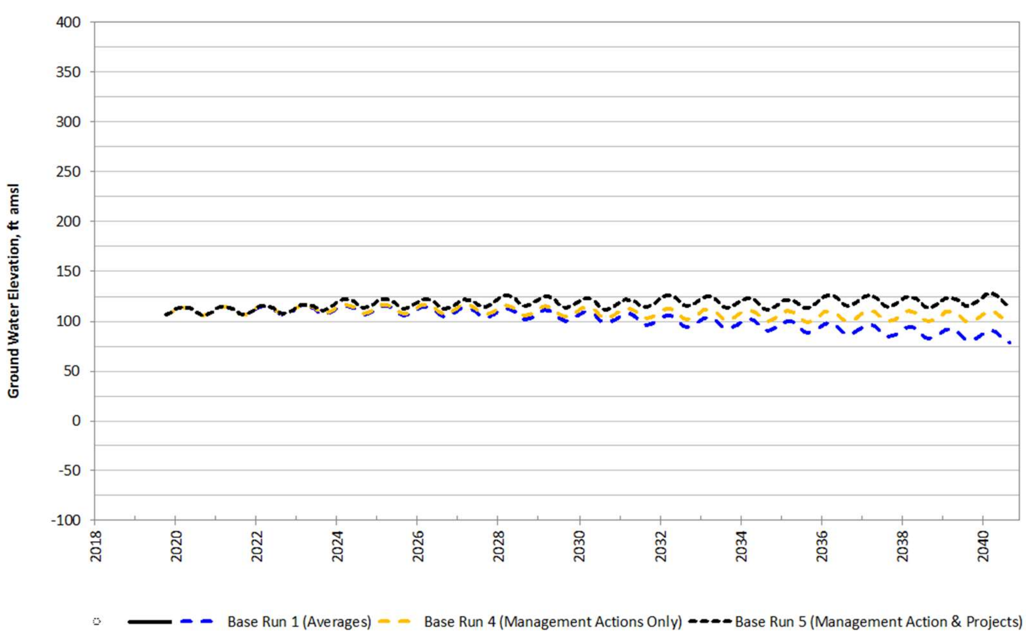
Well KSB-1183
Greater Kaweah GSA
Well ID: 19S22E16A03M
Aquifer System: Unknown - Model Layer 3



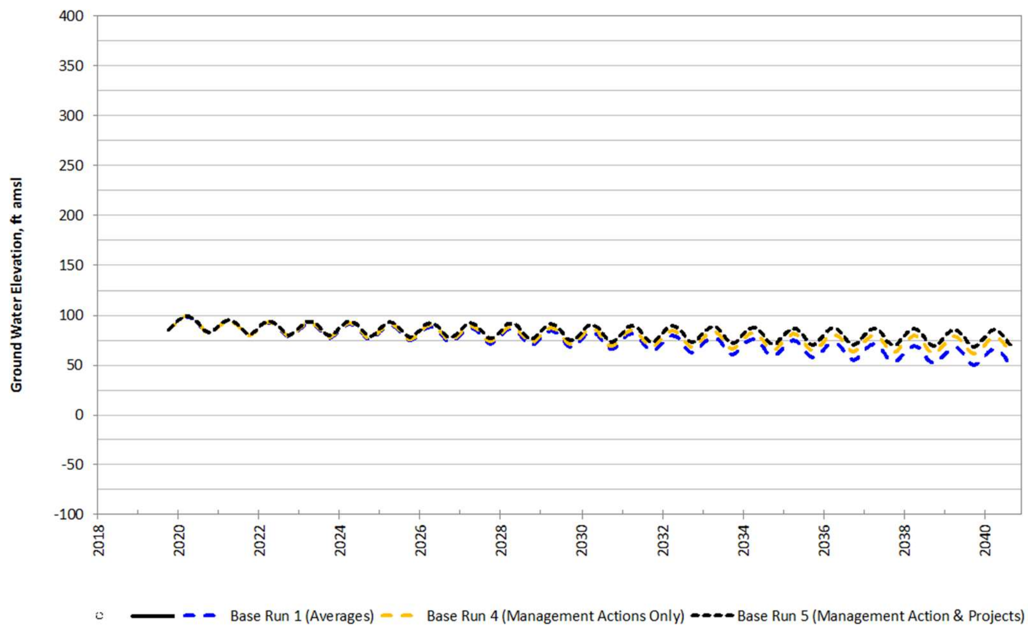
Well KSB-1214
Greater Kaweah GSA
Well ID: 19S22E21J01M
Aquifer System: Unknown - Model Layer 3



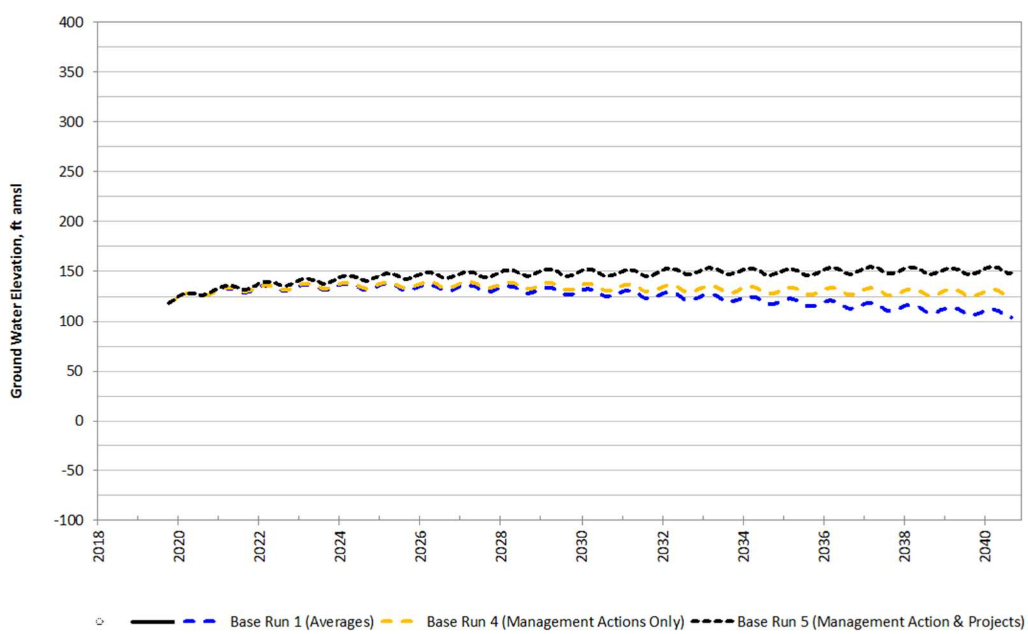
Well KSB-1222
Greater Kaweah GSA
Well ID: 19S22E16A02M
Aquifer System: Unknown - Model Layer 1



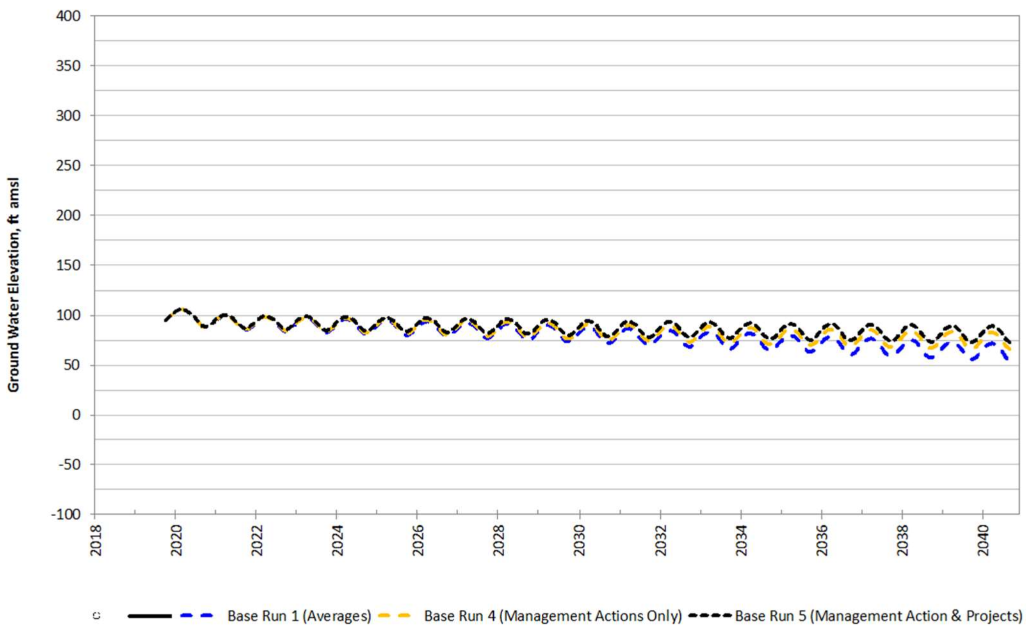
Well KSB-1226
Mid Kaweah GSA
Well ID: CID_027
Aquifer System: Unknown - Model Layer 3



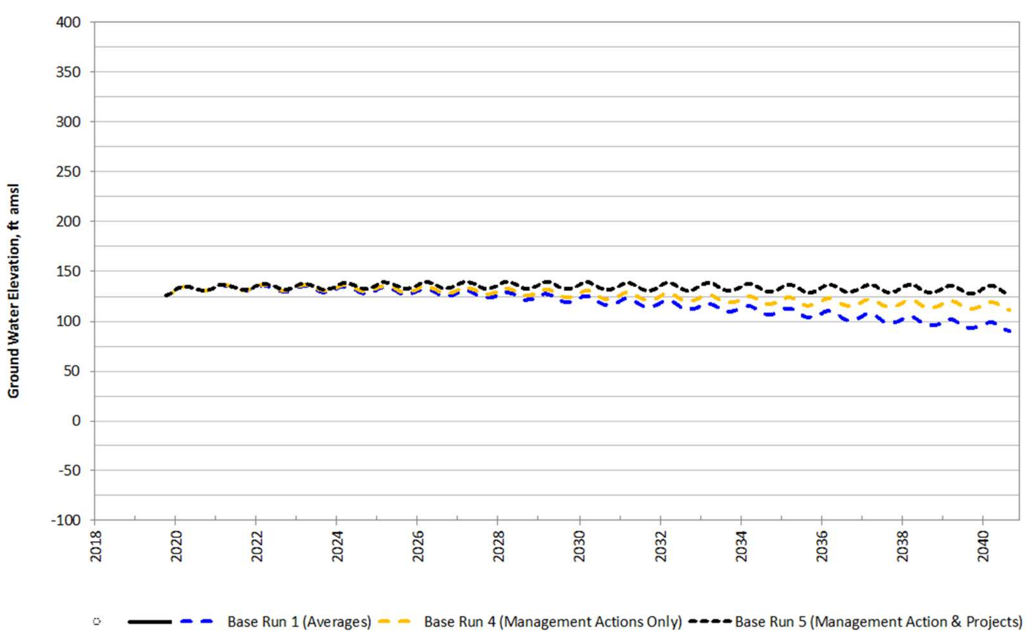
Well KSB-1259
Greater Kaweah GSA
Well ID: 19S22E15M01M
Aquifer System: Unknown - Model Layer 3

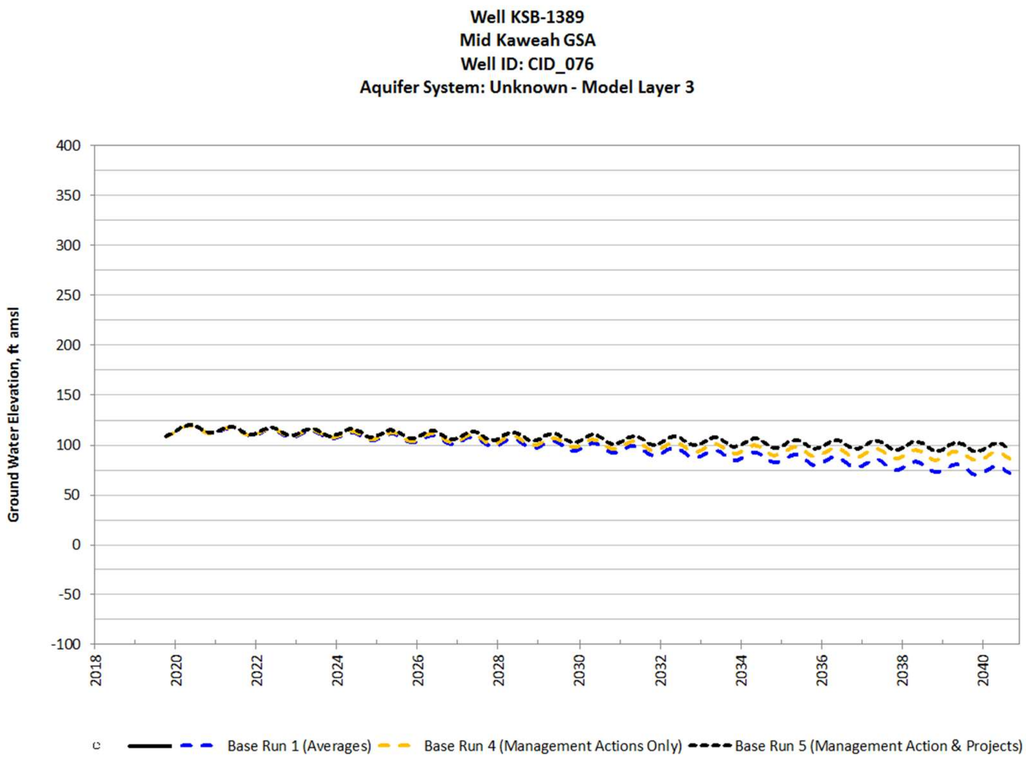


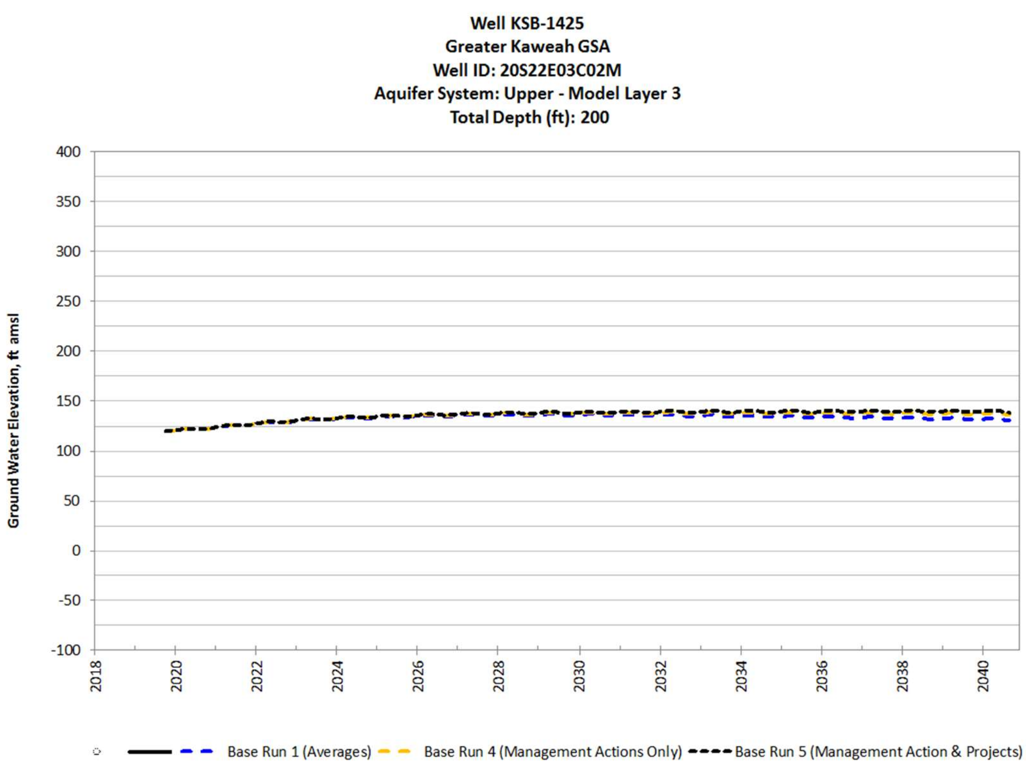
Well KSB-1359
Mid Kaweah GSA
Well ID: CID_068
Aquifer System: Unknown - Model Layer 3

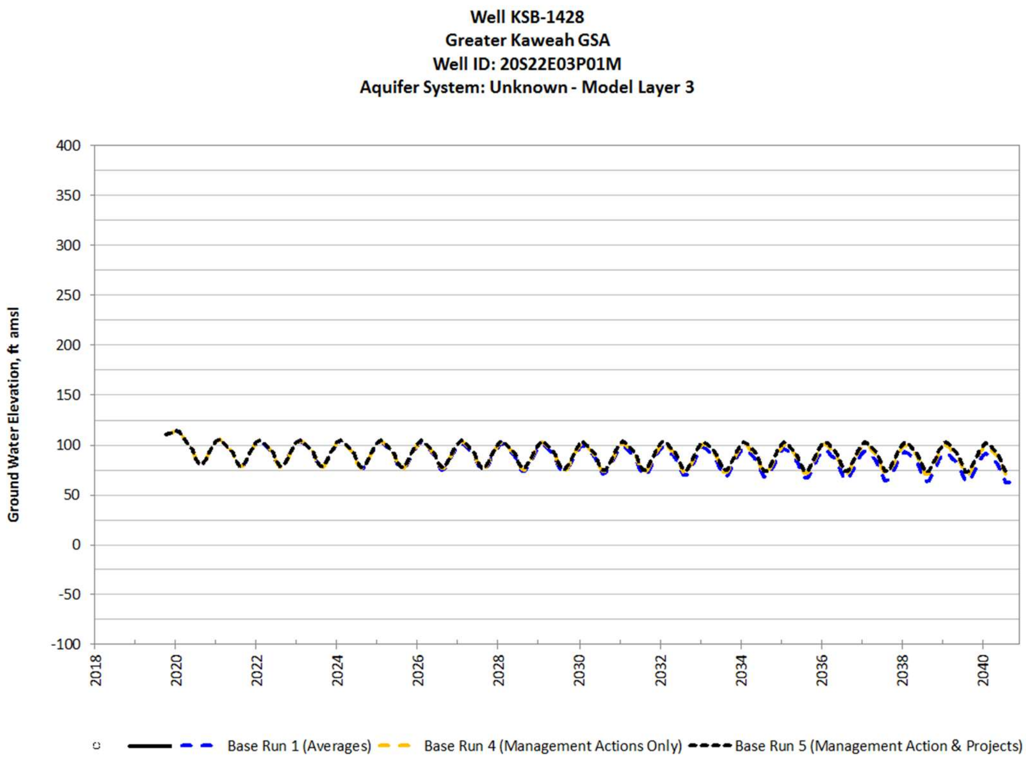


Well KSB-1384
Greater Kaweah GSA
Well ID: 362000N1195800W001
Aquifer System: Unknown - Model Layer 3

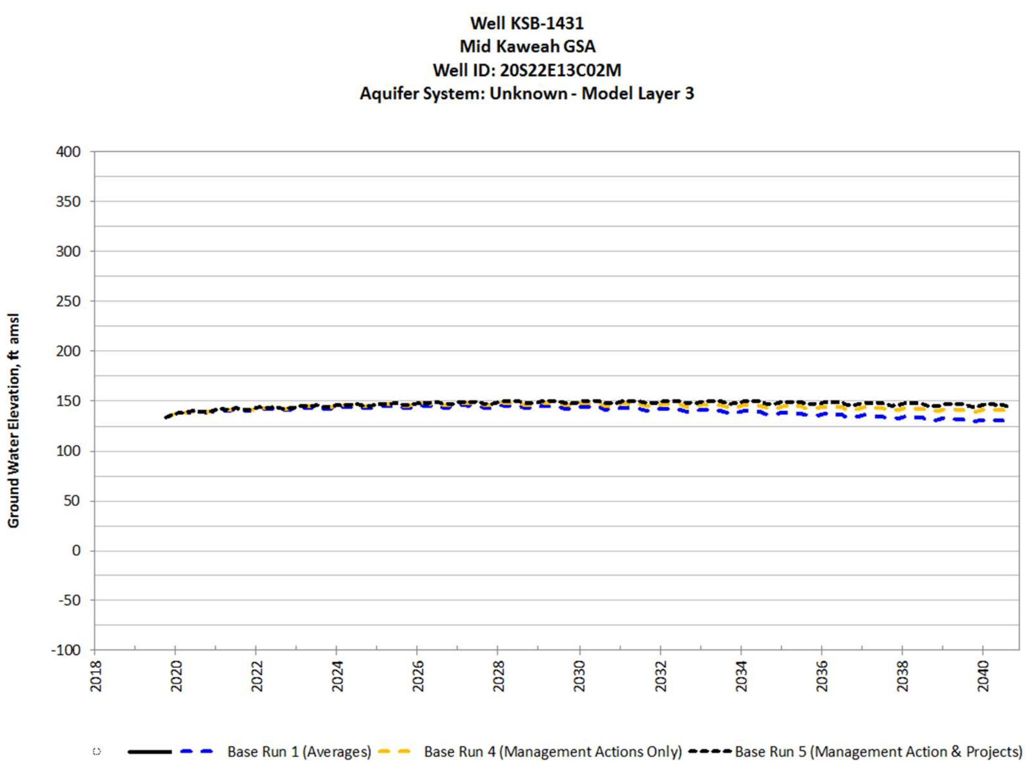



Well KSB-1389
Mid Kaweah GSA
Well ID: CID_076
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

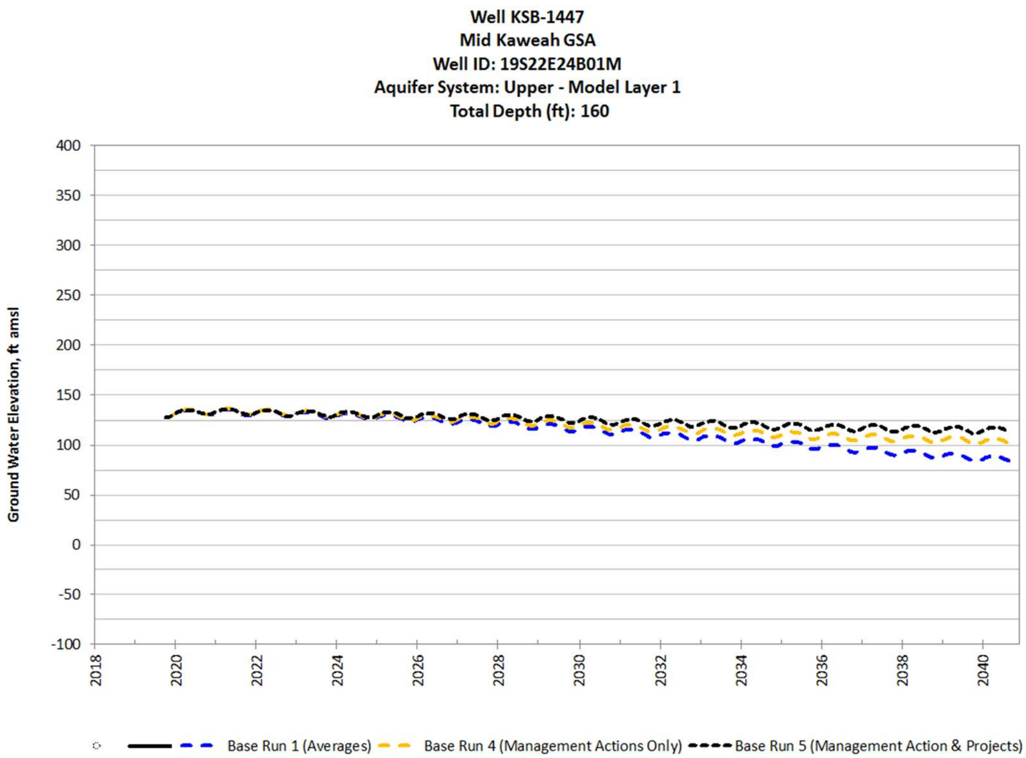

Well KSB-1425
Greater Kaweah GSA
Well ID: 20S22E03C02M
Aquifer System: Upper - Model Layer 3
Total Depth (ft): 200
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

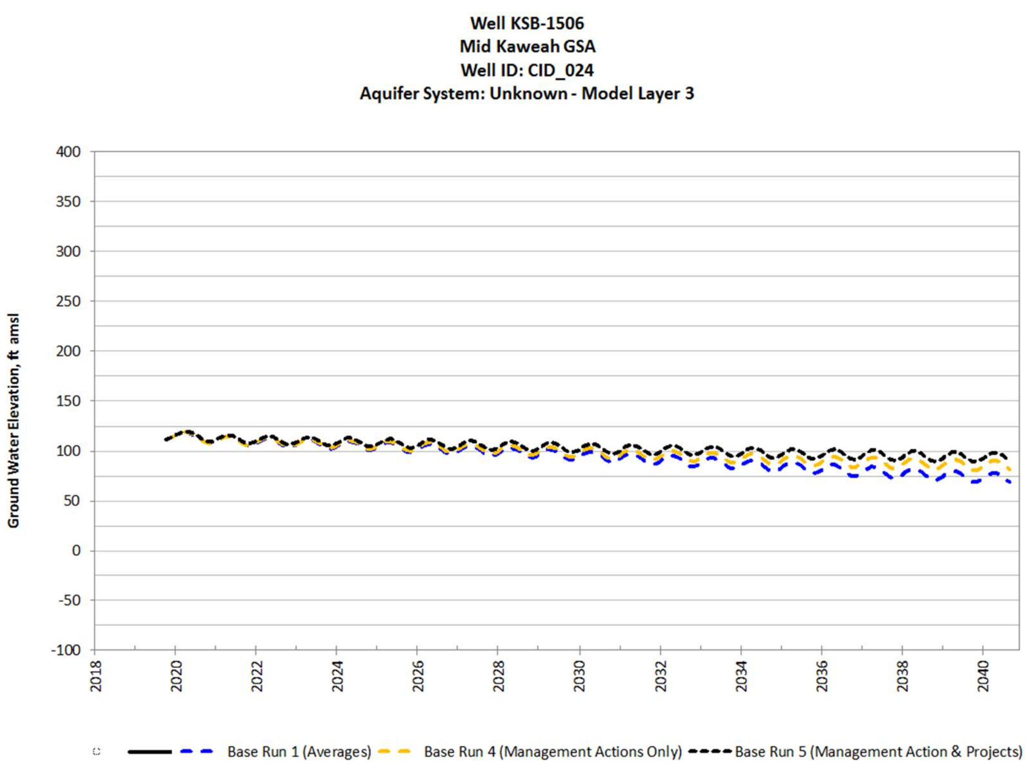


Well KSB-1428
Greater Kaweah GSA
Well ID: 20S22E03P01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

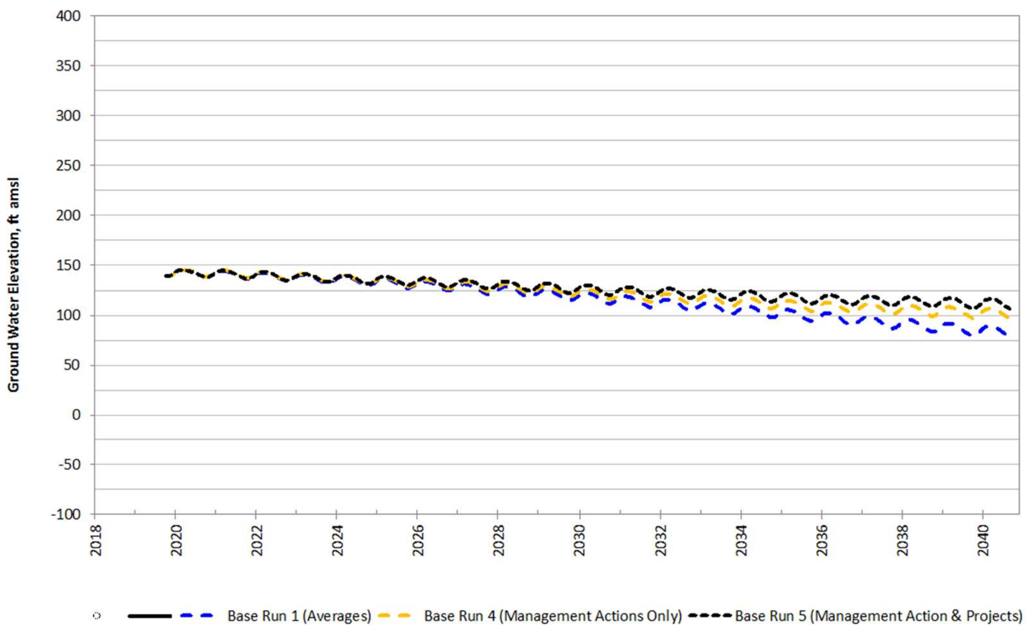


Well KSB-1431
Mid Kaweah GSA
Well ID: 20S22E13C02M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

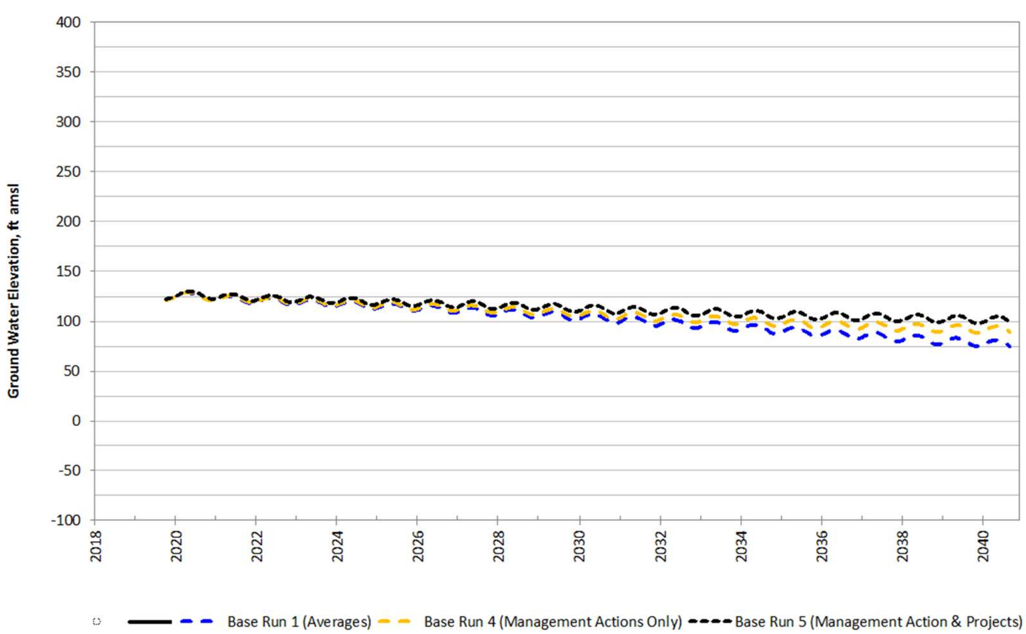

Well KSB-1447
Mid Kaweah GSA
Well ID: 19S22E24B01M
Aquifer System: Upper - Model Layer 1
Total Depth (ft): 160
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-1506
Mid Kaweah GSA
Well ID: CID_024
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

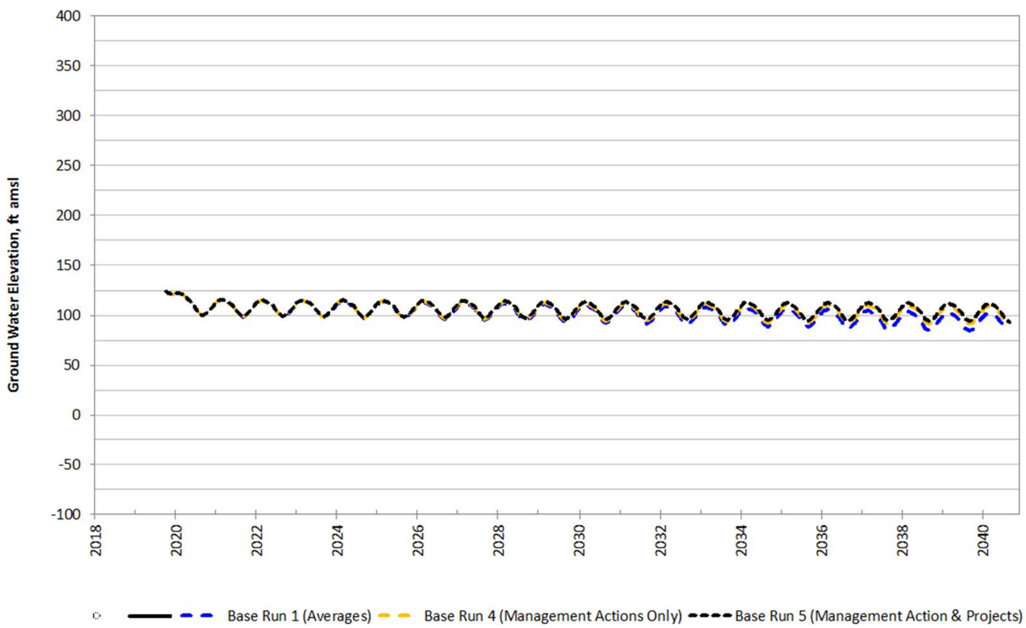
Well KSB-1526
Mid Kaweah GSA
Well ID: CID_037
Aquifer System: Unknown - Model Layer 3



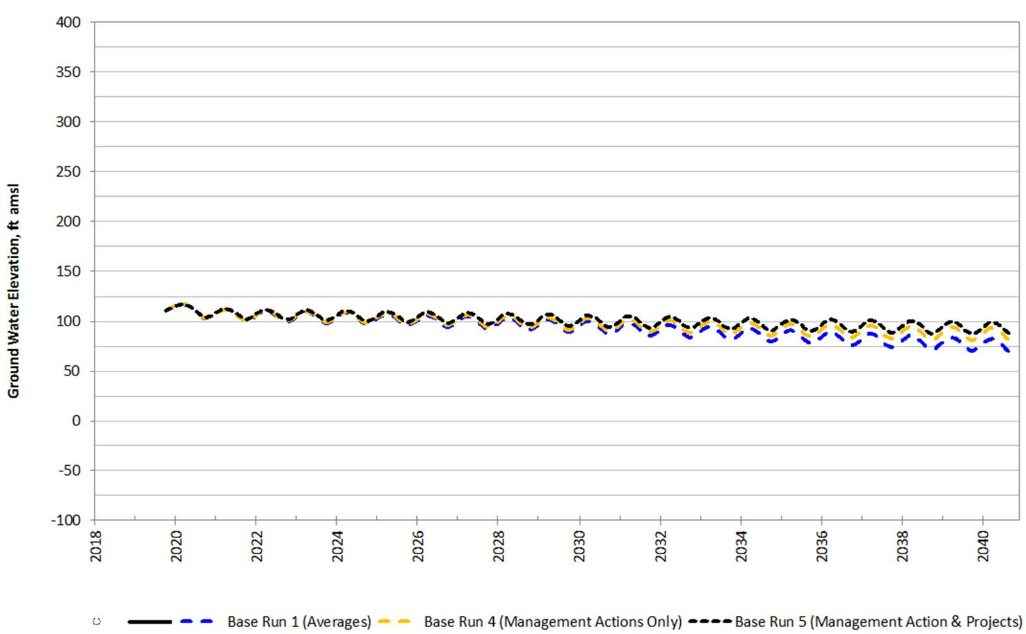
Well KSB-1532
Mid Kaweah GSA
Well ID: CID_052
Aquifer System: Unknown - Model Layer 3

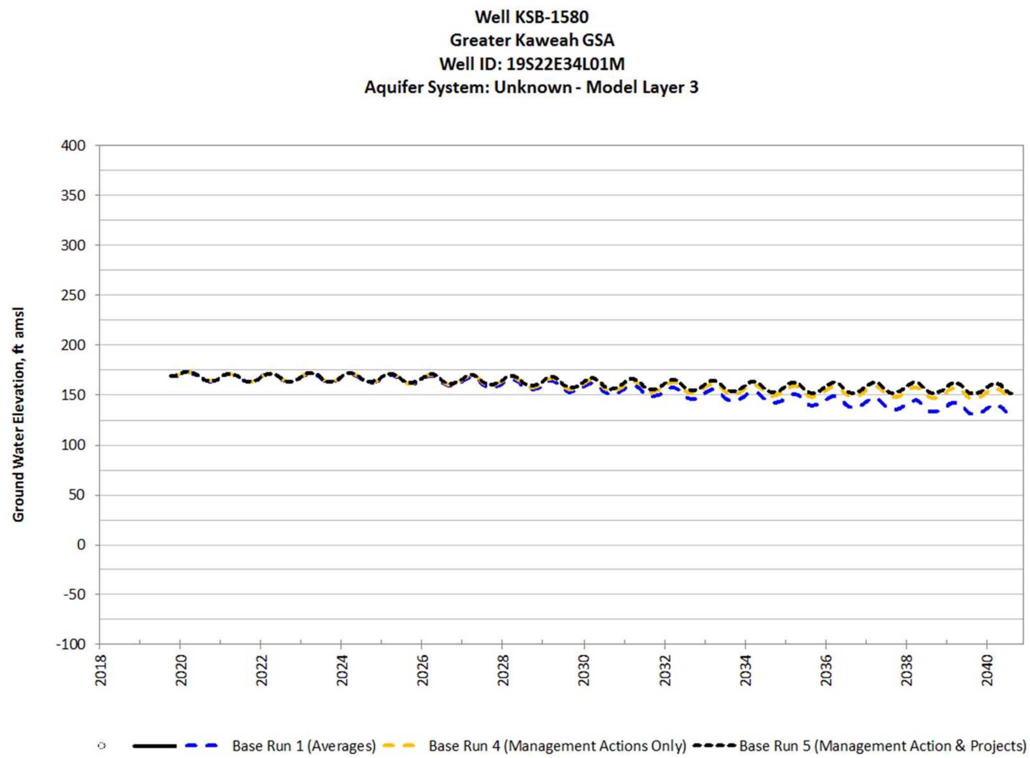


Well KSB-1535
Greater Kaweah GSA
Well ID: 19S22E27C01M
Aquifer System: Unknown - Model Layer 3

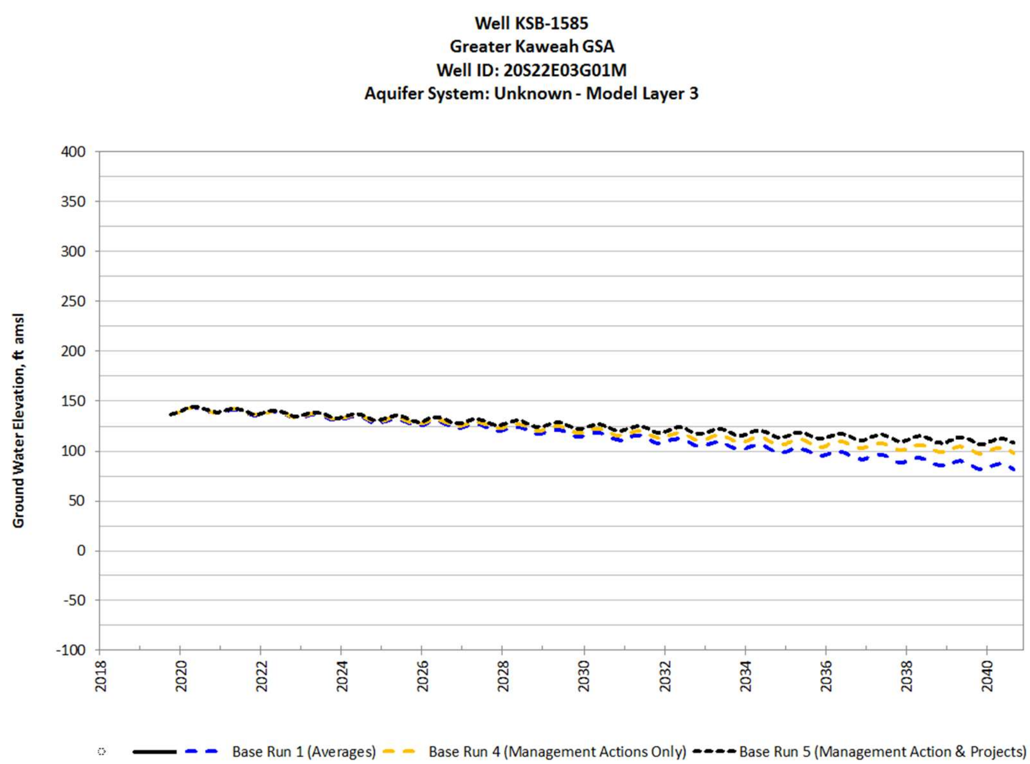


Well KSB-1538
Mid Kaweah GSA
Well ID: 18S22E01C01M
Aquifer System: Unknown - Model Layer 1





Well KSB-1580
Greater Kaweah GSA
Well ID: 19S22E34L01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)



Well KSB-1585
Greater Kaweah GSA
Well ID: 20S22E03G01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
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2032
2034
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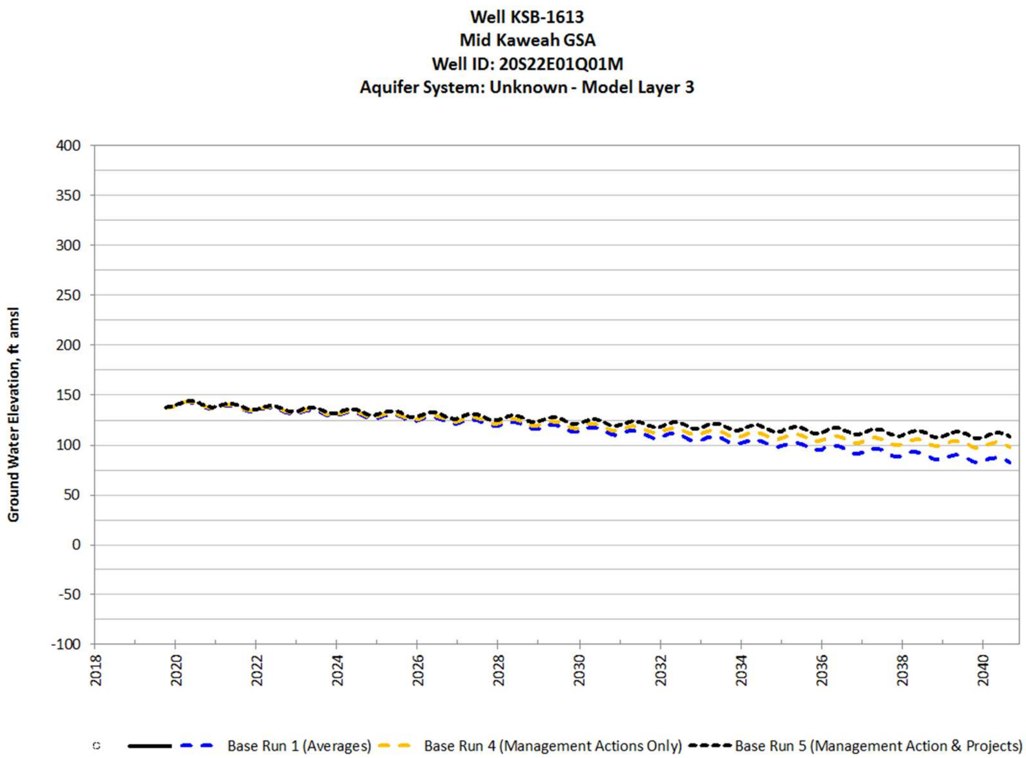
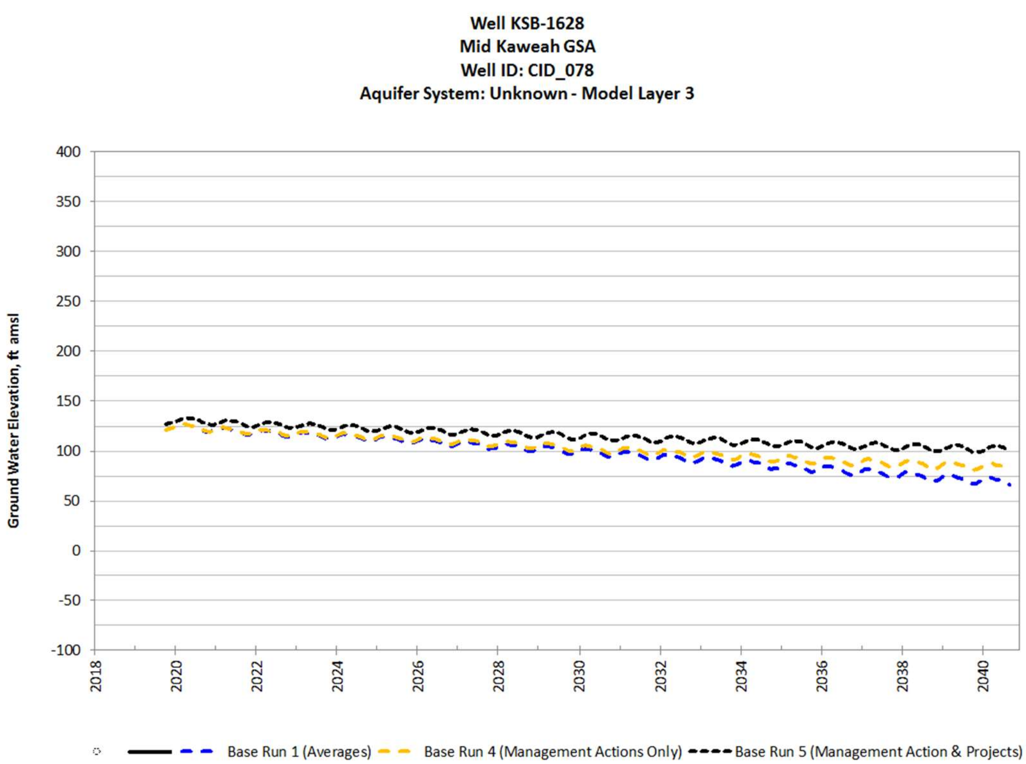
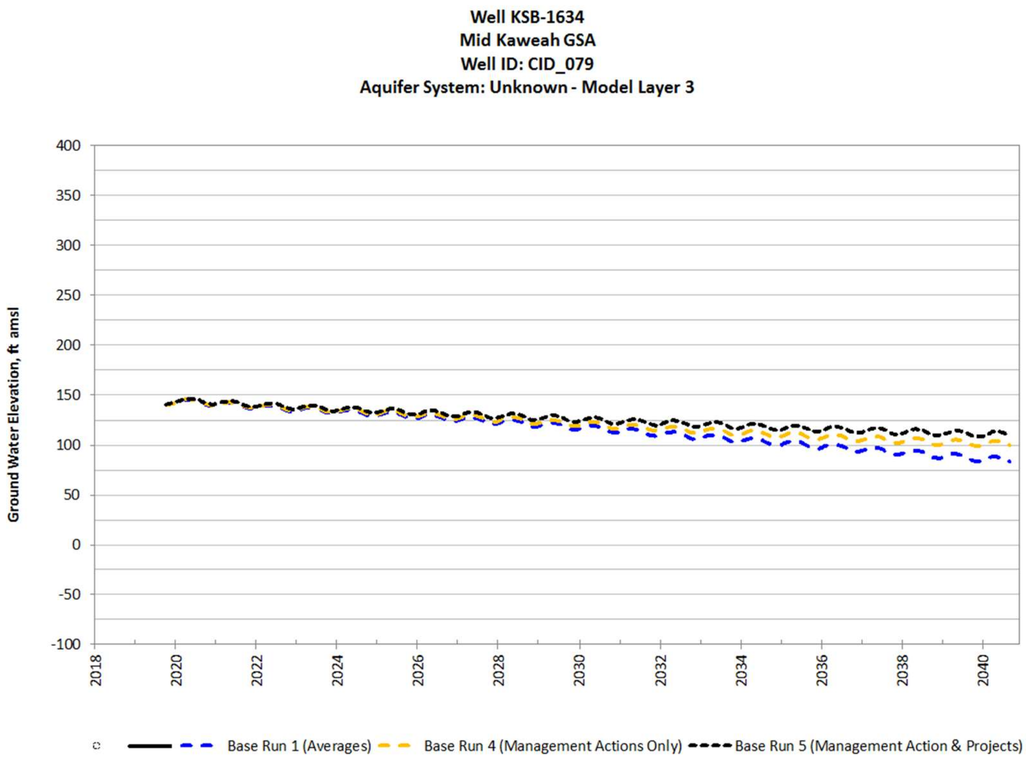
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

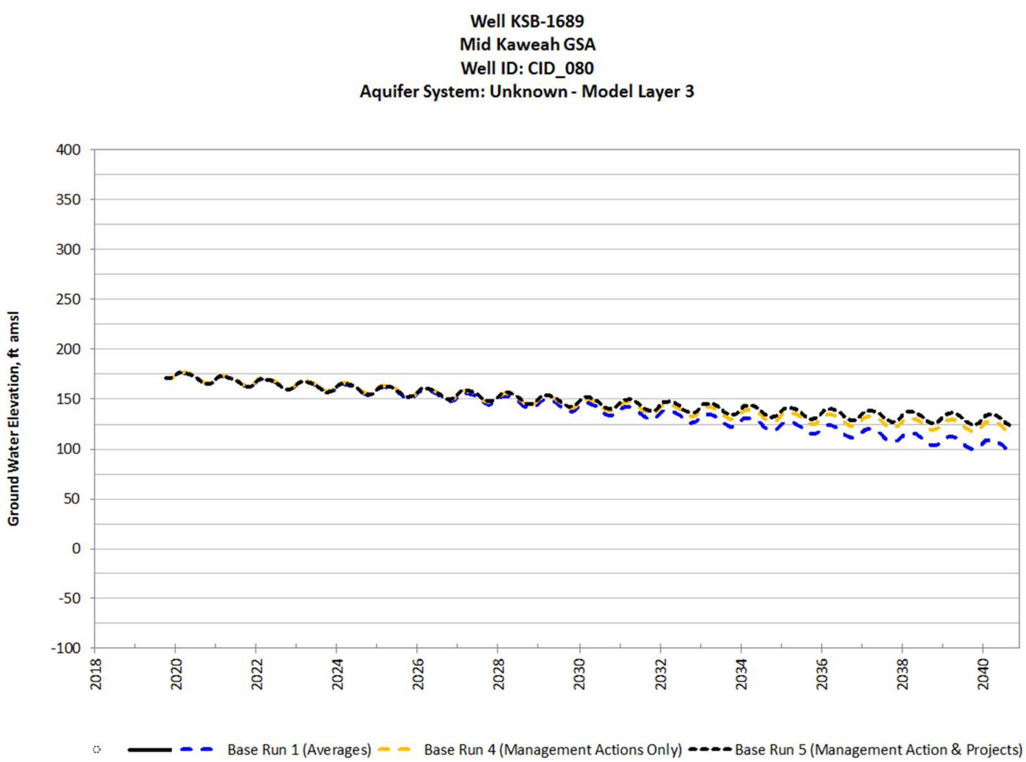


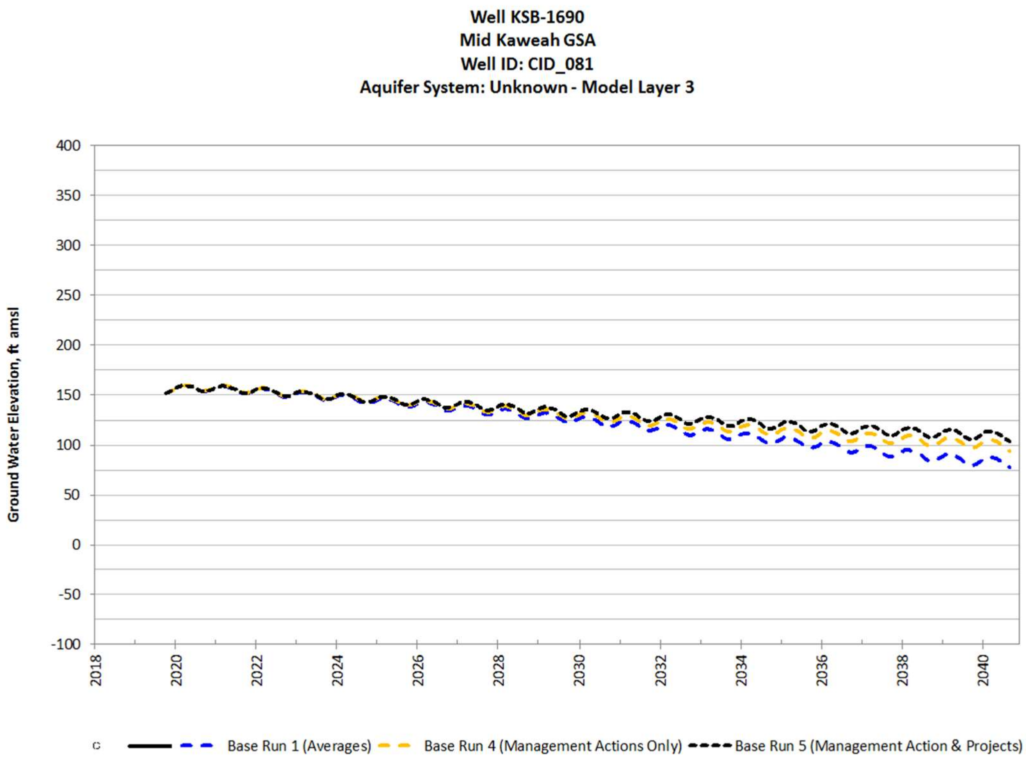
Well KSB-1613
Mid Kaweah GSA
Well ID: 20S22E01Q01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

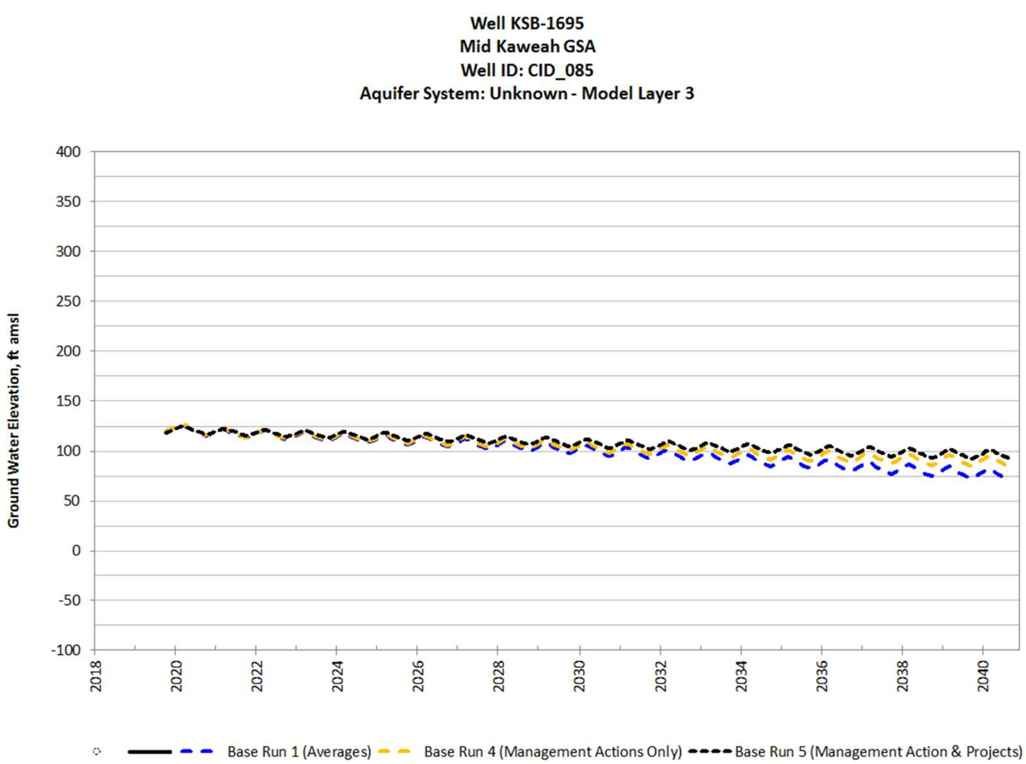


Well KSB-1628
Mid Kaweah GSA
Well ID: CID_078
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

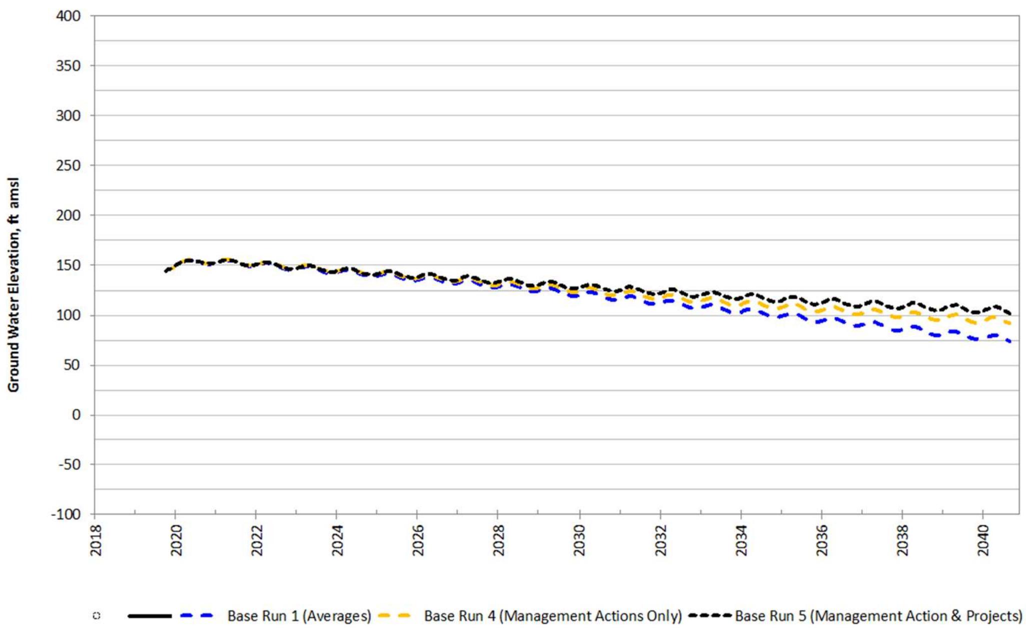

Well KSB-1634
Mid Kaweah GSA
Well ID: CID_079
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-1689
Mid Kaweah GSA
Well ID: CID_080
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

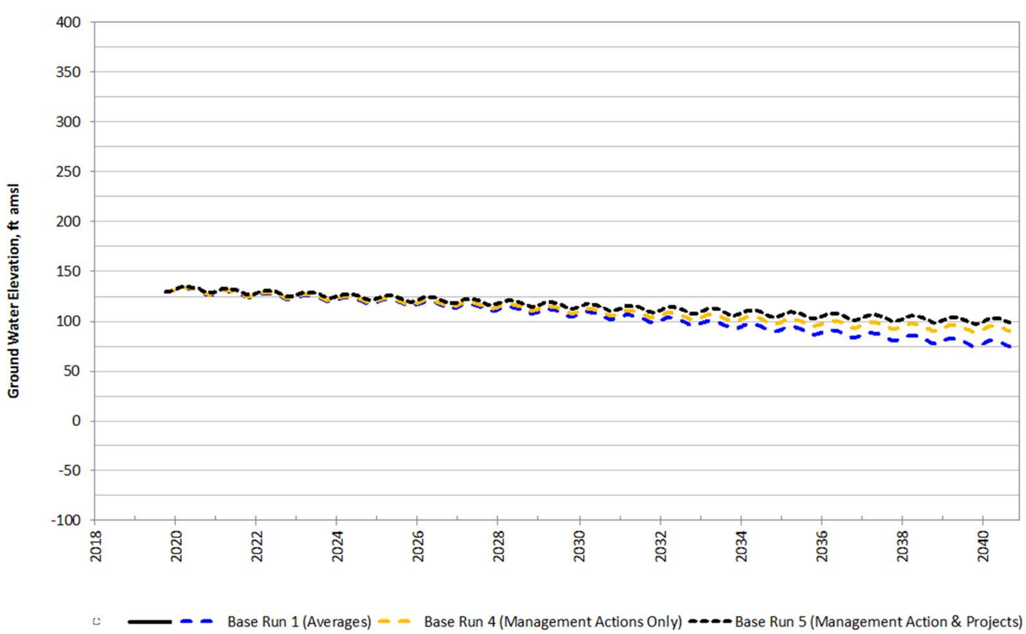

Well KSB-1690
Mid Kaweah GSA
Well ID: CID_081
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-1695
Mid Kaweah GSA
Well ID: CID_085
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

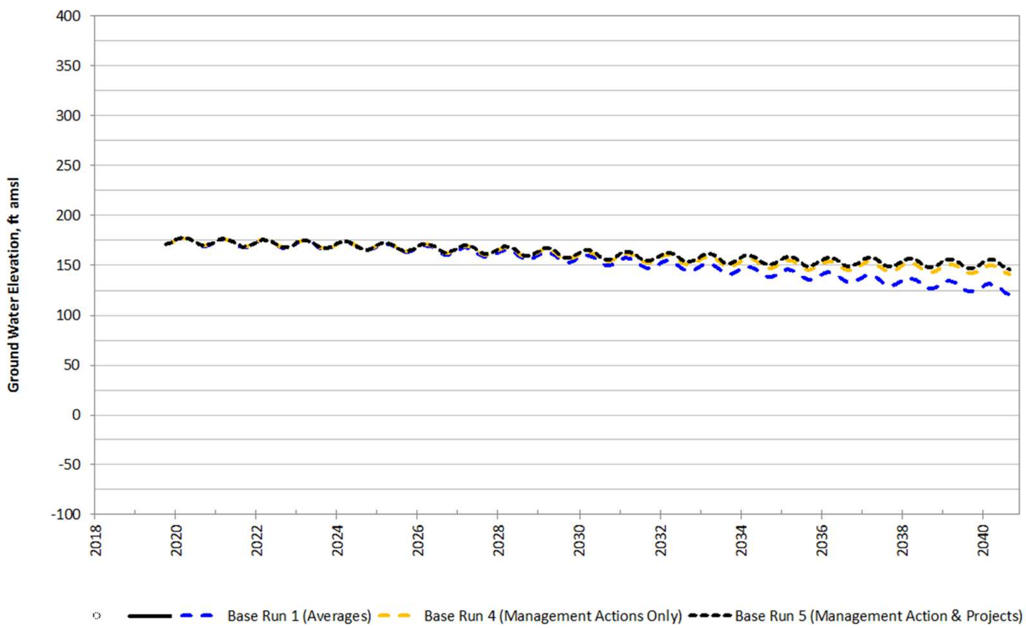
Well KSB-1696
Mid Kaweah GSA
Well ID: 21S23E18N02M
Aquifer System: Unknown - Model Layer 3



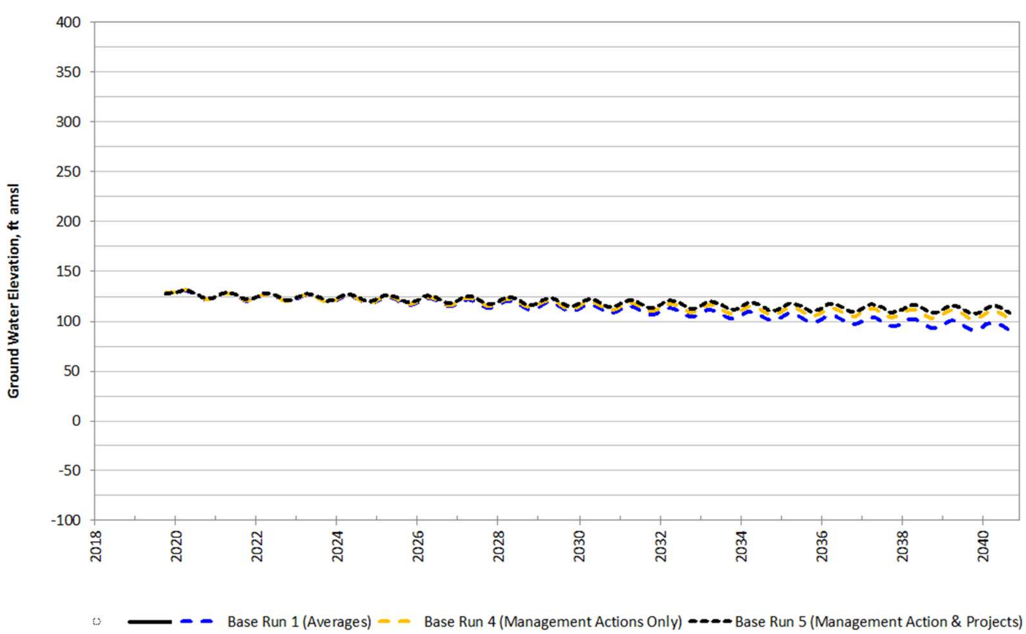
Well KSB-1770
Mid Kaweah GSA
Well ID: 21S23E18N01M
Aquifer System: Unknown - Model Layer 1

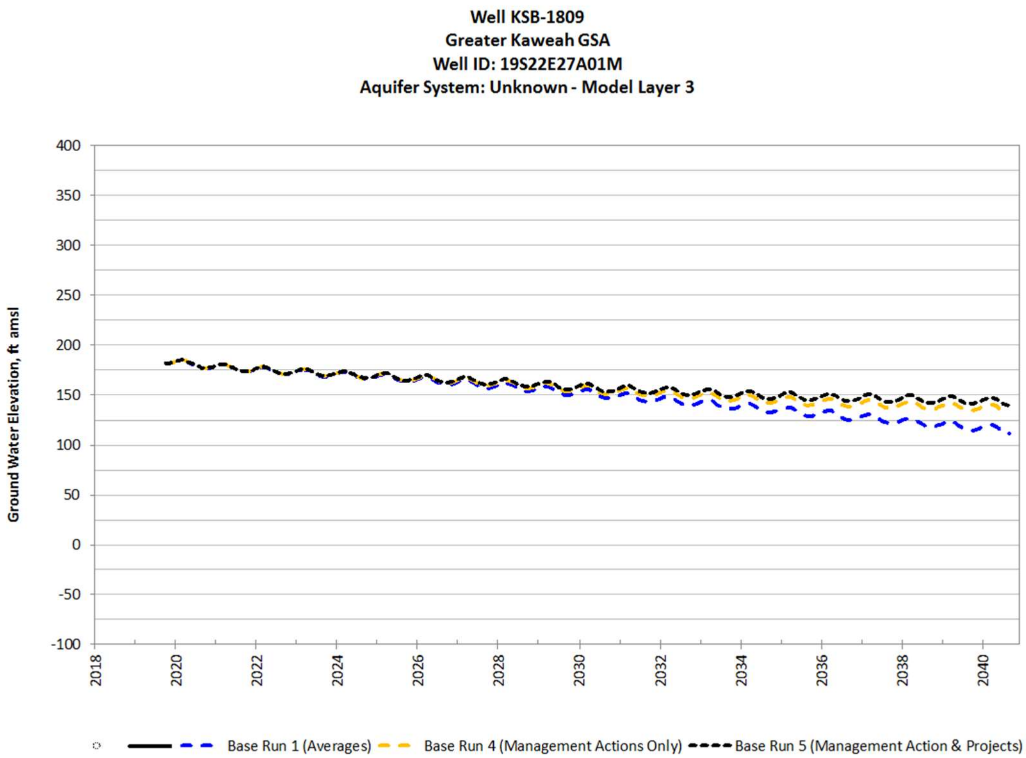


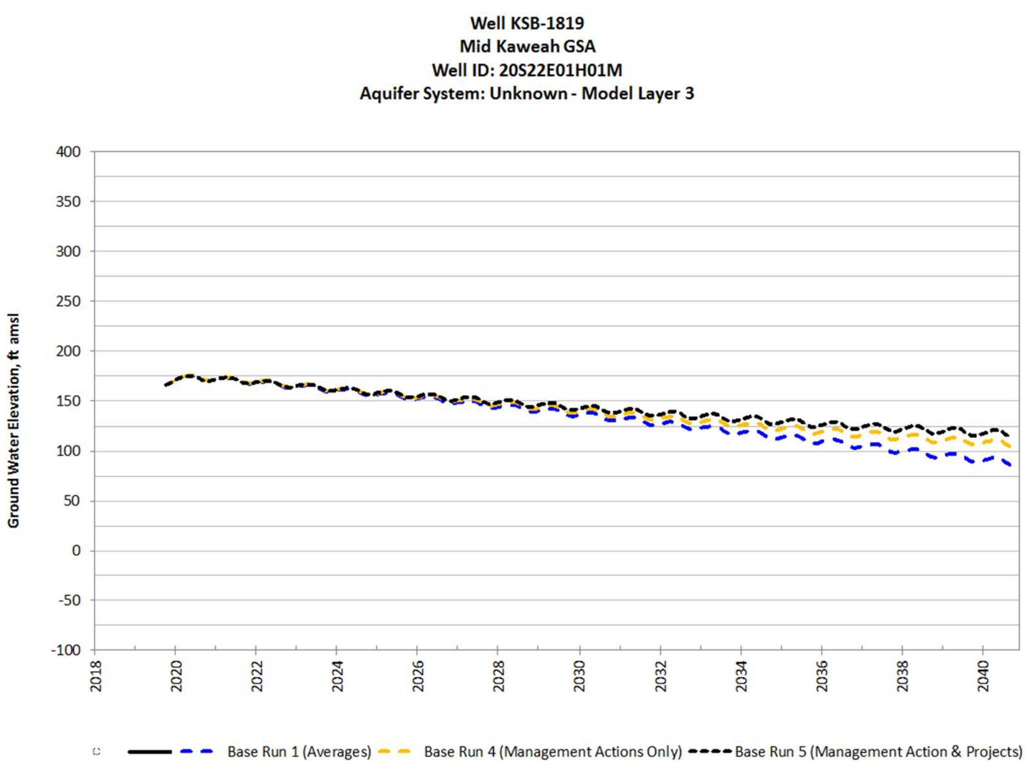
Well KSB-1775
Greater Kaweah GSA
Well ID: 20S22E03K01M
Aquifer System: Unknown - Model Layer 3

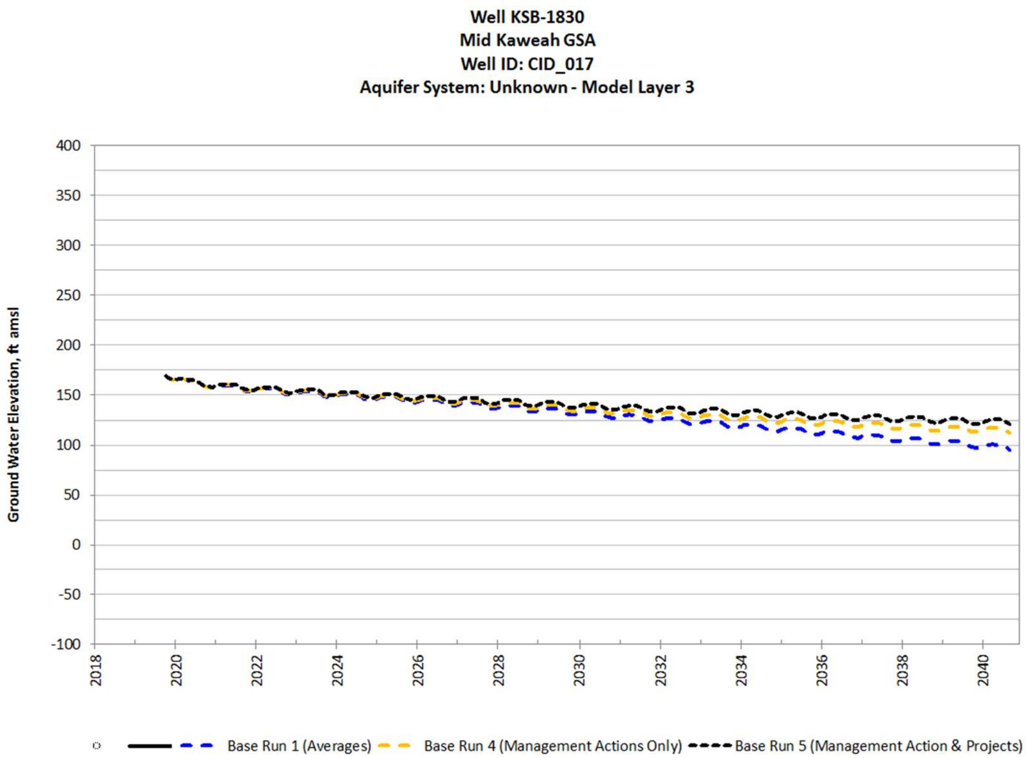


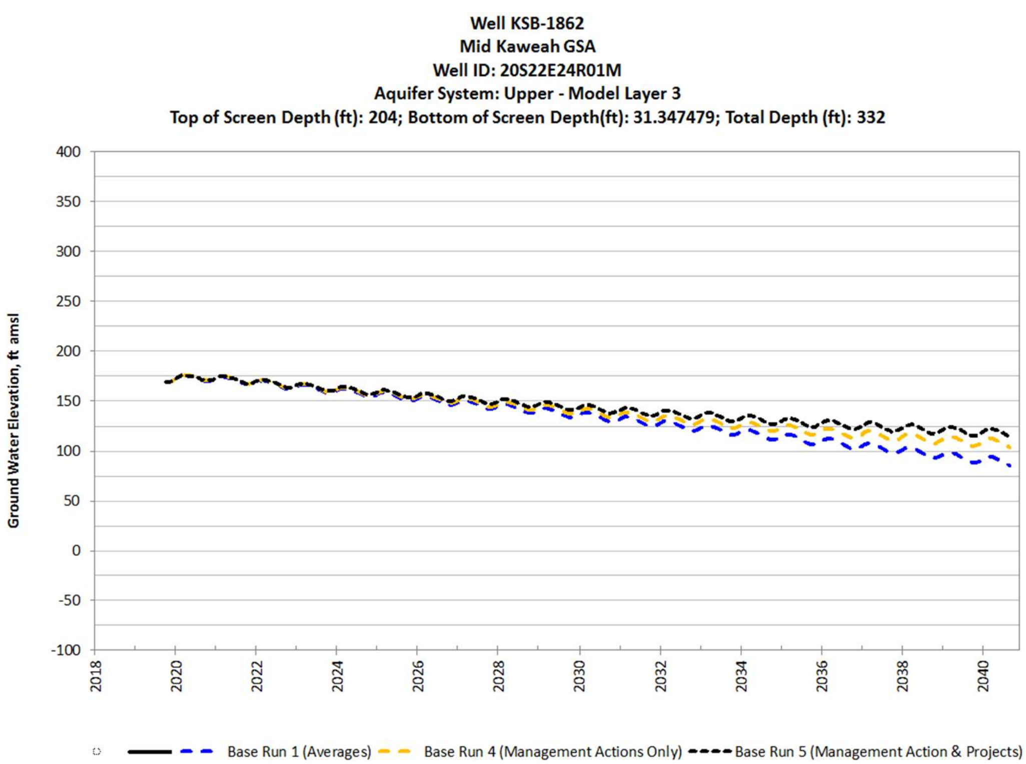
Well KSB-1783
Greater Kaweah GSA
Well ID: 20S22E03B01M
Aquifer System: Unknown - Model Layer 3

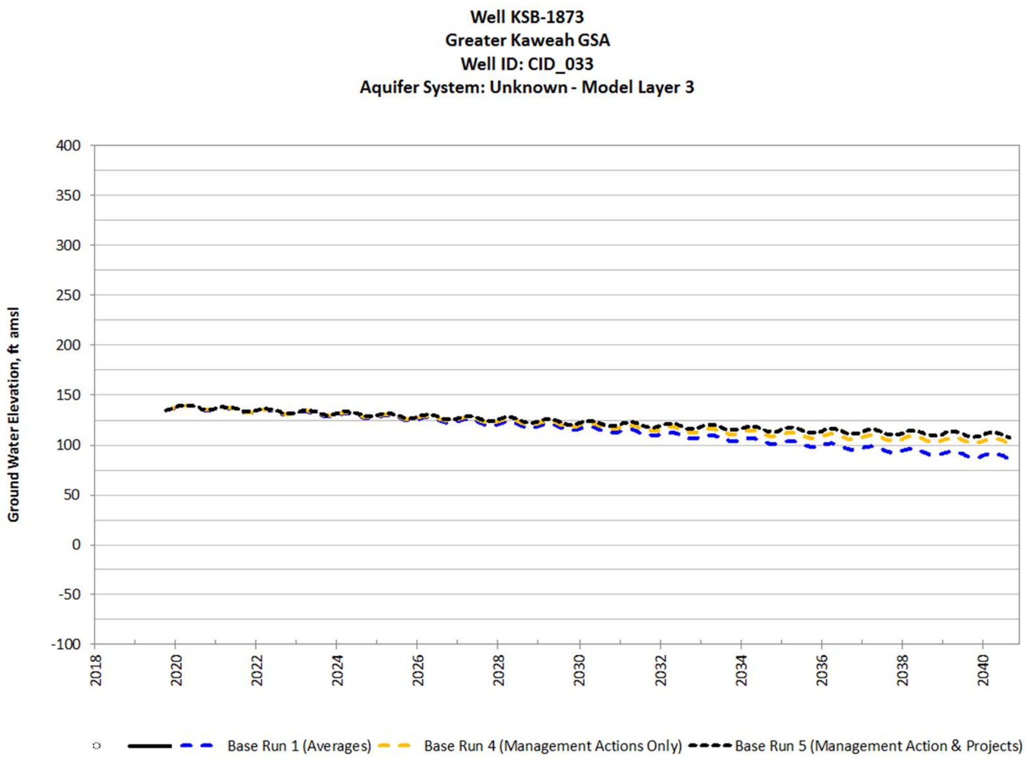


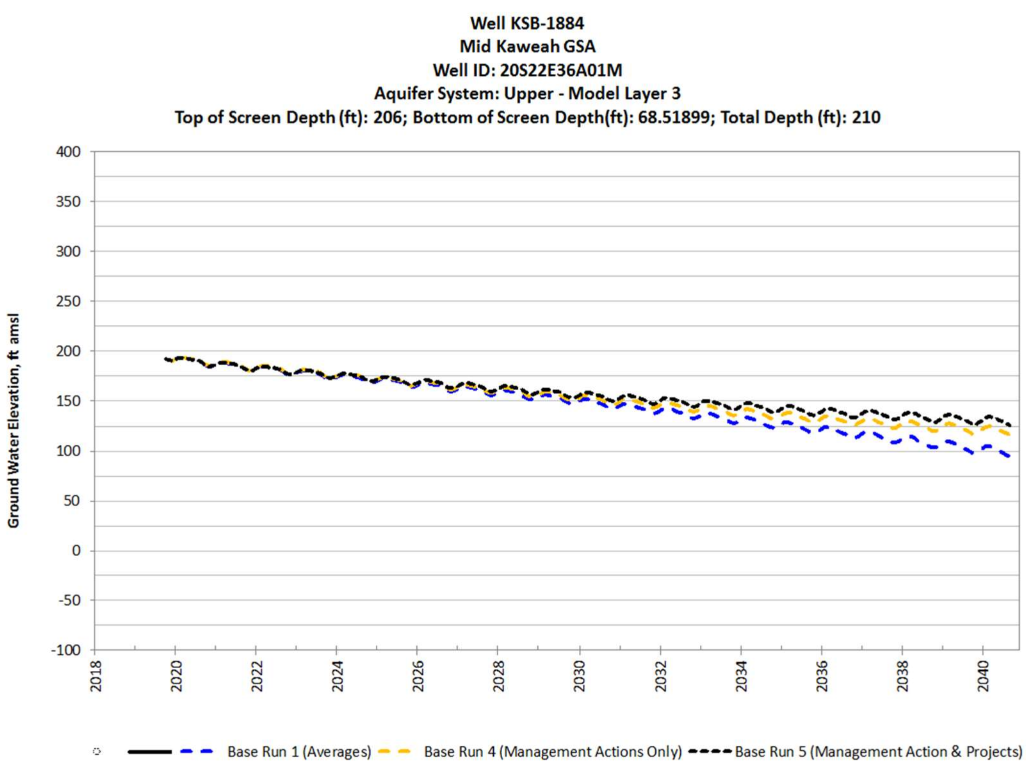

Well KSB-1809
Greater Kaweah GSA
Well ID: 19S22E27A01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

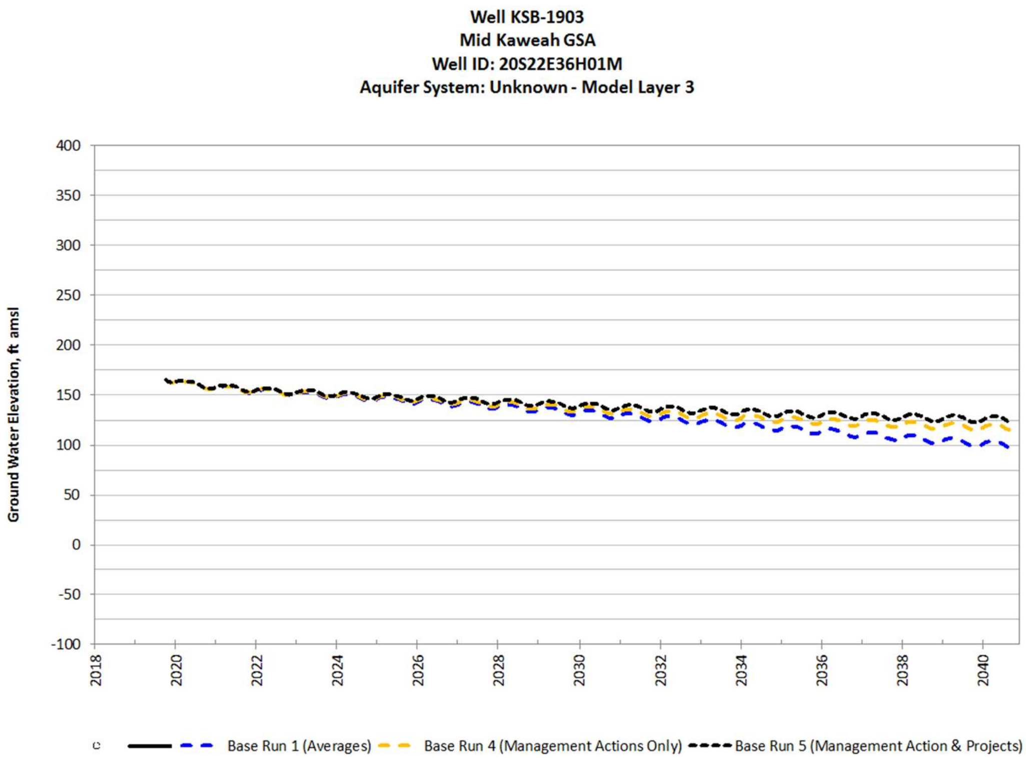

Well KSB-1819
Mid Kaweah GSA
Well ID: 20S22E01H01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

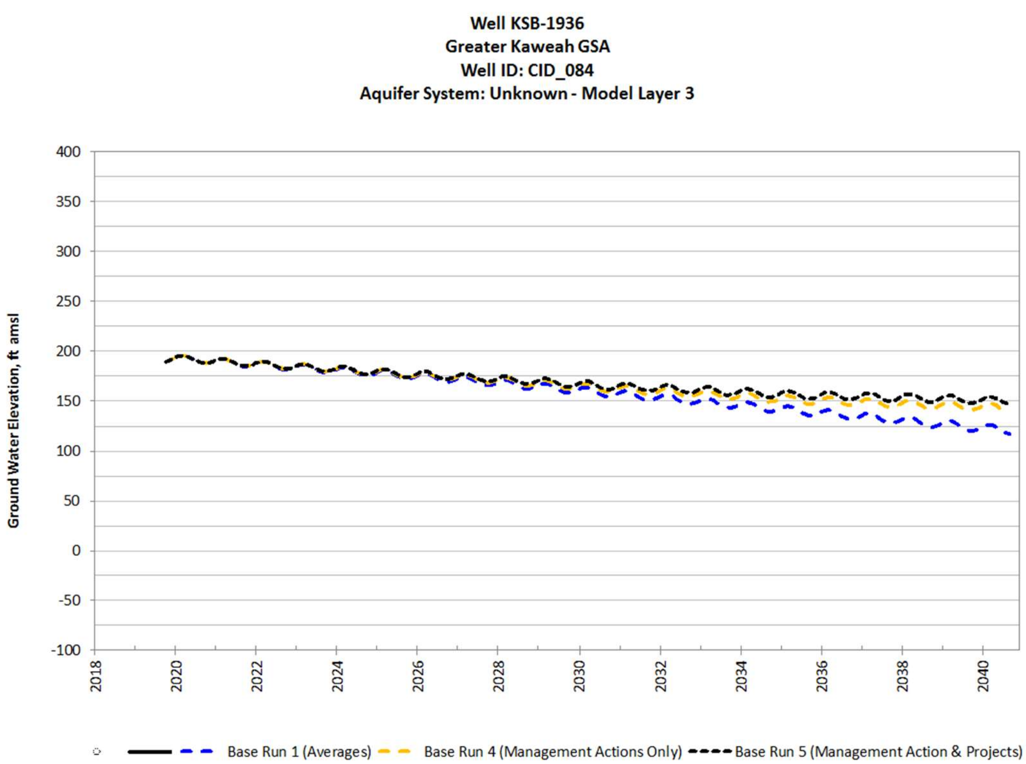

Well KSB-1830
Mid Kaweah GSA
Well ID: CID_017
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

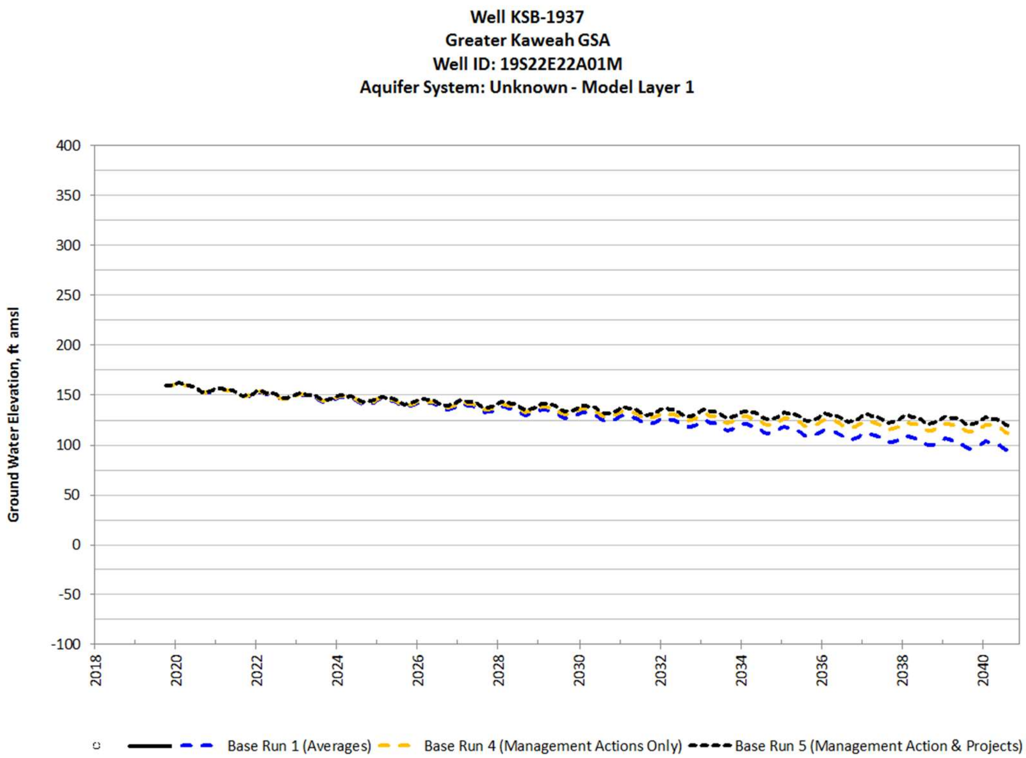

Well KSB-1862
Mid Kaweah GSA
Well ID: 20S22E24R01M
Aquifer System: Upper - Model Layer 3
Top of Screen Depth (ft): 204; Bottom of Screen Depth(ft): 31.347479; Total Depth (ft): 332
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

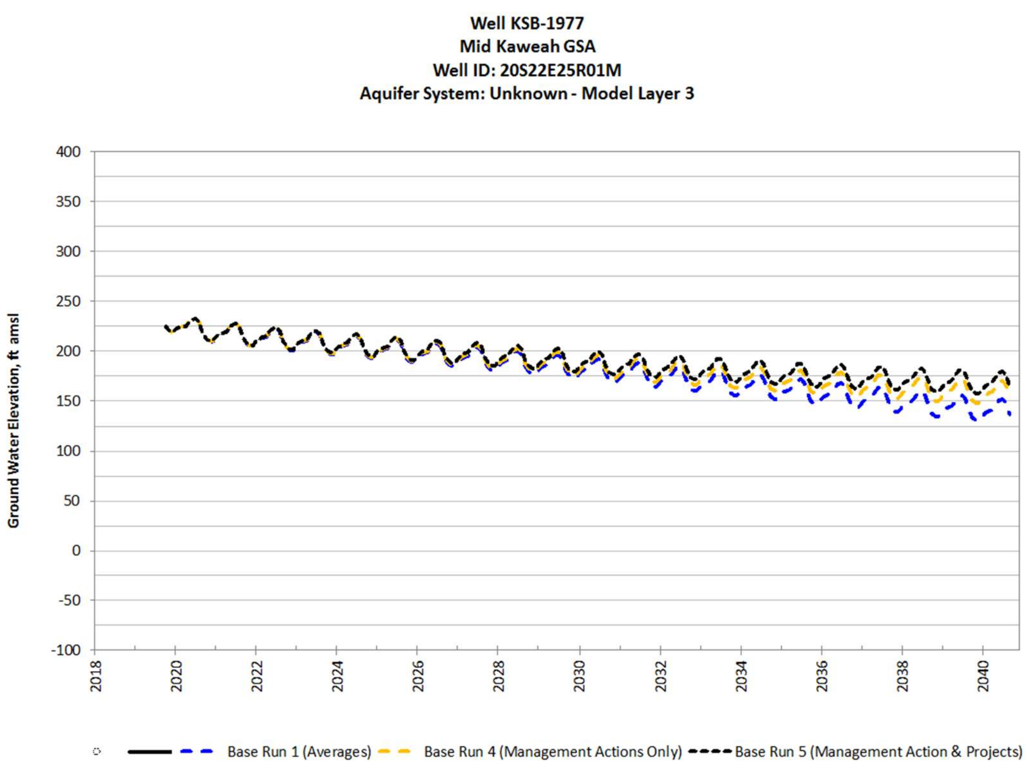

Well KSB-1873
Greater Kaweah GSA
Well ID: CID_033
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

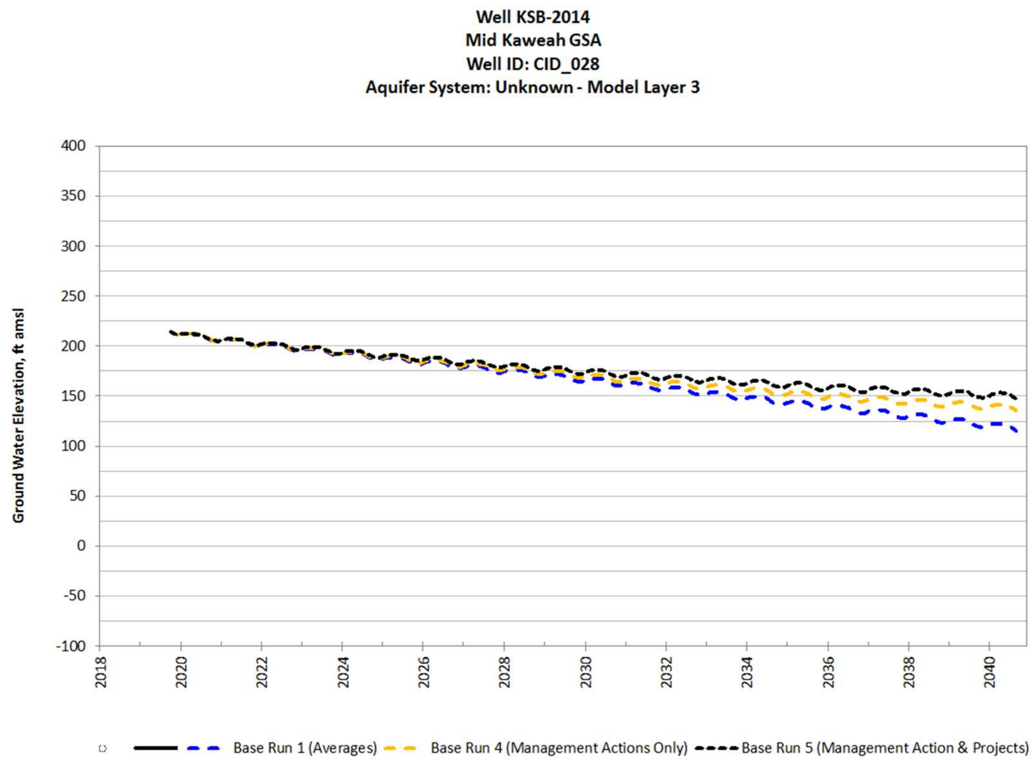

Well KSB-1884
Mid Kaweah GSA
Well ID: 20S22E36A01M
Aquifer System: Upper - Model Layer 3
Top of Screen Depth (ft): 206; Bottom of Screen Depth(ft): 68.51899; Total Depth (ft): 210
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

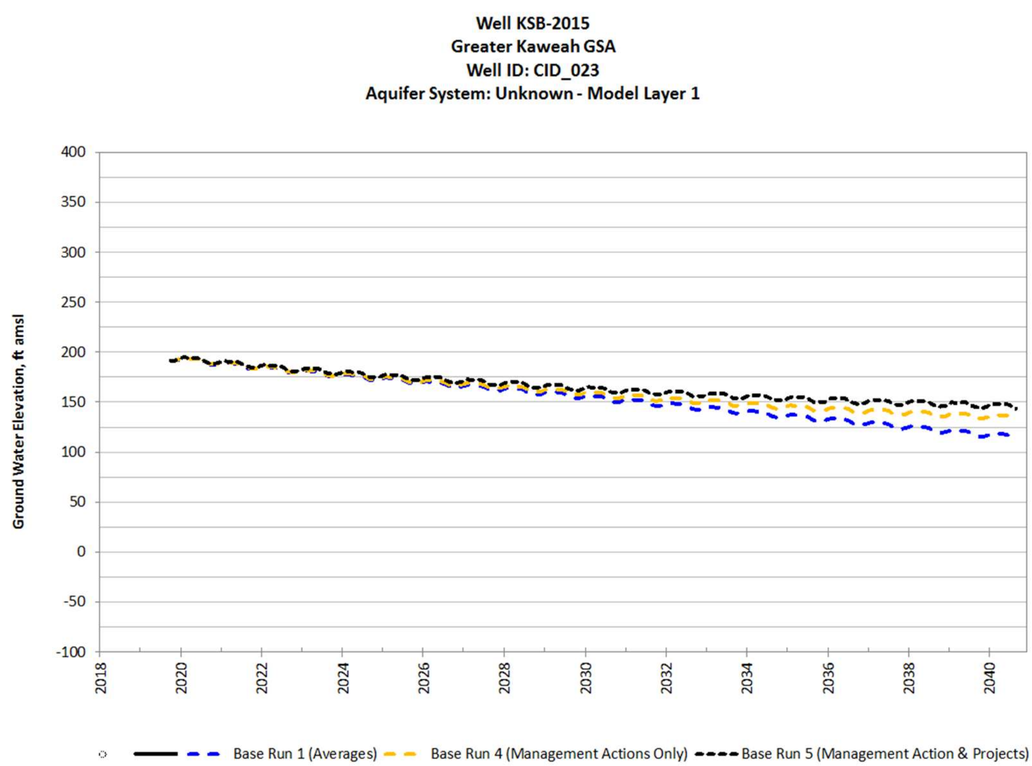

Well KSB-1903
Mid Kaweah GSA
Well ID: 20S22E36H01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

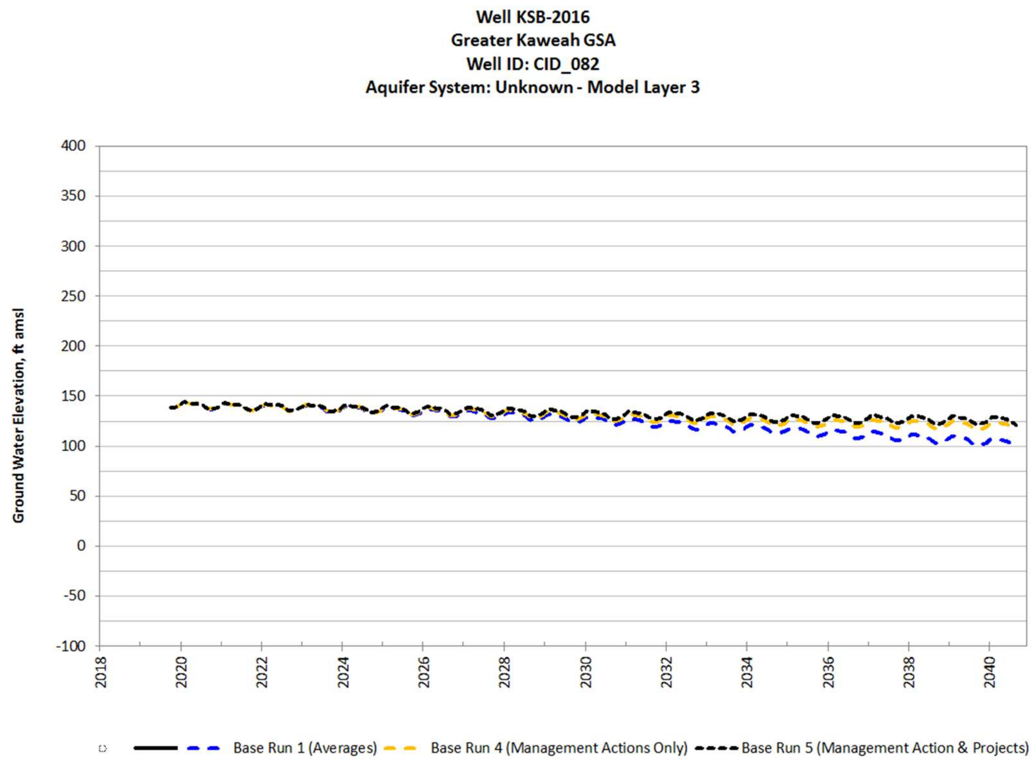

Well KSB-1936
Greater Kaweah GSA
Well ID: CID_084
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

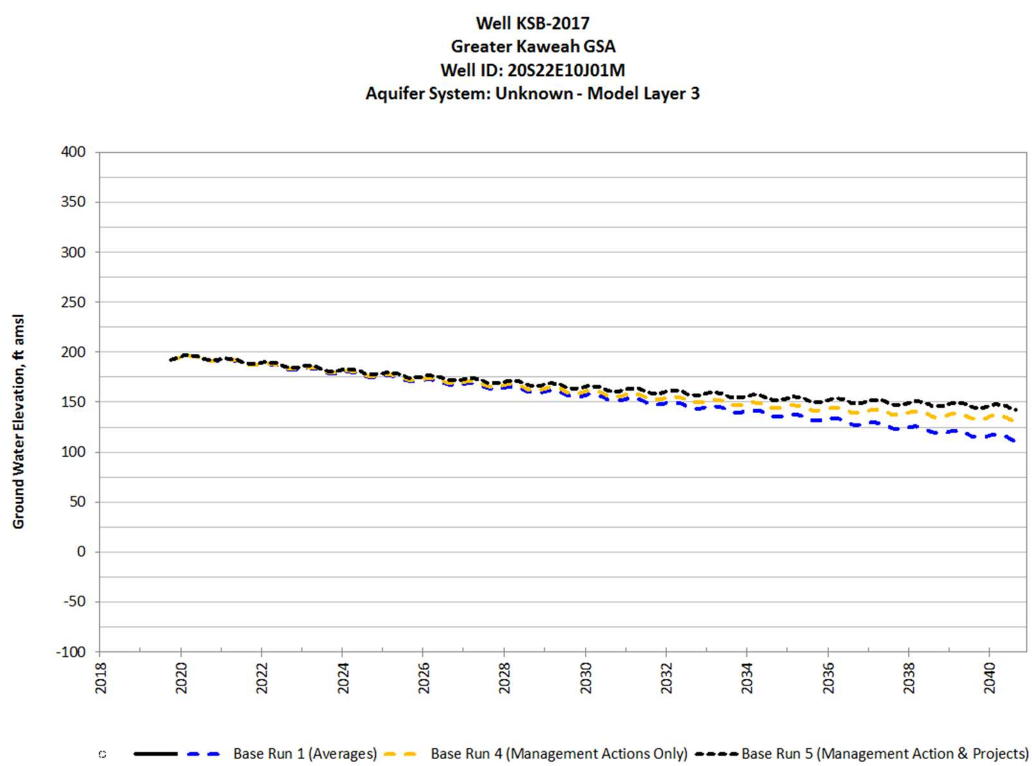

Well KSB-1937
Greater Kaweah GSA
Well ID: 19S22E22A01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-1977
Mid Kaweah GSA
Well ID: 20S22E25R01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

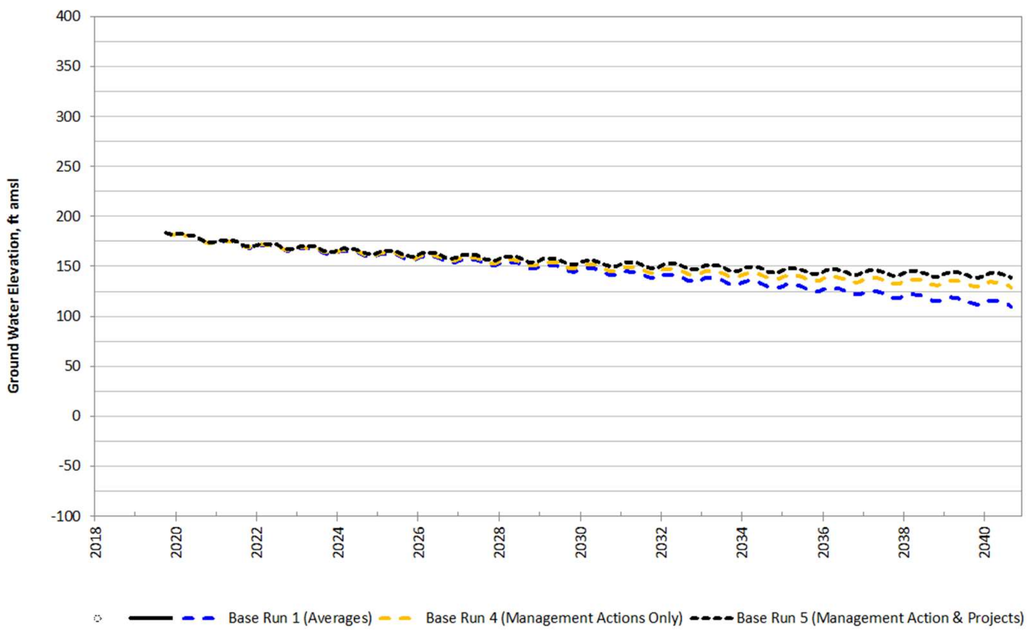

Well KSB-2014
Mid Kaweah GSA
Well ID: CID_028
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2015
Greater Kaweah GSA
Well ID: CID_023
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

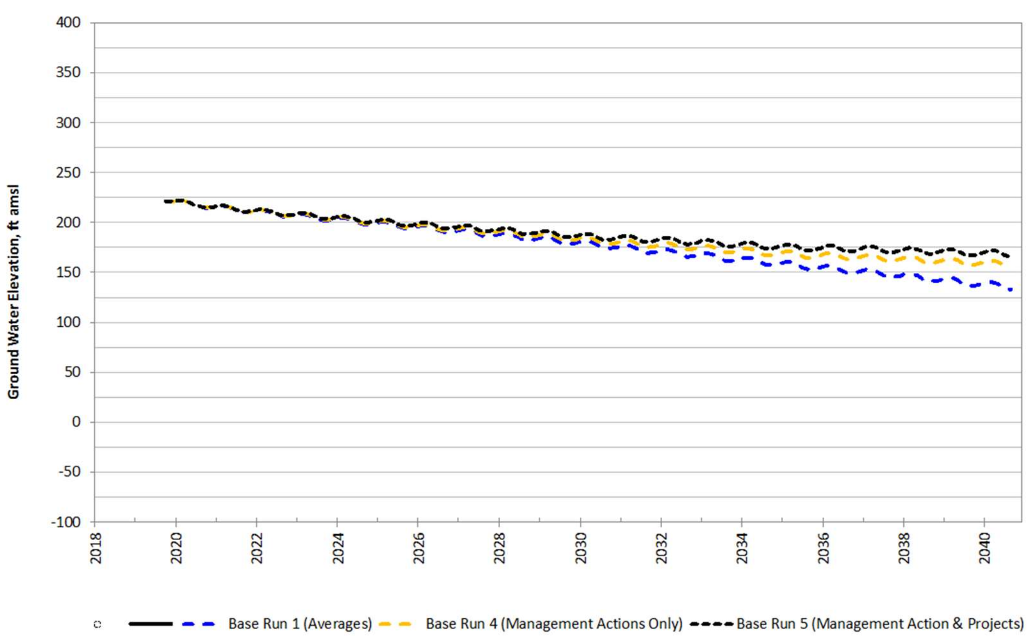

Well KSB-2016
Greater Kaweah GSA
Well ID: CID_082
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

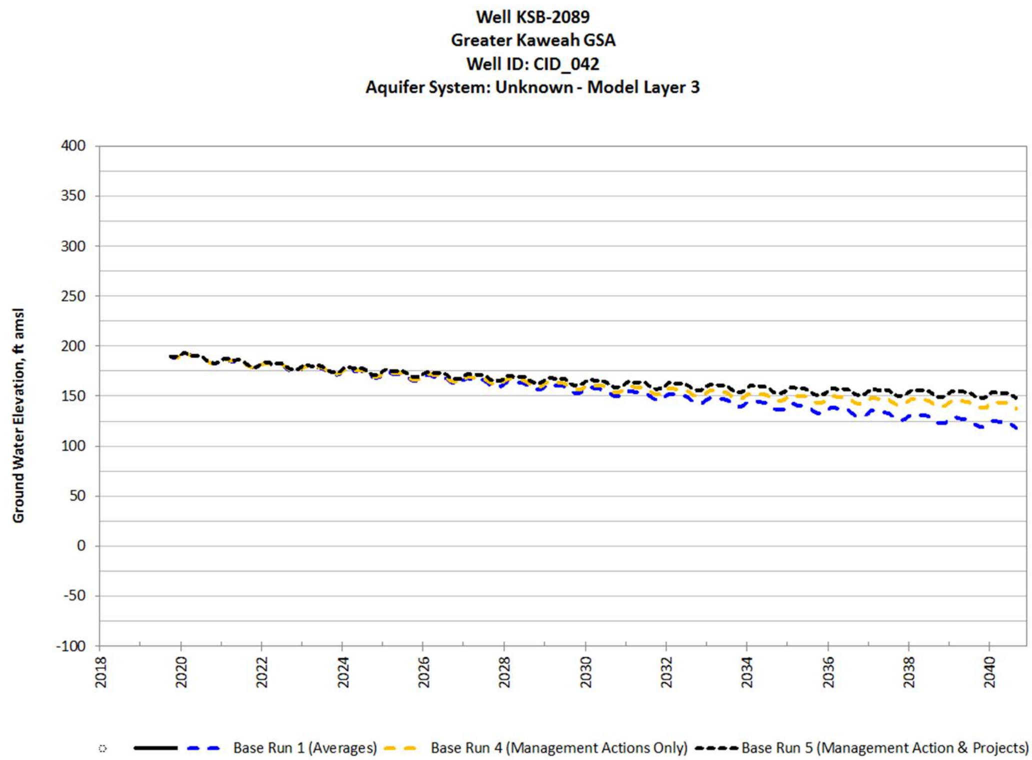

Well KSB-2017
Greater Kaweah GSA
Well ID: 20S22E10J01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

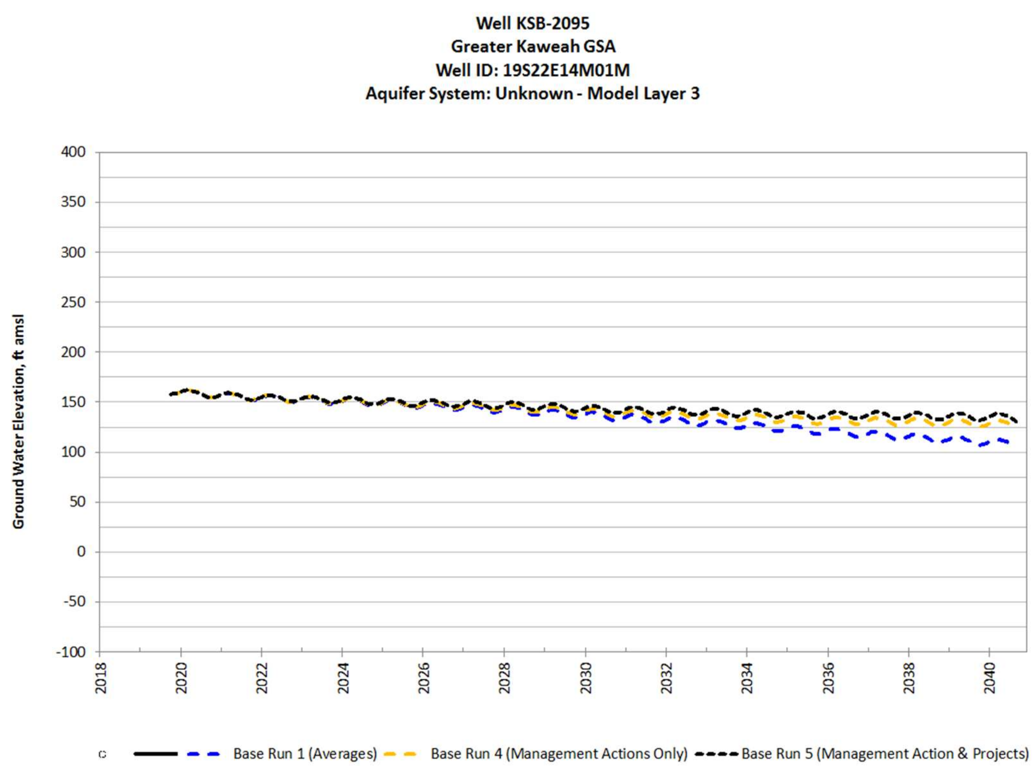
Well KSB-2021
Greater Kaweah GSA
Well ID: 19S22E10R02M
Aquifer System: Unknown - Model Layer 1

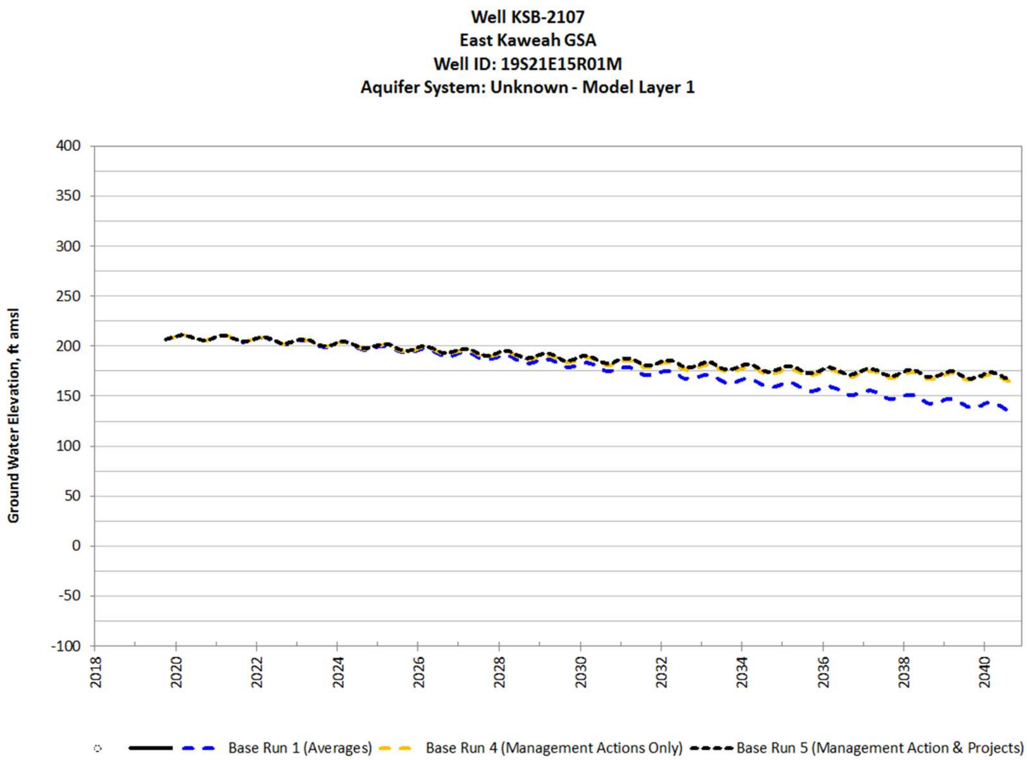


Well KSB-2058
Greater Kaweah GSA
Well ID: 19S22E14N01M
Aquifer System: Unknown - Model Layer 3

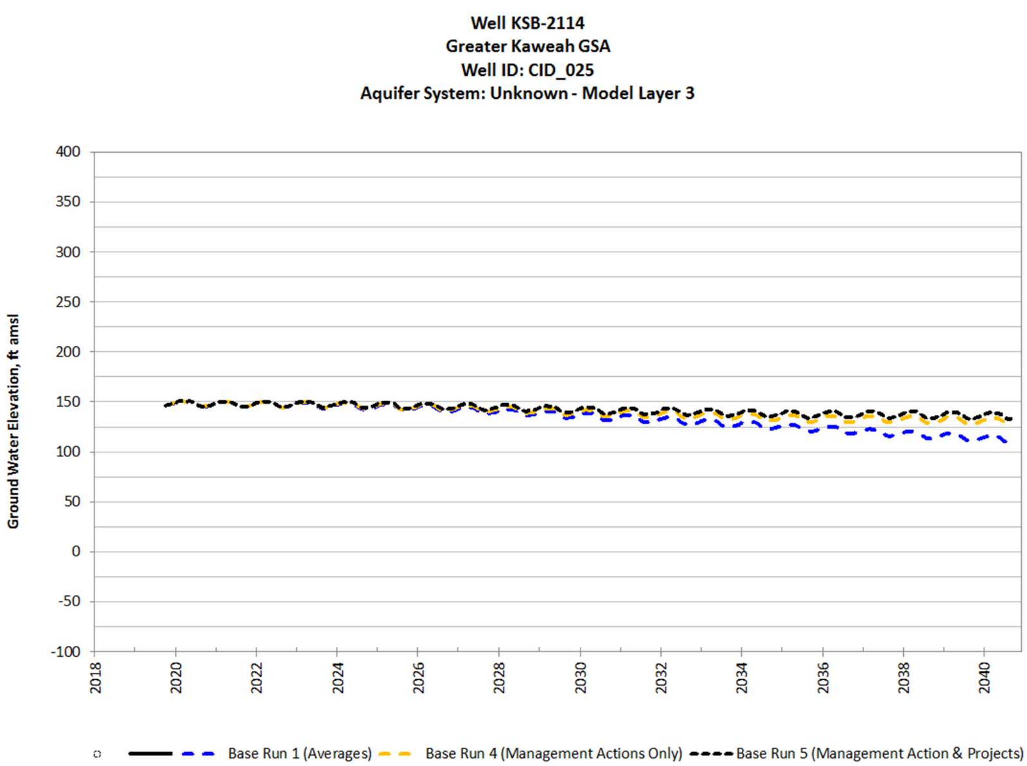



Well KSB-2089
Greater Kaweah GSA
Well ID: CID_042
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

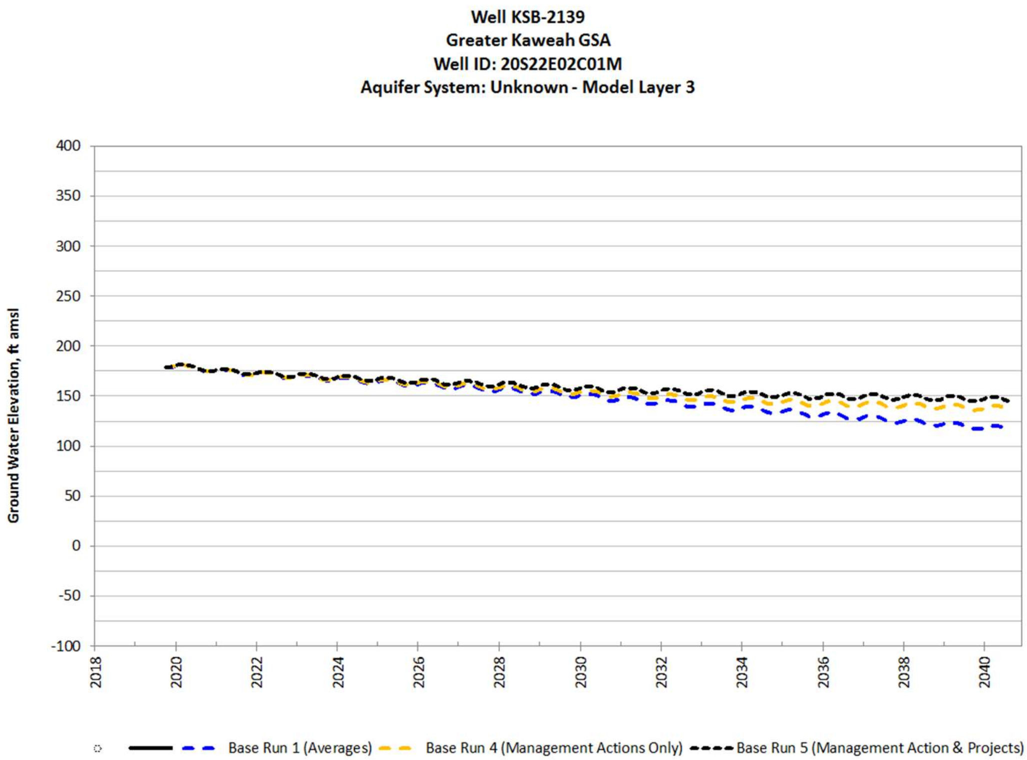

Well KSB-2095
Greater Kaweah GSA
Well ID: 19S22E14M01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

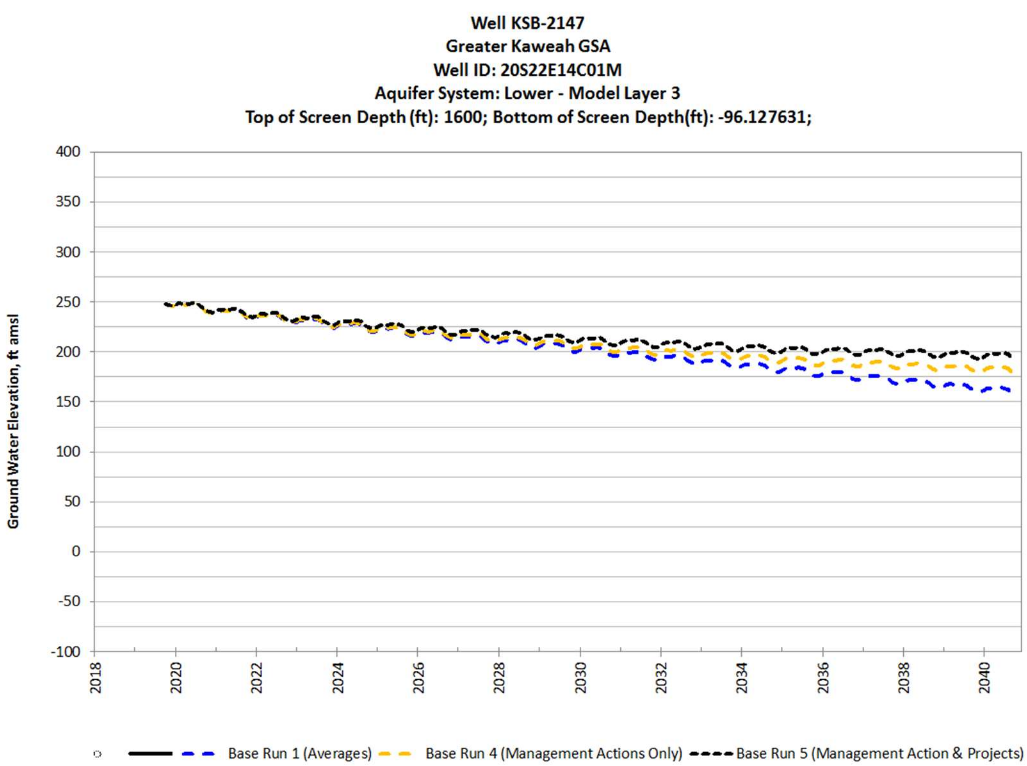


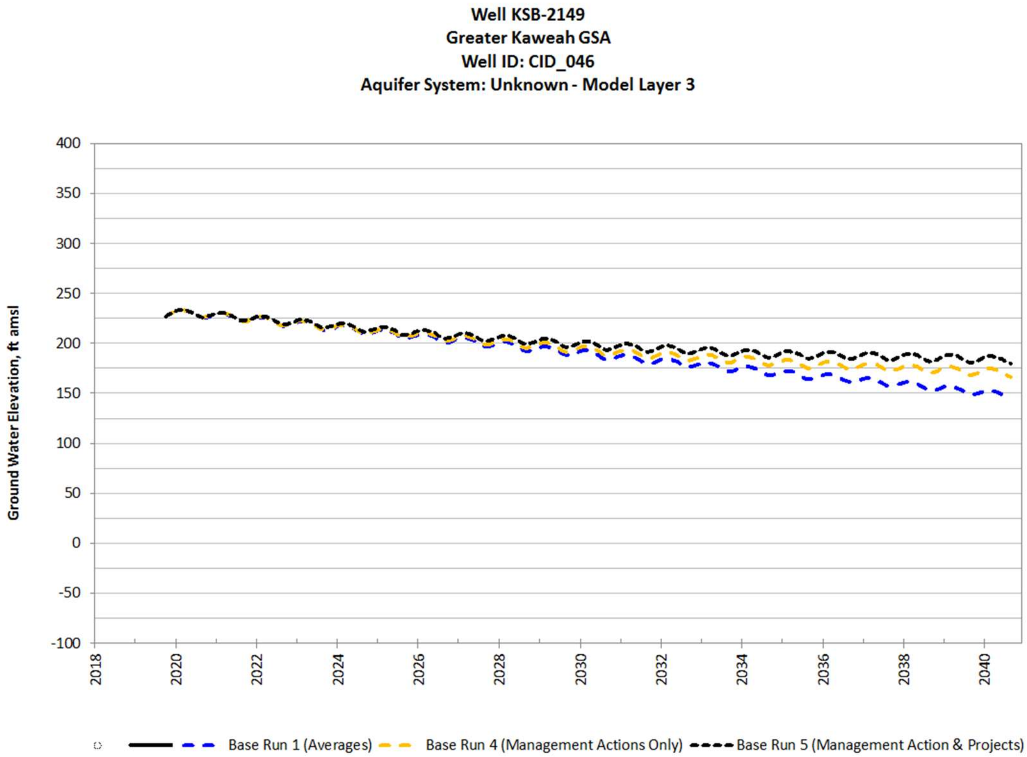
Well KSB-2107
East Kaweah GSA
Well ID: 19S21E15R01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

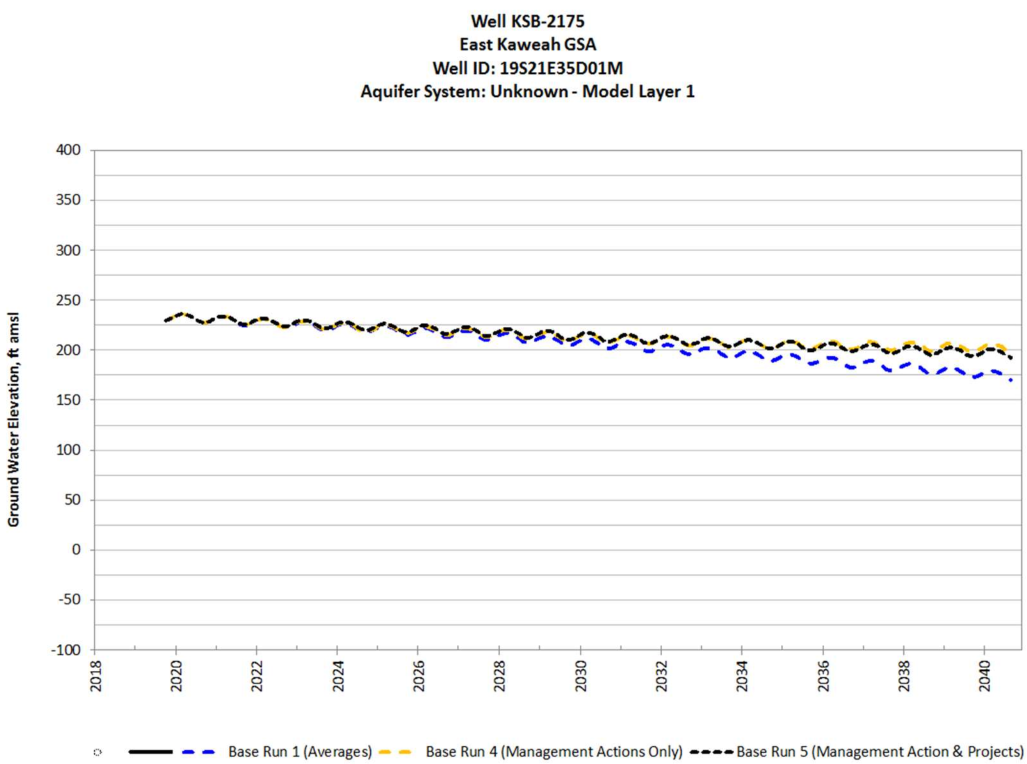


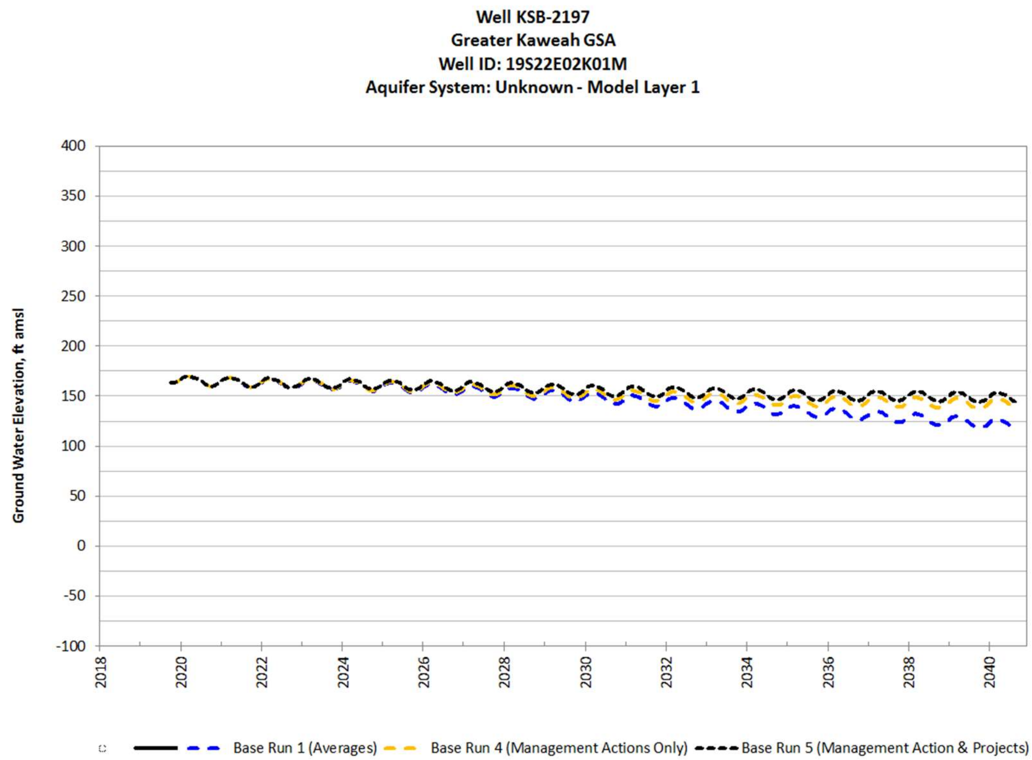
Well KSB-2114
Greater Kaweah GSA
Well ID: CID_025
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

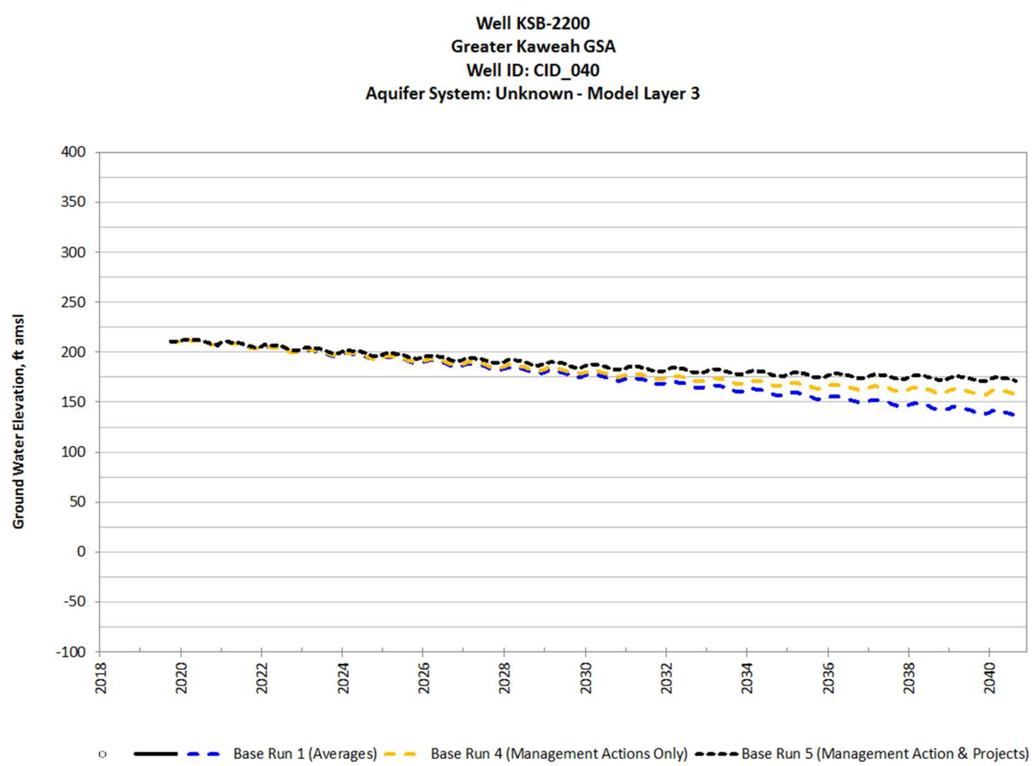

Well KSB-2139
Greater Kaweah GSA
Well ID: 20S22E02C01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2147
Greater Kaweah GSA
Well ID: 20S22E14C01M
Aquifer System: Lower - Model Layer 3
Top of Screen Depth (ft): 1600; Bottom of Screen Depth(ft): -96.127631;
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

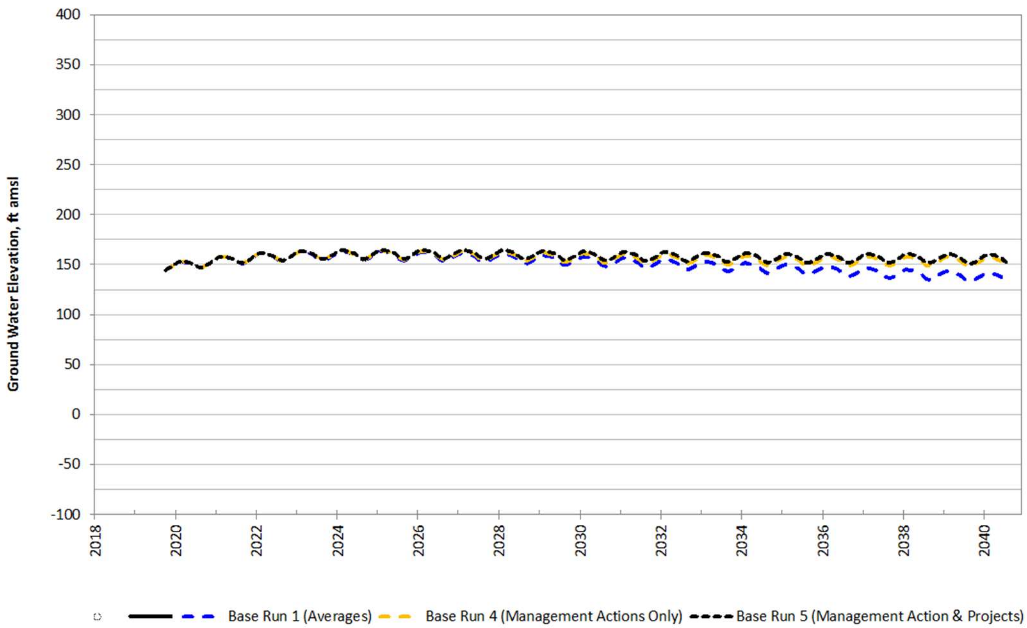

Well KSB-2149
Greater Kaweah GSA
Well ID: CID_046
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2175
East Kaweah GSA
Well ID: 19S21E35D01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

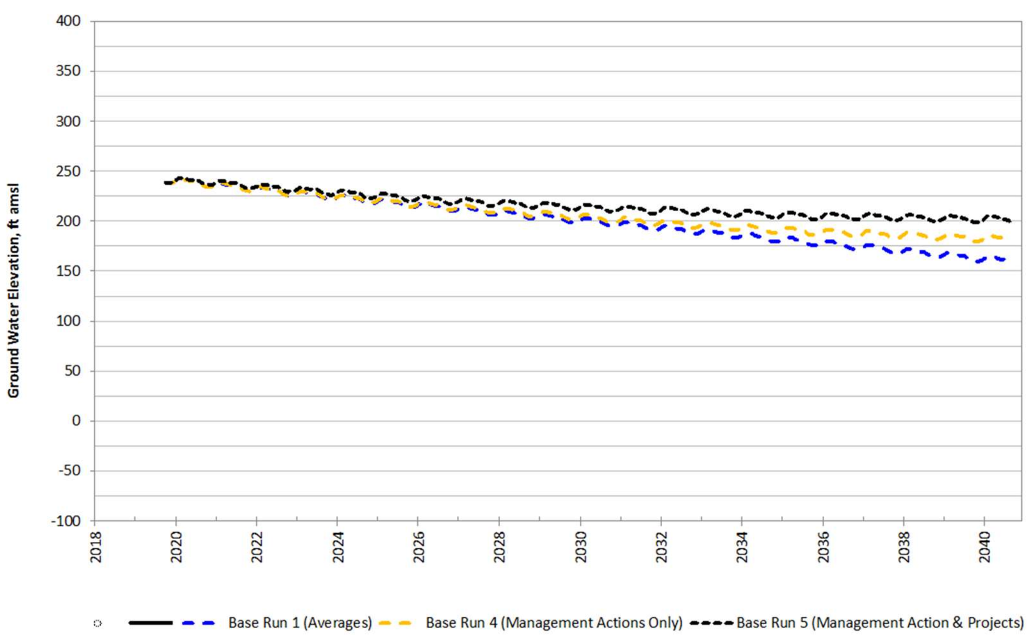

Well KSB-2197
Greater Kaweah GSA
Well ID: 19S22E02K01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2200
Greater Kaweah GSA
Well ID: CID_040
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

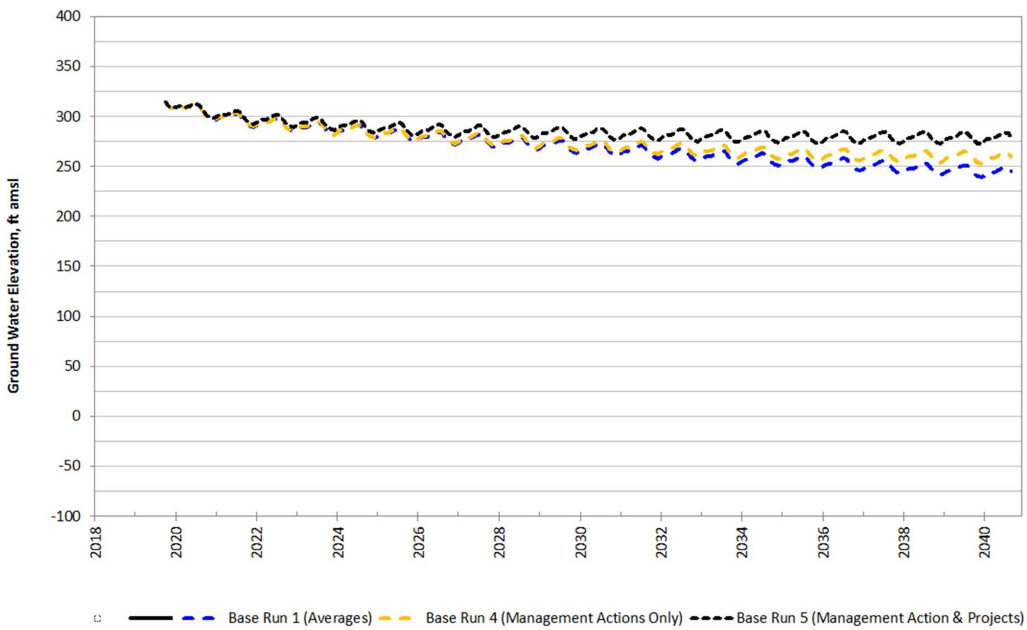
Well KSB-2203
Greater Kaweah GSA
Well ID: 18S22E24D01M
Aquifer System: Upper - Model Layer 1
Top of Screen Depth (ft): 340; Bottom of Screen Depth(ft): 19.156423;



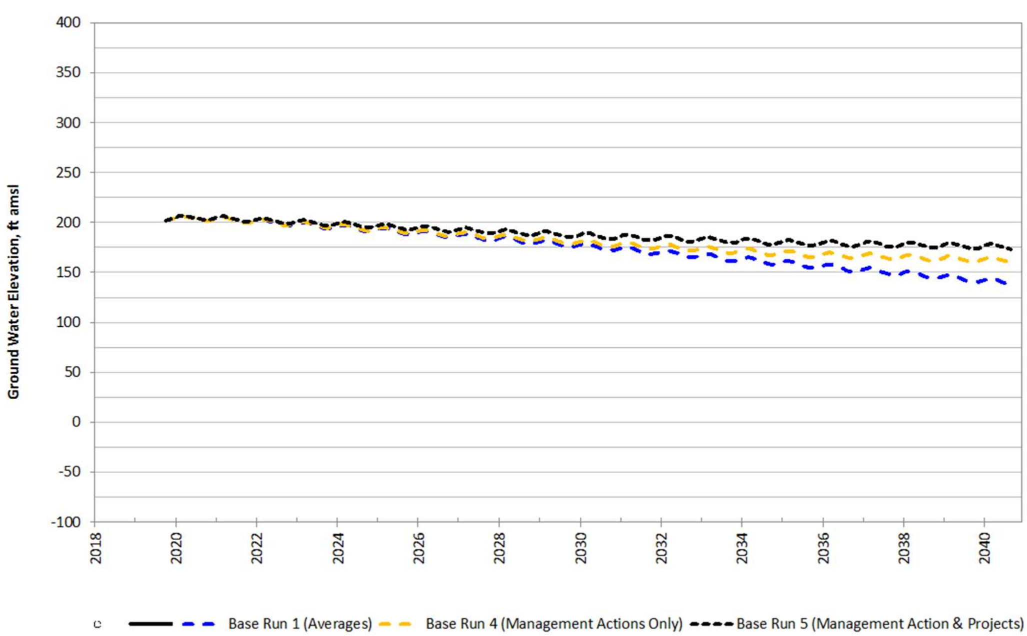
Well KSB-2291
Greater Kaweah GSA
Well ID: 19S22E23A01M
Aquifer System: Unknown - Model Layer 3

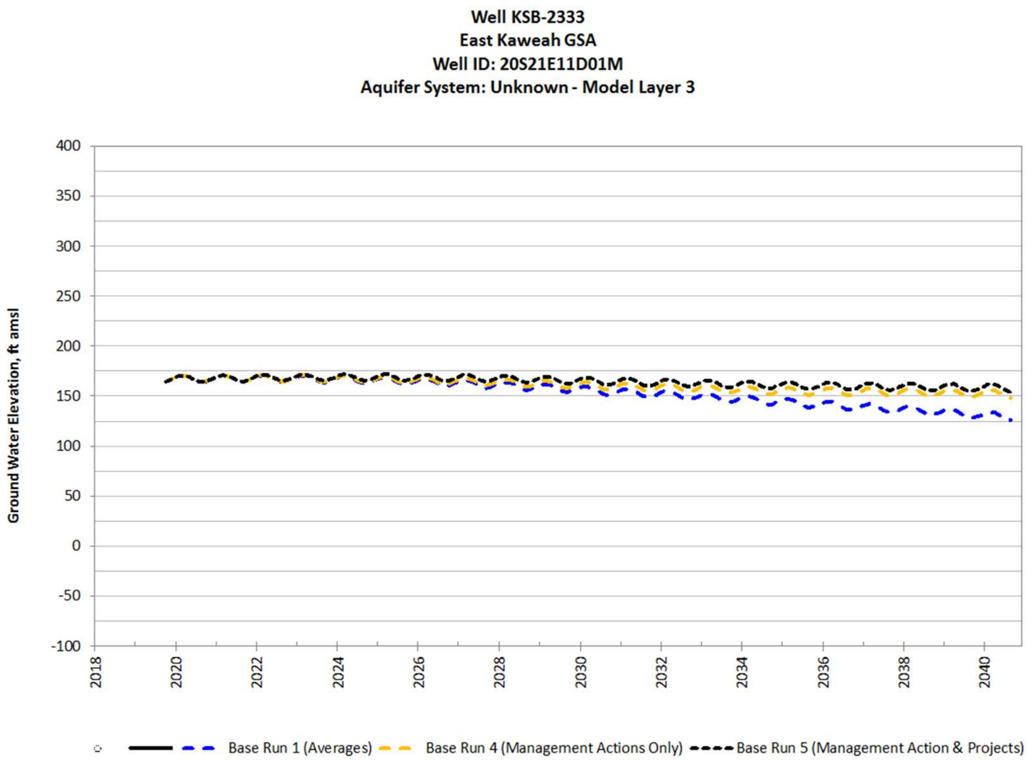


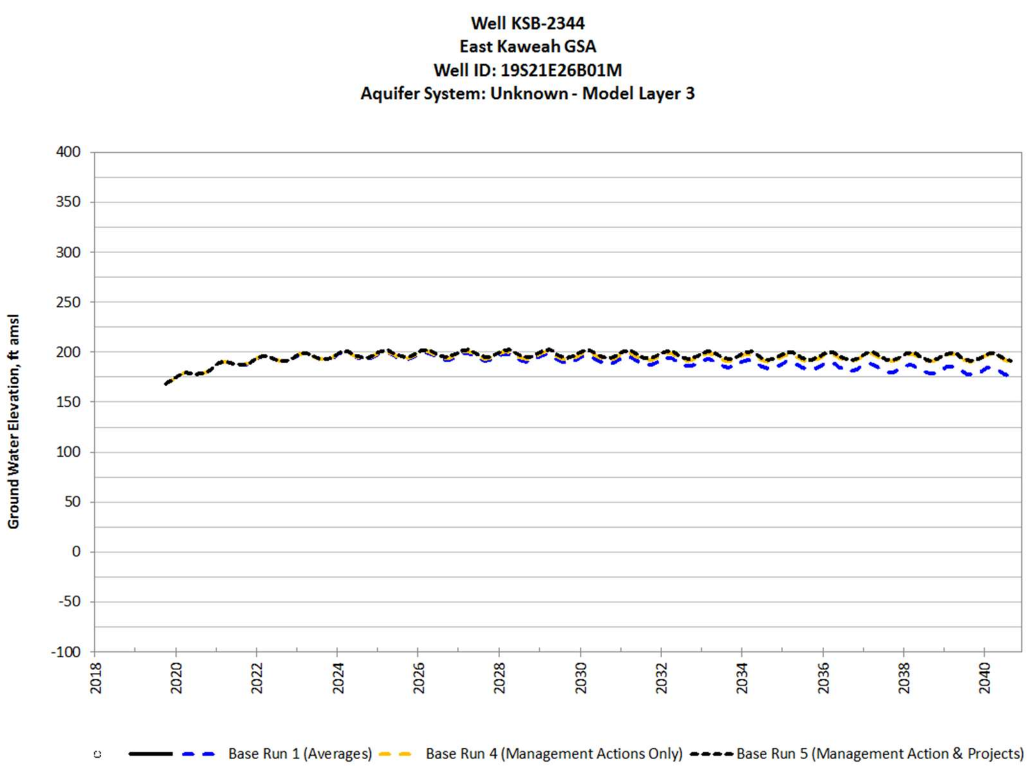
Well KSB-2297
Greater Kaweah GSA
Well ID: CID_065
Aquifer System: Unknown - Model Layer 3

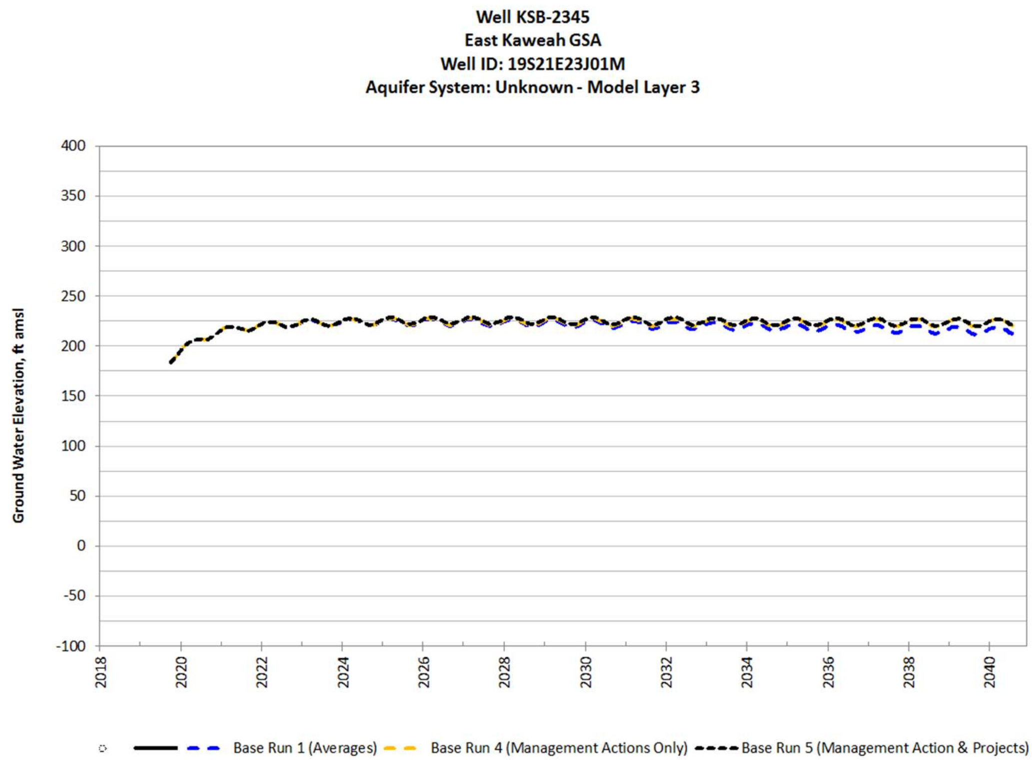


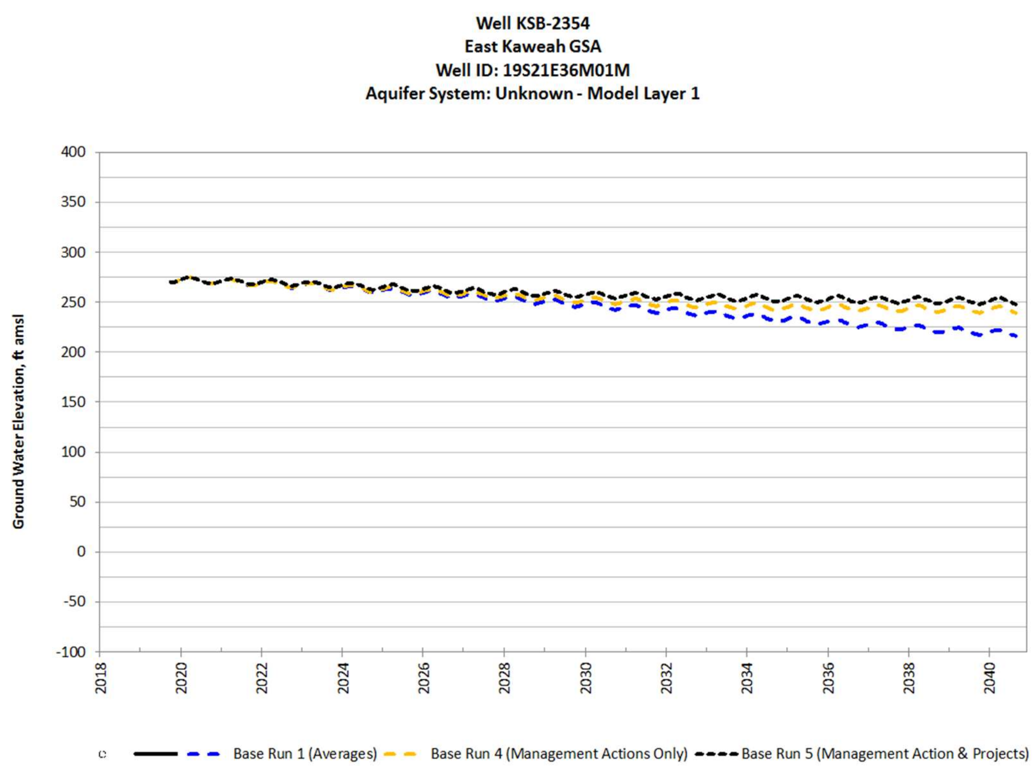
Well KSB-2322
Greater Kaweah GSA
Well ID: 19S22E36E01M
Aquifer System: Unknown - Model Layer 3



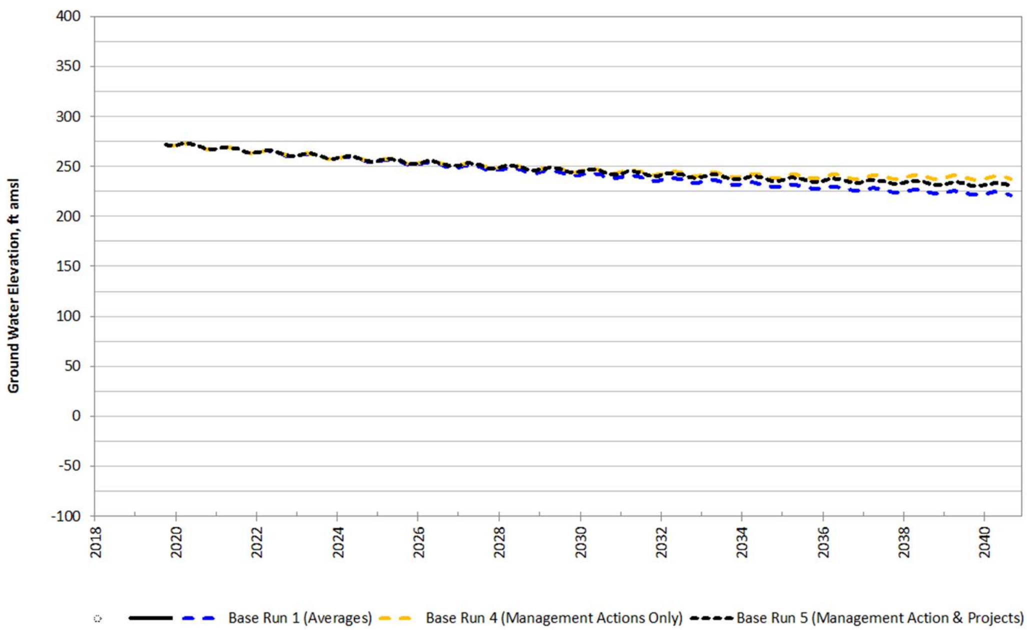

Well KSB-2333
East Kaweah GSA
Well ID: 20S21E11D01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2344
East Kaweah GSA
Well ID: 19S21E26B01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

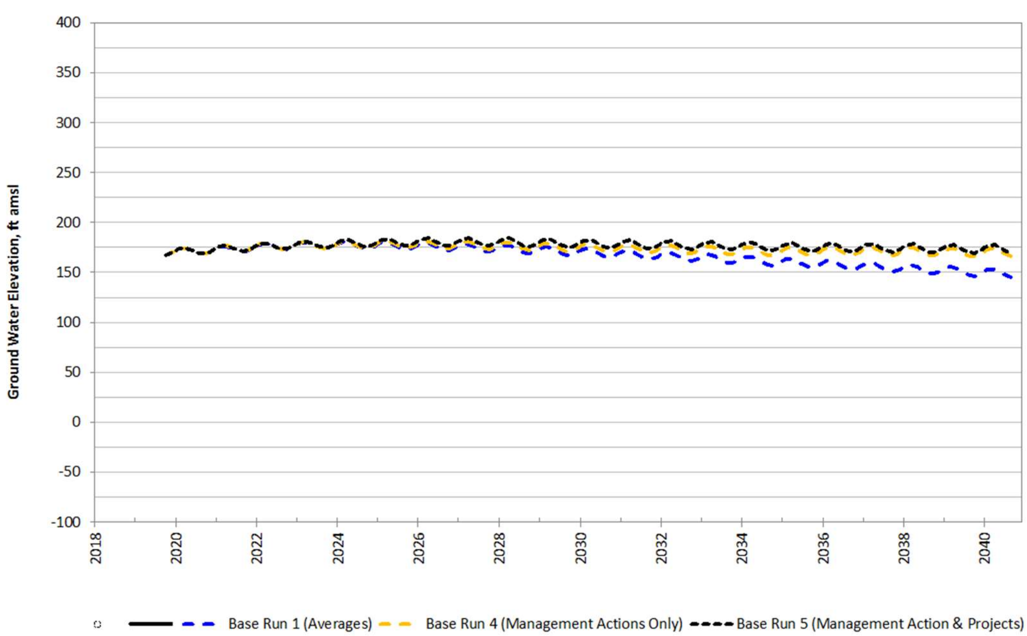

Well KSB-2345
East Kaweah GSA
Well ID: 19S21E23J01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

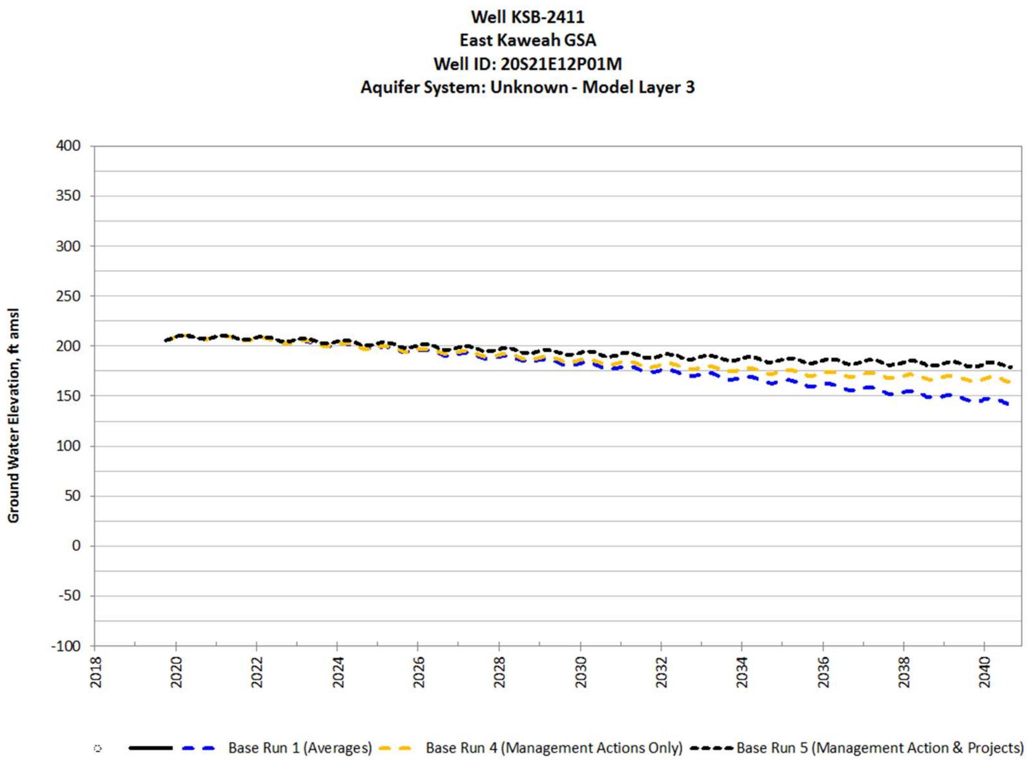

Well KSB-2354
East Kaweah GSA
Well ID: 19S21E36M01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

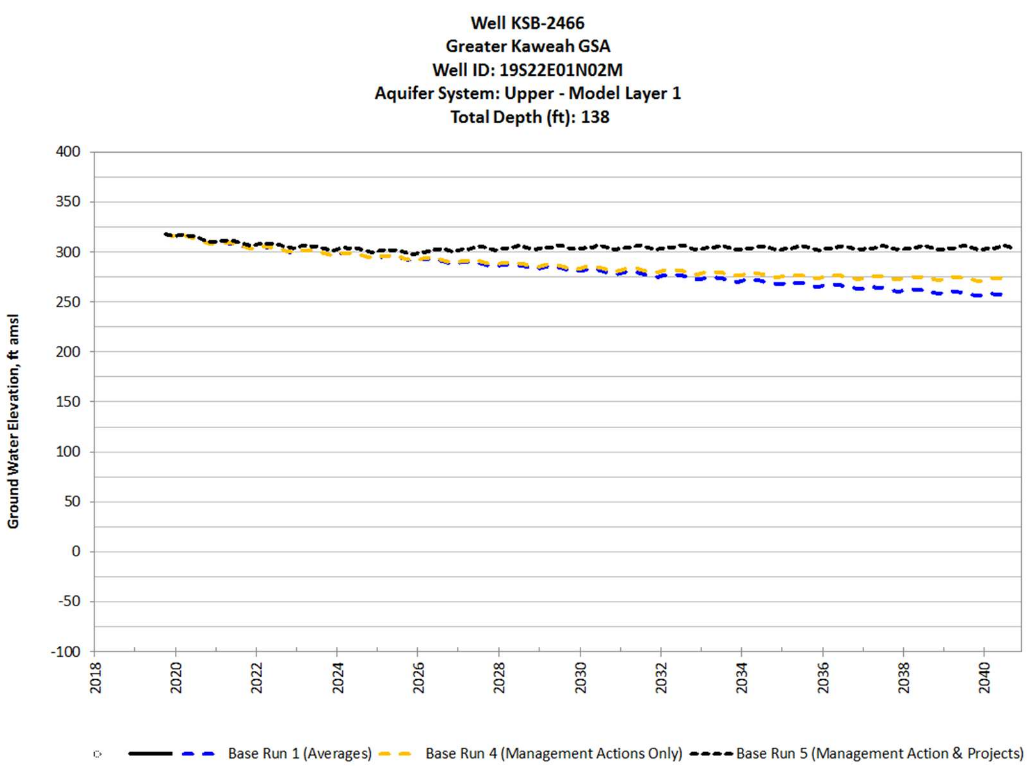
Well KSB-2369
East Kaweah GSA
Well ID: 19S21E13C03M
Aquifer System: Unknown - Model Layer 3

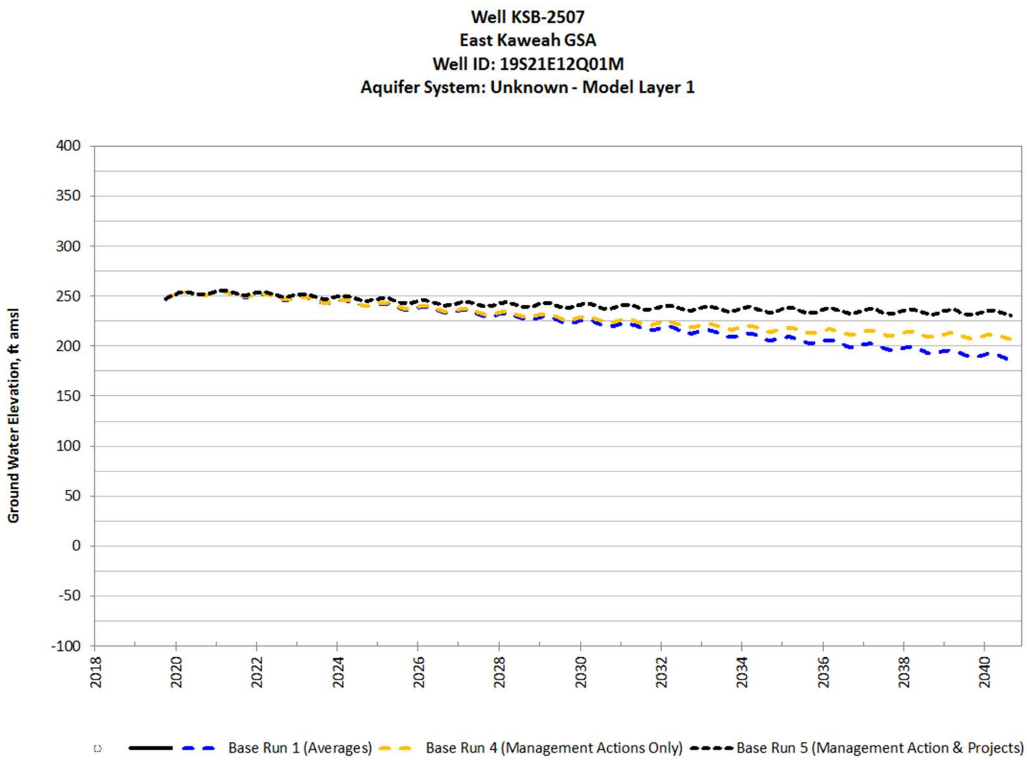


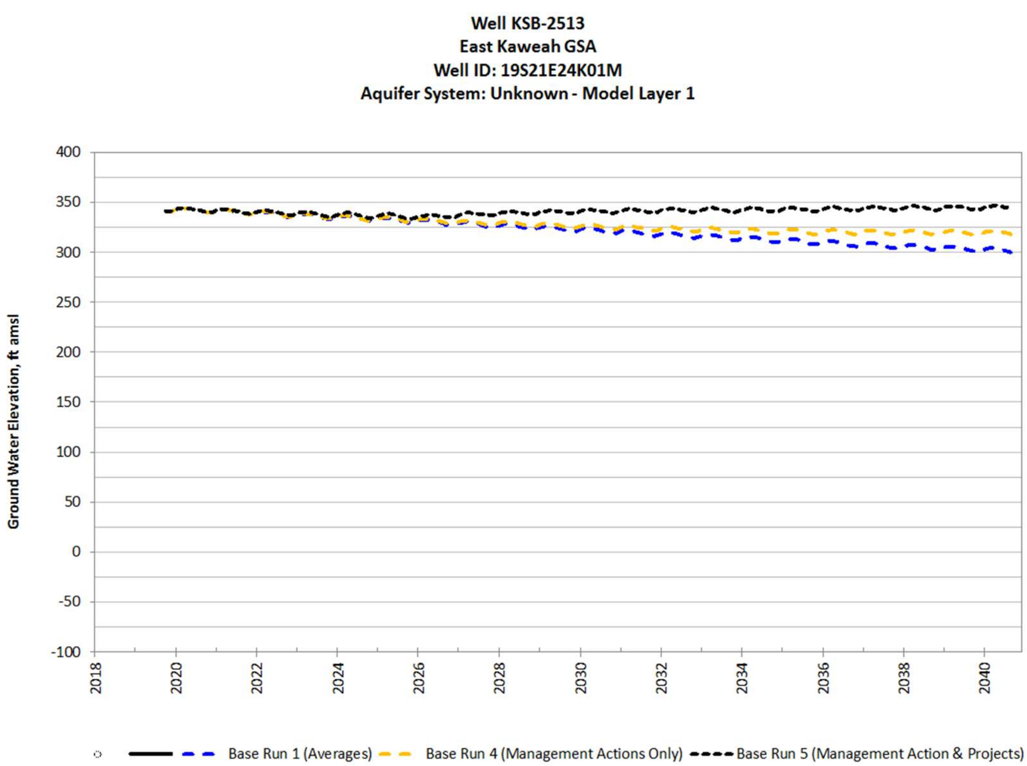
Well KSB-2405
East Kaweah GSA
Well ID: 20S21E01L01M
Aquifer System: Unknown - Model Layer 3

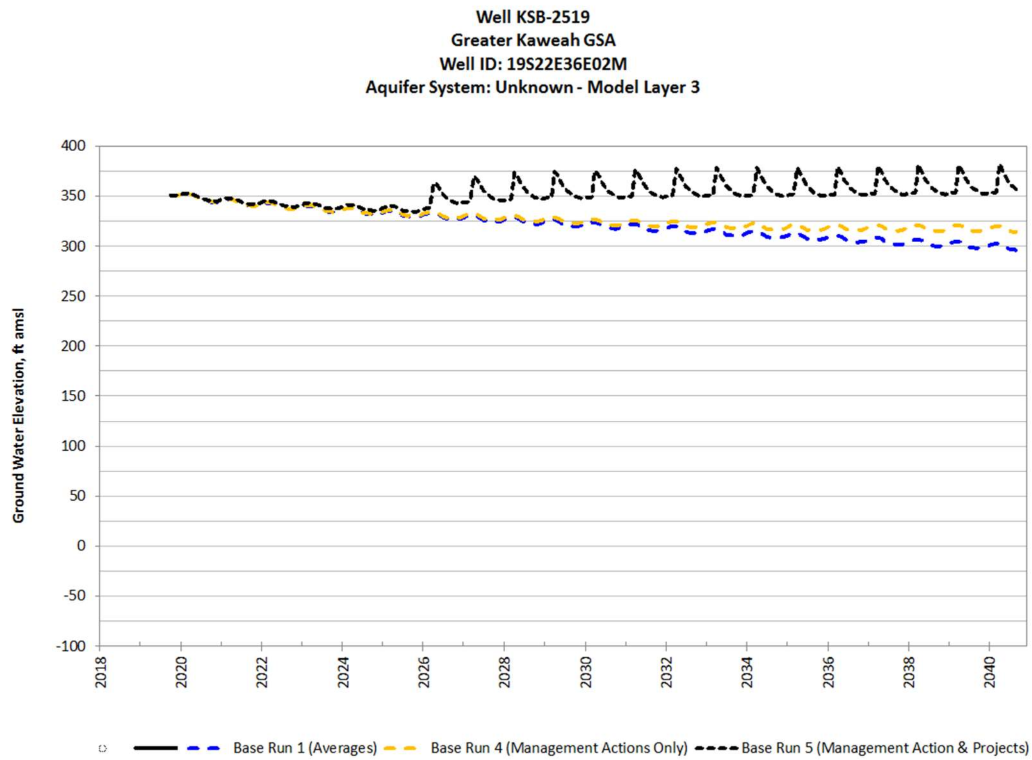


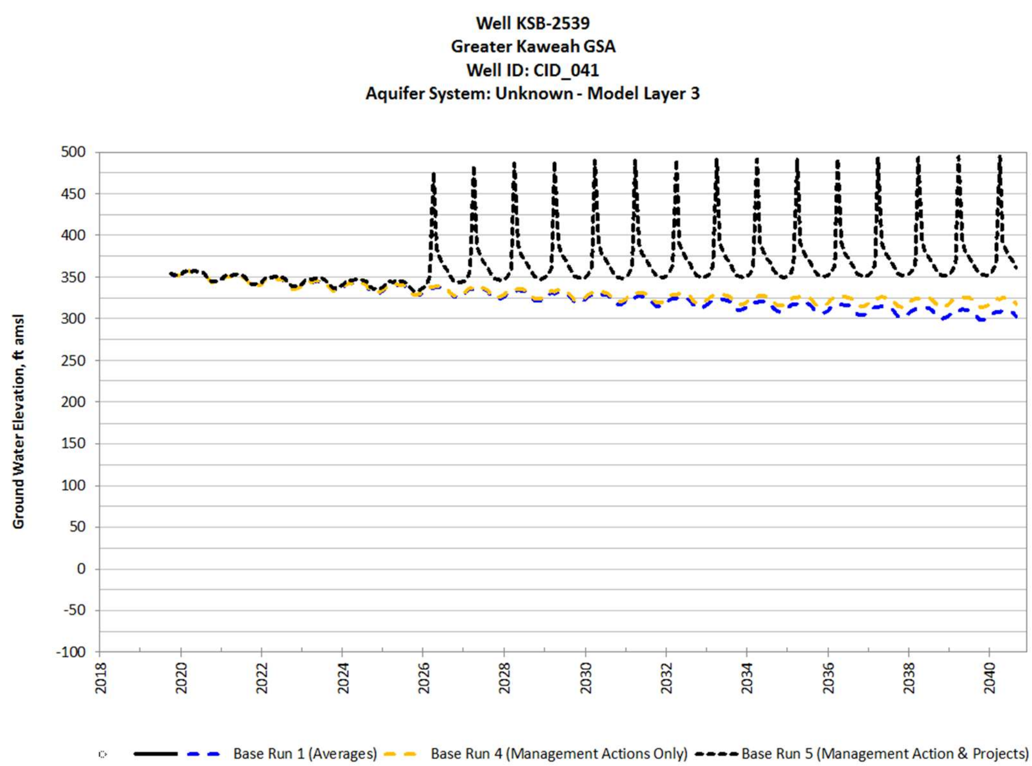

Well KSB-2411
East Kaweah GSA
Well ID: 20S21E12P01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2466
Greater Kaweah GSA
Well ID: 19S22E01N02M
Aquifer System: Upper - Model Layer 1
Total Depth (ft): 138
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

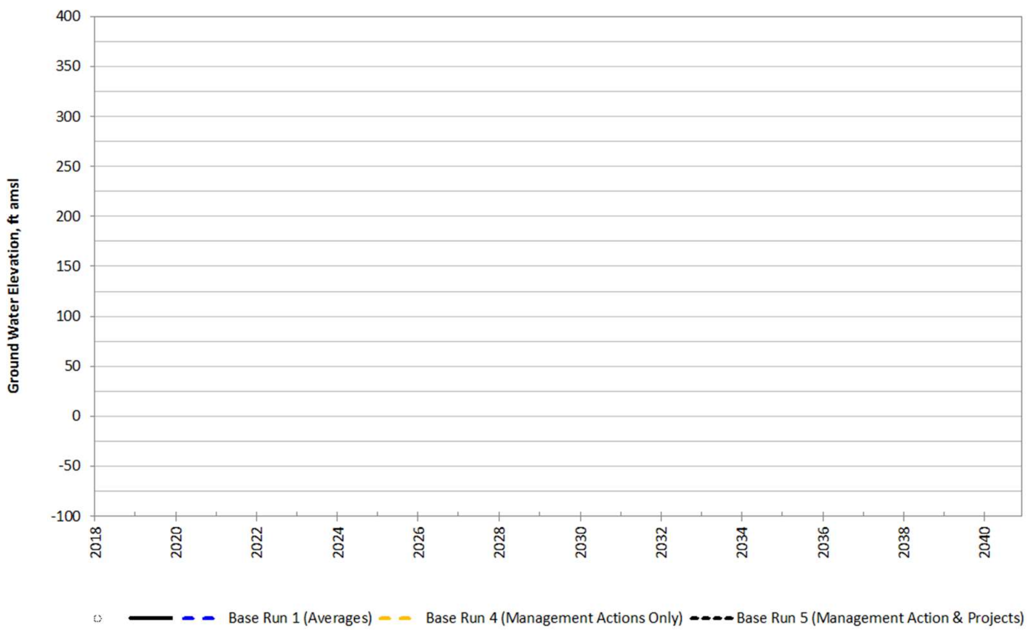

Well KSB-2507
East Kaweah GSA
Well ID: 19S21E12Q01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2513
East Kaweah GSA
Well ID: 19S21E24K01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

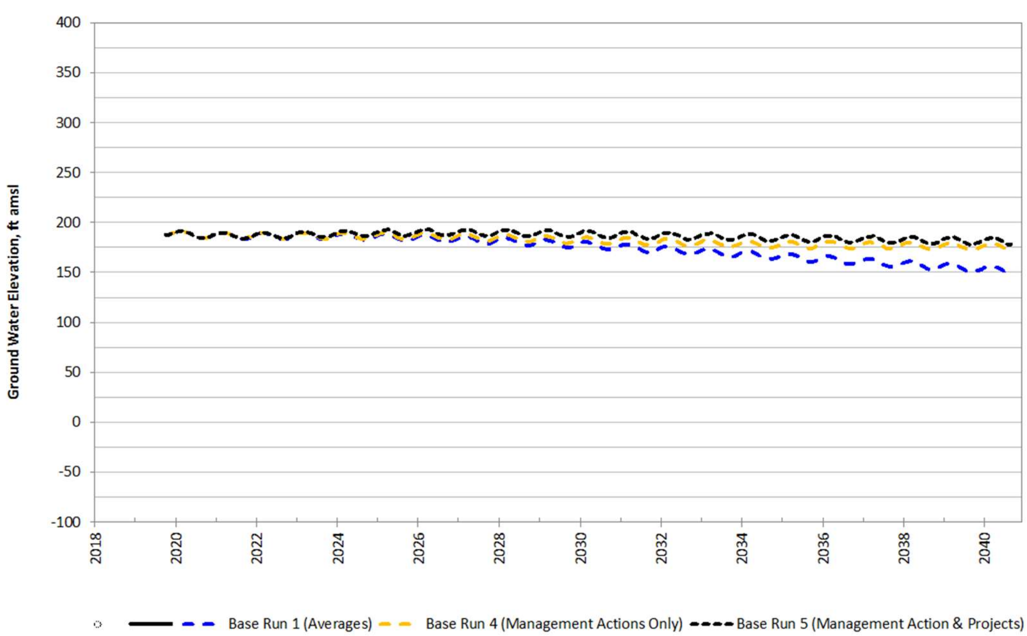

Well KSB-2519
Greater Kaweah GSA
Well ID: 19S22E36E02M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

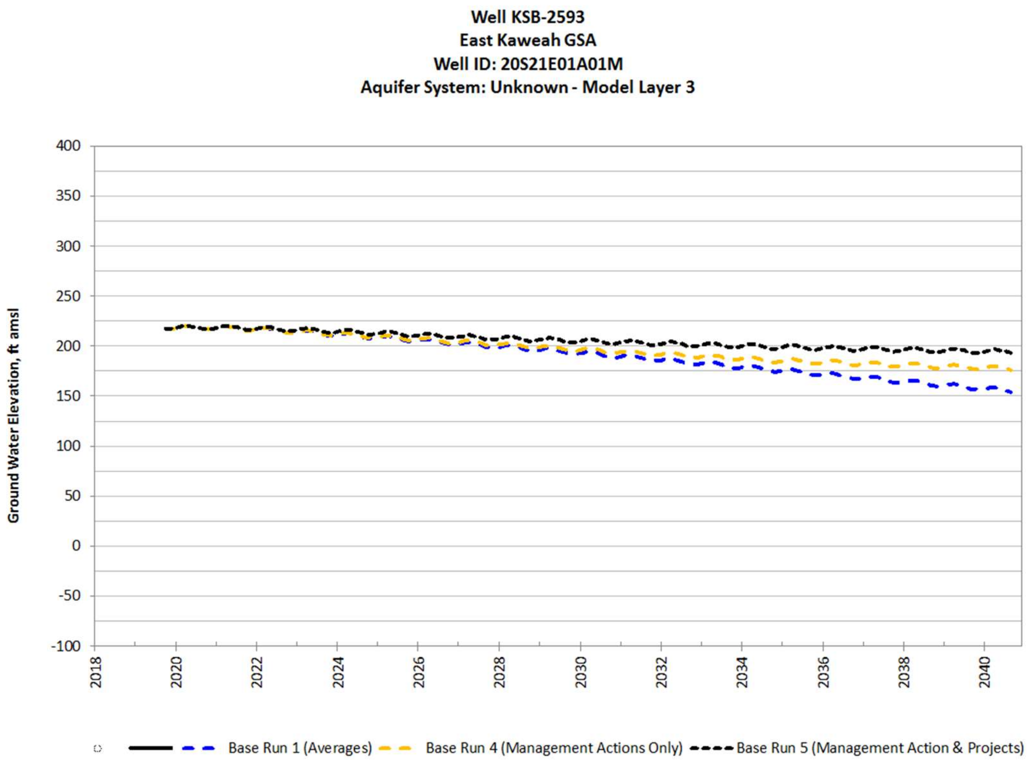

Well KSB-2539
Greater Kaweah GSA
Well ID: CID_041
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
500
450
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

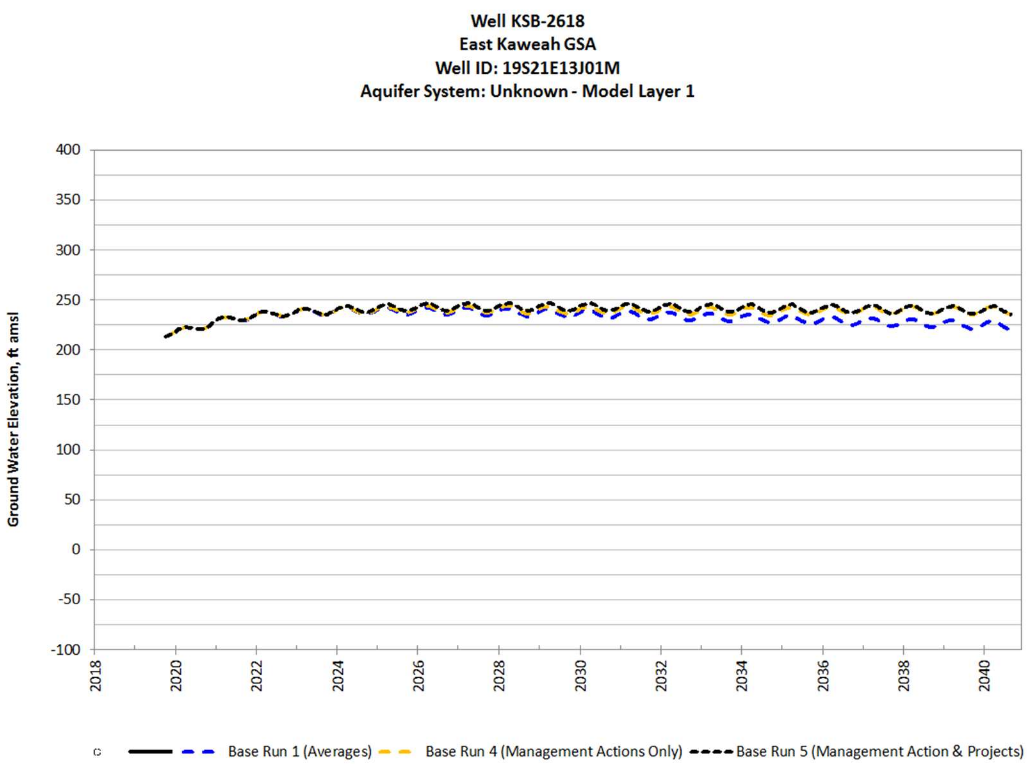
Well KSB-2588
East Kaweah GSA
Well ID: 20S21E13B01M
Aquifer System: Unknown - Model Layer 1

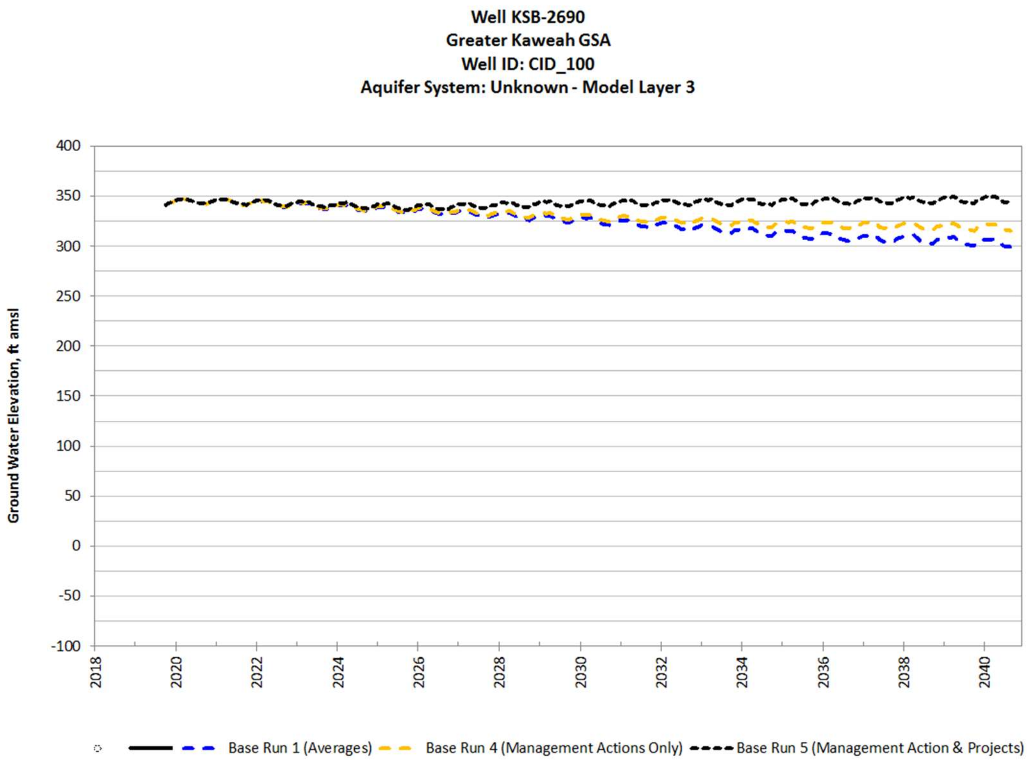


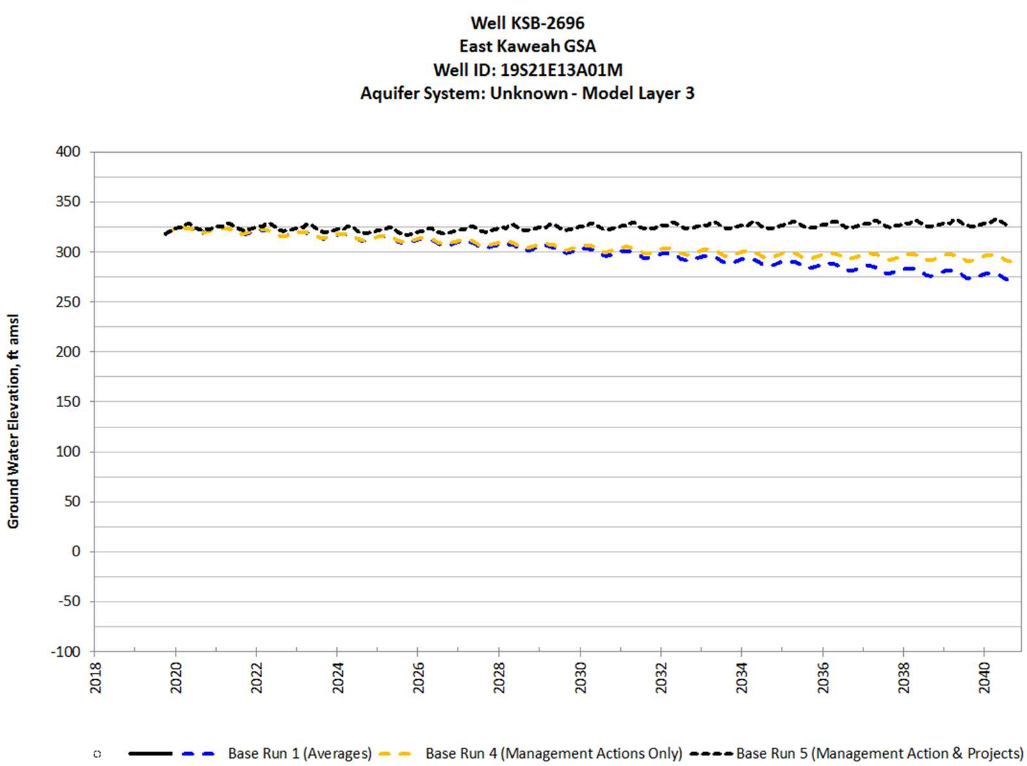
Well KSB-2590
East Kaweah GSA
Well ID: 19S21E24H01M
Aquifer System: Unknown - Model Layer 3

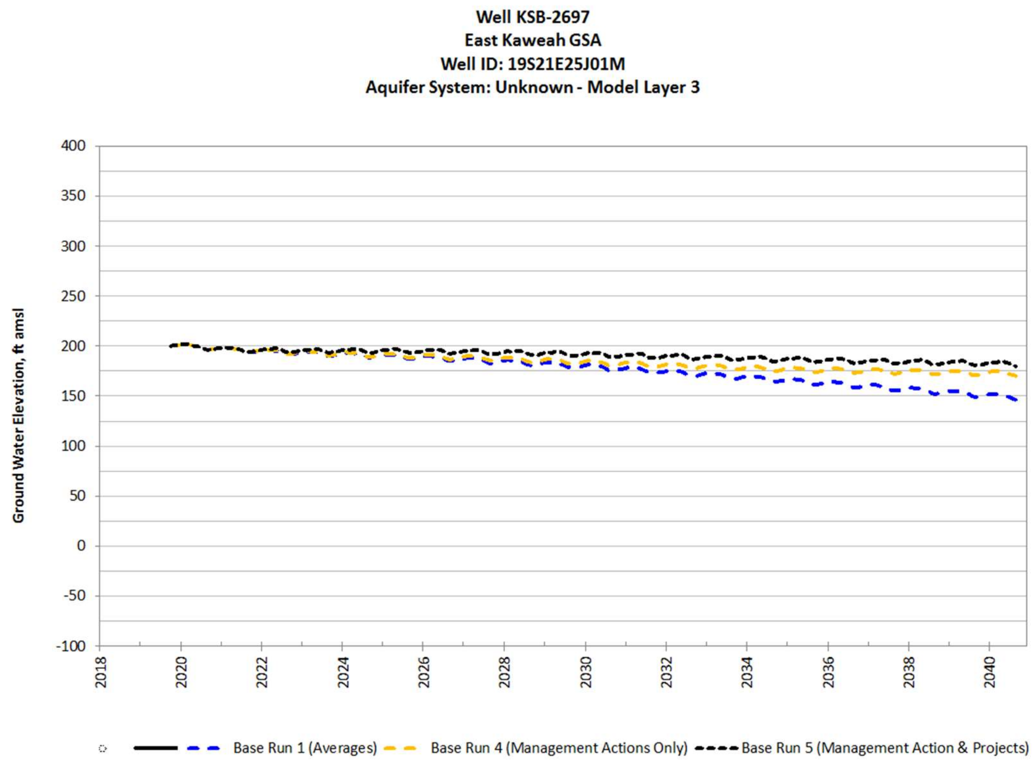


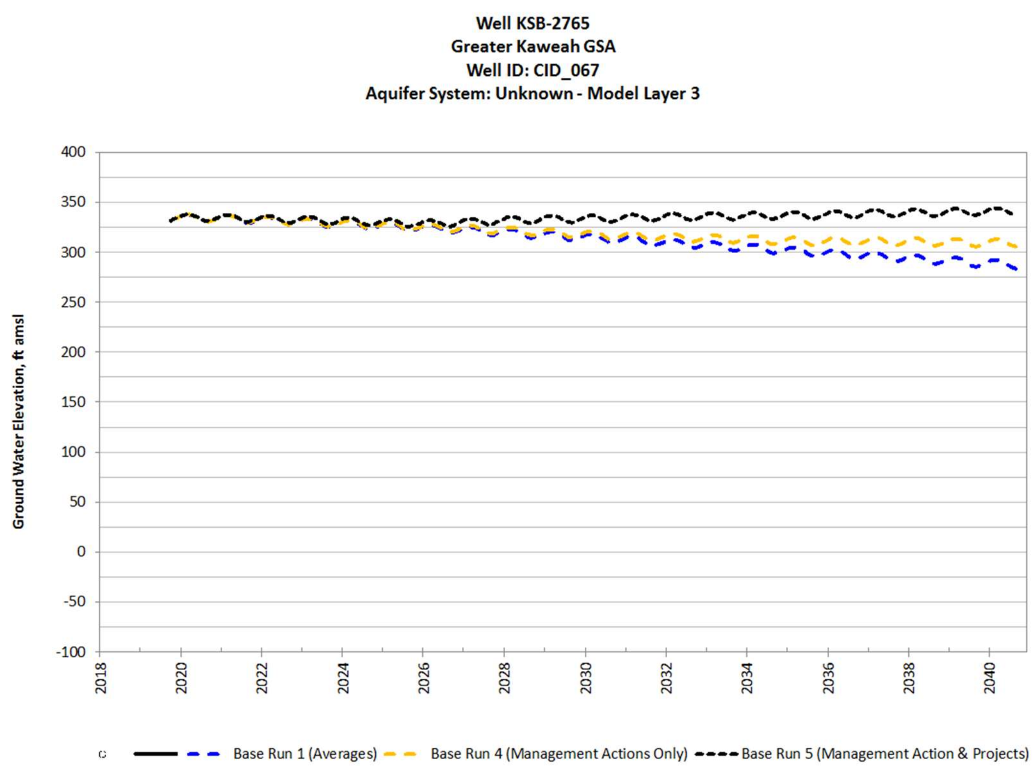

Well KSB-2593
East Kaweah GSA
Well ID: 20S21E01A01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

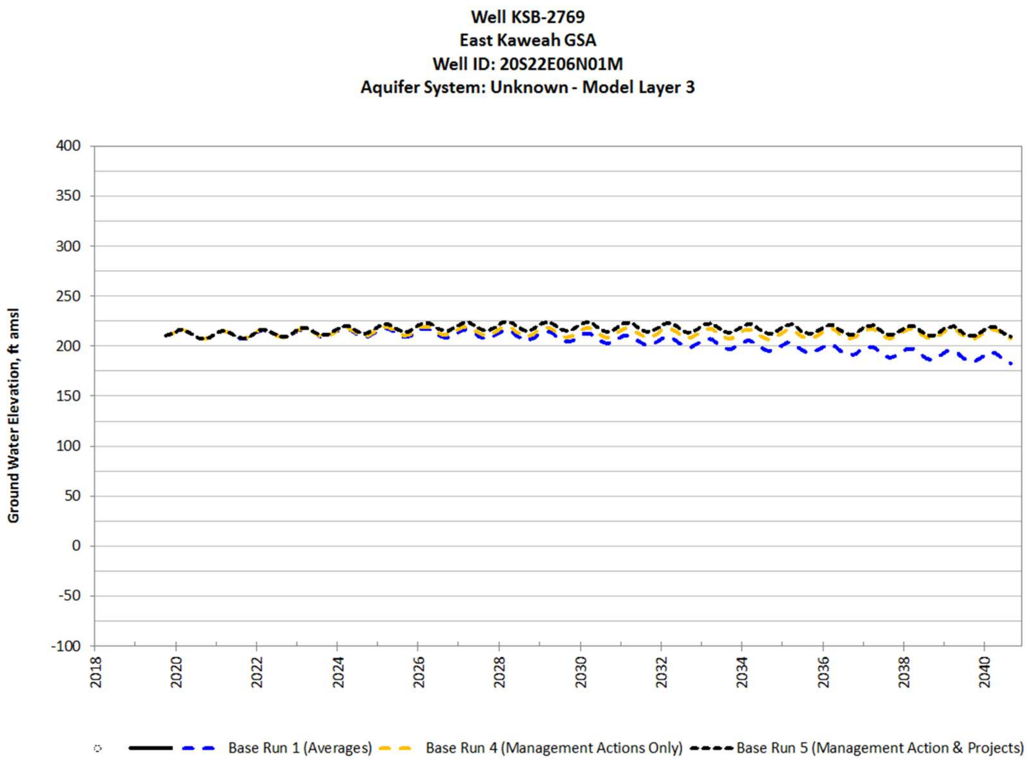

Well KSB-2618
East Kaweah GSA
Well ID: 19S21E13J01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

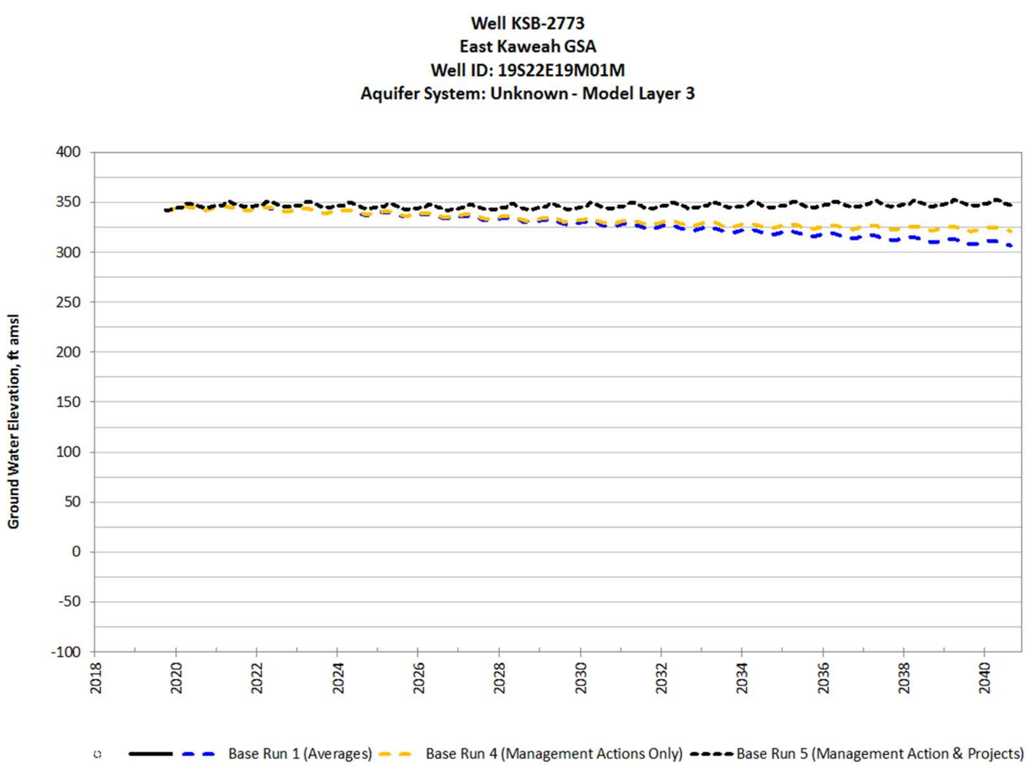

Well KSB-2690
Greater Kaweah GSA
Well ID: CID_100
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

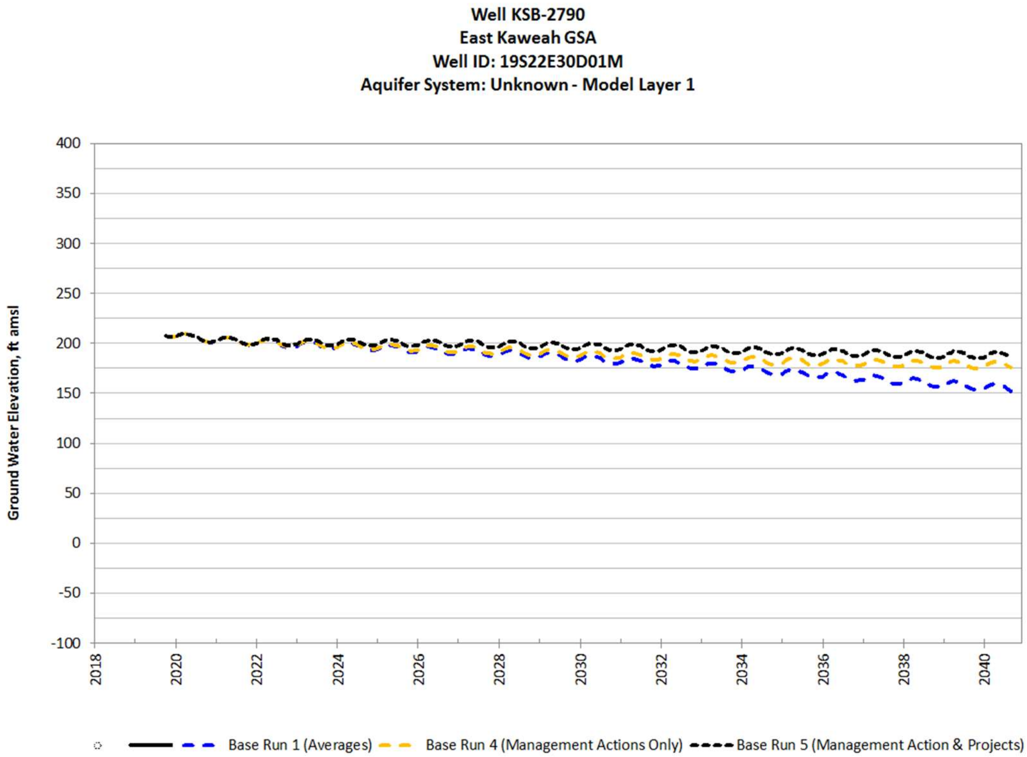

Well KSB-2696
East Kaweah GSA
Well ID: 19S21E13A01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

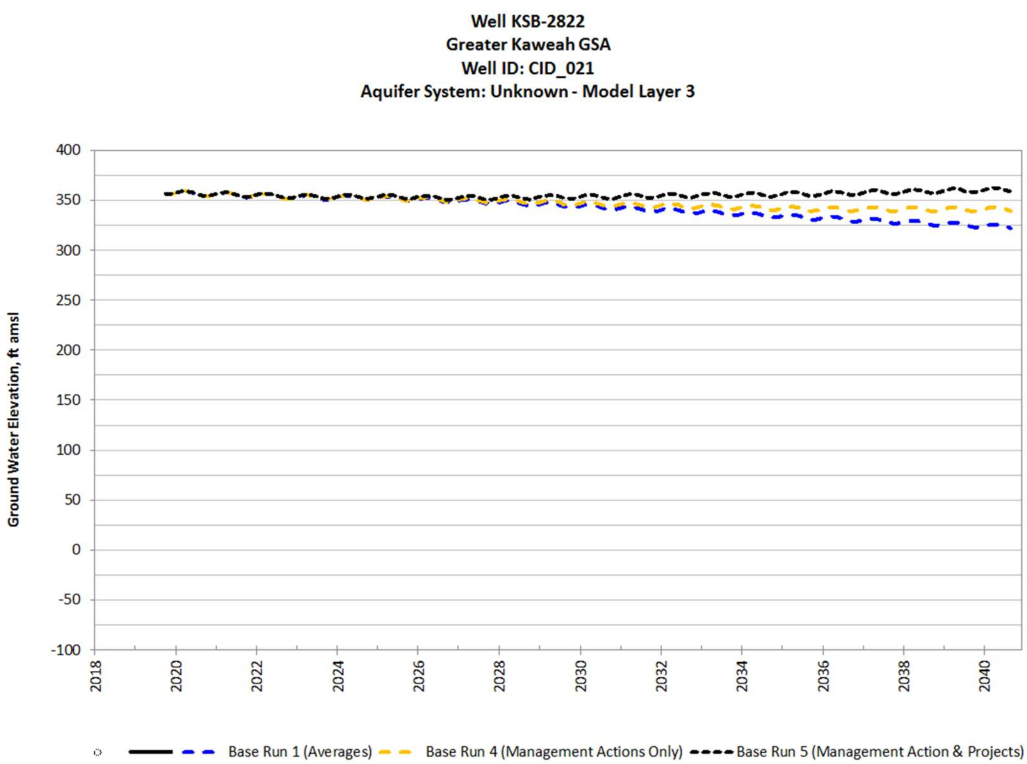

Well KSB-2697
East Kaweah GSA
Well ID: 19S21E25J01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

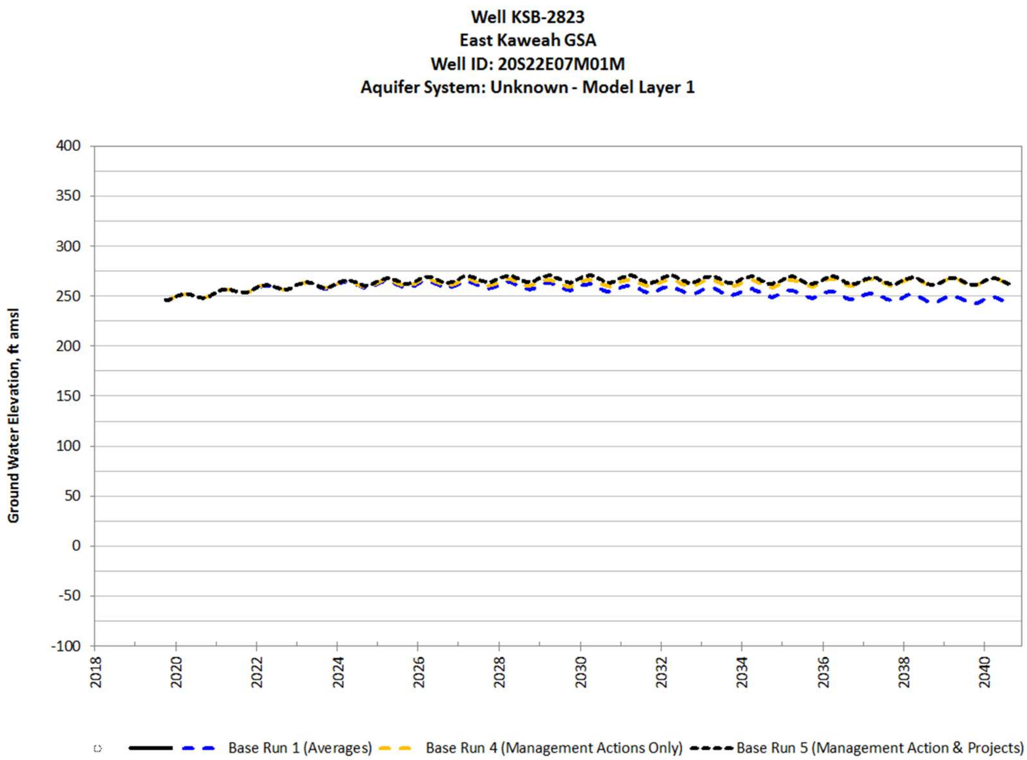

Well KSB-2765
Greater Kaweah GSA
Well ID: CID_067
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

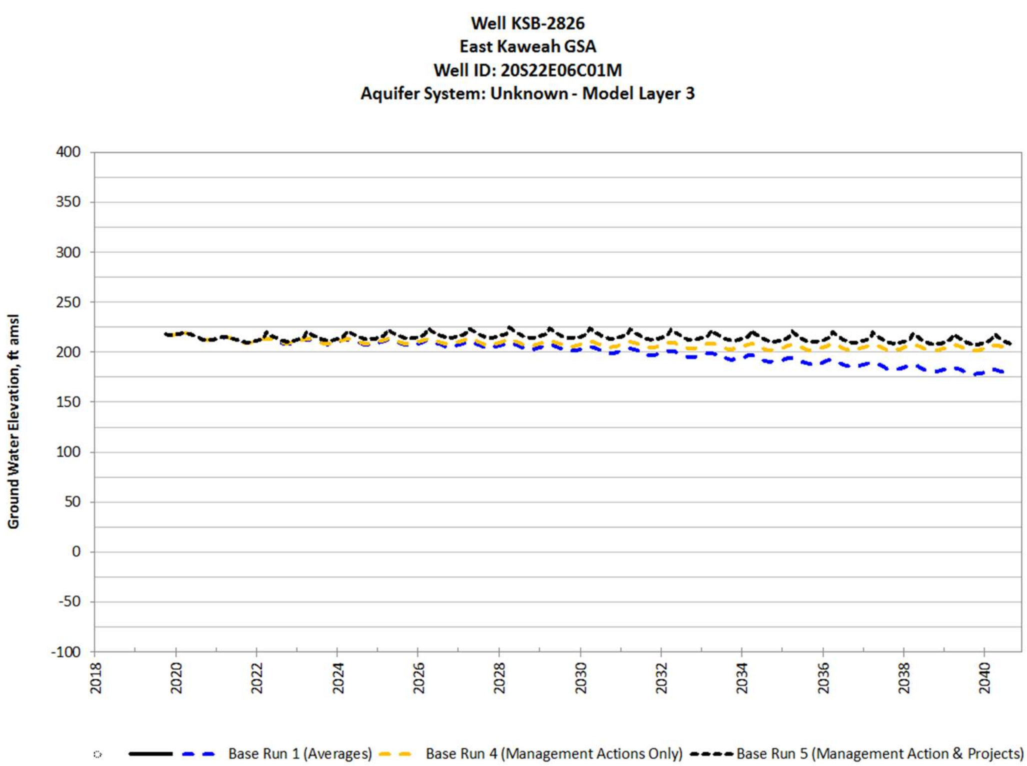

Well KSB-2769
East Kaweah GSA
Well ID: 20S22E06N01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

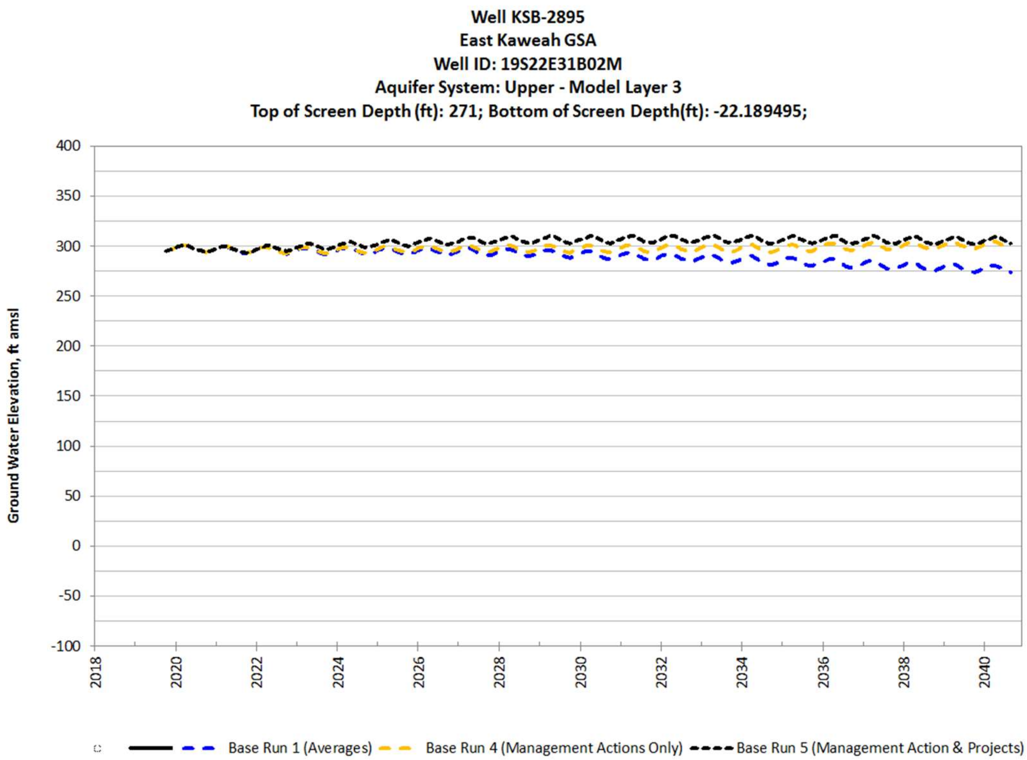

Well KSB-2773
East Kaweah GSA
Well ID: 19S22E19M01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

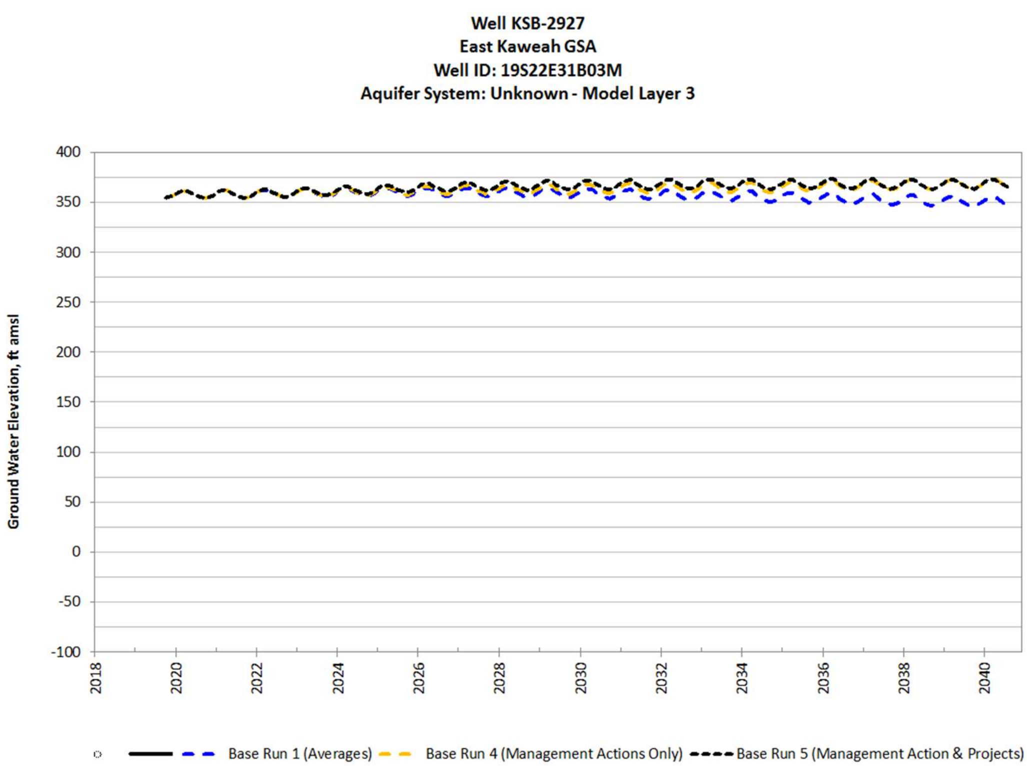

Well KSB-2790
East Kaweah GSA
Well ID: 19S22E30D01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2822
Greater Kaweah GSA
Well ID: CID_021
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2823
East Kaweah GSA
Well ID: 20S22E07M01M
Aquifer System: Unknown - Model Layer 1
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2826
East Kaweah GSA
Well ID: 20S22E06C01M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2895
East Kaweah GSA
Well ID: 19S22E31B02M
Aquifer System: Upper - Model Layer 3
Top of Screen Depth (ft): 271; Bottom of Screen Depth(ft): -22.189495;
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)


Well KSB-2927
East Kaweah GSA
Well ID: 19S22E31B03M
Aquifer System: Unknown - Model Layer 3
Ground Water Elevation, ft amsl
400
350
300
250
200
150
100
50
0
-50
-100
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Base Run 1 (Averages)
Base Run 4 (Management Actions Only)
Base Run 5 (Management Action & Projects)

Appendix 1-B

Communication & Engagement Plan

East Kaweah Groundwater Sustainability Agency

Communication & Engagement Plan

Tulare County, California
Adopted January 2018
Updated May 2018
Updated December 2019

Prepared for:

EAST KAWEAH
GROUNDWATER SUSTAINABILITY AGENCY

East Kaweah Groundwater Sustainability Agency
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Note: This Communication & Engagement Plan is a living document, and will be updated as necessary throughout the GSP development, public review, and implementation phases.

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Abbreviations

AB	Assembly Bill
DAC	Disadvantaged Community
DBCP	1,2-Dibromo-3-chloropropane
DDW	Division of Drinking Water
DWR	Department of Water Resources
East Kaweah GSA	East Kaweah Groundwater Sustainability Agency
EKGSA	East Kaweah Groundwater Sustainability Agency
FKC	Friant-Kern Canal
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
ILRP	Irrigated Lands Regulatory Program
JPA	Joint Powers Authority
LSID	Lindsay-Strathmore Irrigation District
MCL	Maximum contaminant levels
MOU	Memorandum of Understanding
PMWC	Plainview Mutual Water Company
PSA	Public service announcement
SB	Senate Bill
SDAC	Severely Disadvantaged Community
SRT	Sequoia Riverlands Trust
SGMA	Sustainable Groundwater Management Act
SWRCB	State Water Resources Control Board
TBWP	Tulare Basin Wildlife Partners

Introduction

SGMA Overview

The Sustainable Groundwater Management Act (**SGMA**) is a combination of three bills signed by California Governor Jerry Brown in 2014: Assembly Bill (**AB**) 1739, Senate Bill (**SB**) 1168, and SB 1319. SGMA provides local agencies with the framework to manage groundwater basins in a sustainable manner. The legislation recognizes that groundwater is most effectively managed at the local level, and local agencies will need to achieve groundwater sustainability by 2040.

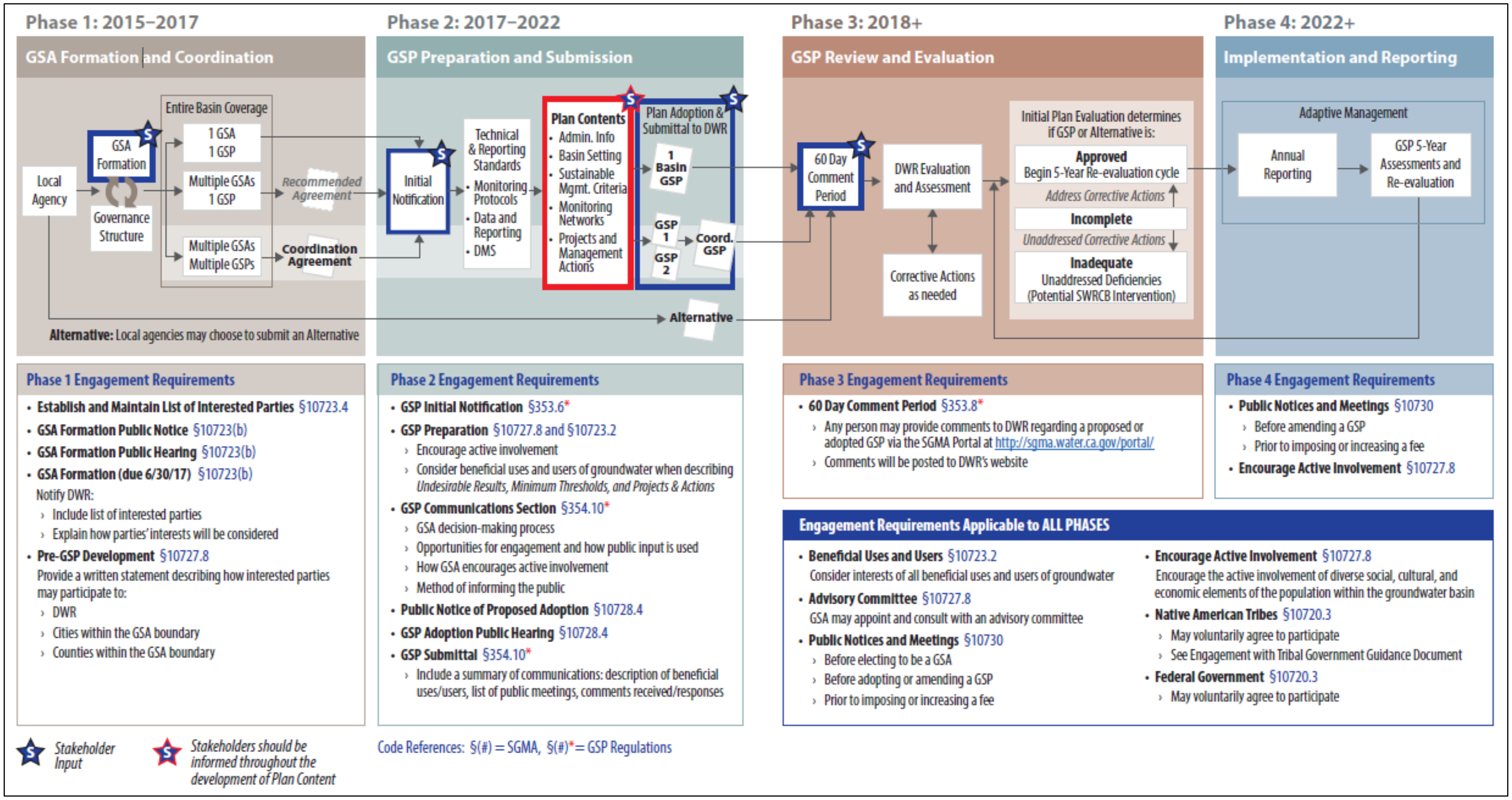
In SGMA, sustainable groundwater management is defined as management of groundwater supplies in a manner that can be maintained in planning and implementation phases without causing undesirable results. Undesirable results include significant and unreasonable chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence, and interconnected surface waters.

Implementation of SGMA and outreach requirements are broken down into four phases (**Figure 0-1**):

- **Phase 1: GSA Formation and Coordination –** Phase 1 ranged from 2015 to 2017, and during this phase, local agencies created groundwater sustainability agencies (**GSA**). The responsibility of a GSA is to develop and implement a groundwater sustainability plan (**GSP**) that will consider all beneficial uses and groundwater users within the basin. GSAs were required to be formed by June 30, 2017.
- **Phase 2: GSP Preparation and Submission –** The second phase of SGMA implementation ranged from 2017 to 2020. During this phase, GSAs developed GSPs with measurable objectives and milestones that ensure basin sustainability. A basin may be managed by a single GSP or multiple-coordinated GSPs. The California Department of Water Resources (**DWR**) developed regulations for evaluating GSPs and alternatives to GSPs by June 1, 2016.
- **Phase 3: GSP Review and Evaluation –** For the East Kaweah GSA, Phase 3 was held in late in the third quarter and fourth quarter of 2019, and consisted of the public review period. The public review period was held 90 days prior to the adoption of the GSP. Once the GSP has been submitted to the DWR by January 31, 2020, DWR will hold another 60-day review and comment period for stakeholders.
- **Phase 4: Implementation and Reporting –** Following the submission of the GSP, GSAs will immediately begin the implementation of efforts described in the GSP to reach sustainability within the basin. This will be an ongoing phase, as the goal of SGMA is to reach sustainability by 2040.

Communication & Engagement Plan

As required by SGMA, GSAs must consider the interests of all beneficial uses and users of groundwater and include them in the GSP development process. The East Kaweah Groundwater Sustainability Agency's (**East Kaweah GSA**) Communication & Engagement Plan addresses how stakeholders within the GSA's boundary will be engaged through stakeholder education and opportunities for input and public review during the development and implementation of the GSP, and will be updated throughout the phases. This plan provides an overview of the East Kaweah GSA, its stakeholders, and decision making process; identifies opportunities for public engagement and discussion of how public input and responses will be used; describes how the East Kaweah GSA encourages the active involvement of diverse, social, cultural, and economic elements of the population within the GSA boundary; and the methods the GSA will use to inform the public stakeholders about the progress of GSP development, public review and implementation.



Source: GSP Stakeholder Communication and Engagement Guidance Document, California Department of Water Resources, June 2017

Figure Intro-1. Stakeholder Engagement Requirements by Phase

I. Goals and Desired Outcomes

This section of the Communication & Engagement Plan provides a description of the East Kaweah GSA, defines the goals of how to address the challenges, regulatory requirements and opportunities, and how to reach the desired outcomes of communication efforts.

A. Description and Background of the East Kaweah GSA

I.A.1 GSA Description & Boundary

SGMA required all high- and medium-priority groundwater basins, as designated by the DWR Bulletin 118, to be managed by a GSA or multiple GSAs. Part of the San Joaquin Valley Basin, the Kaweah Groundwater Sub-basin is a high-priority basin that is in critical groundwater overdraft, and is split into three GSAs: East Kaweah GSA, Mid-Kaweah GSA, and Greater Kaweah GSA.

On May 31, 2017, the East Kaweah GSA, a joint powers authority (**JPA**), elected to become an official GSA for the portion of the Kaweah sub-basin designated in **Figure I-1**.

Member entities listed in **Table I-1** encompass the East Kaweah GSA. These members overlie a portion of the Kaweah Sub-basin (Basin Number 5.022.11, DWR Bulletin 118) of the San Joaquin Valley Basin, which create the boundary of the East Kaweah GSA. The boundary stretches along the eastern portion of Tulare County, California (**Figure I-1**), and includes agricultural lands, urban areas, and foothills.

Table I-1. East Kaweah GSA Member Entities

East Kaweah GSA Member Entities	
City of Lindsay	County of Tulare
Exeter Irrigation District	Ivanhoe Irrigation District
Lindmore Irrigation District	Lindsay-Strathmore Irrigation District
Stone Corral Irrigation District	Sentinel Butte Mutual Water Company
Wutchumna Water Company	

Under SGMA, East Kaweah GSA is responsible for submitting a GSP to the DWR by January 31, 2020. A Memorandum of Understanding (**MOU**) is in place between the East Kaweah GSA, Mid-Kaweah GSA and Greater Kaweah GSA to coordinate throughout the GSP development phase to meet the sustainability requirements for the entire Kaweah Sub-basin. For thorough collaboration efforts, a management team has been established at the sub-basin level. For reference, member entities of the Mid-Kaweah and Greater Kaweah GSAs are listed in **Table I-2**.

Throughout the SGMA phases, the East Kaweah GSA's Board of Directors, Technical Advisory Committee, and Advisory Committee are responsible for collecting and organizing data, engaging and retaining experts and consultants, and soliciting feedback from beneficial users of groundwater and interested parties within the GSA boundary. The specific roles of the Board of Directors and committees are described in **Section II.A**.

Table I-2. Member Entities of Other GSAs in Kaweah Sub-basin

Mid-Kaweah GSA	Greater-Kaweah GSA	
City of Visalia City of Tulare Tulare Irrigation District	Kaweah Delta Water Conservation District Kings County Water District Lakeside Irrigation Water District St. Johns Water District County of Tulare California Water Service Company	**Additional Participating Agencies:** City of Exeter City of Farmersville City of Woodlake Consolidated Peoples Ditch Company Farmers Ditch Company Fleming Ditch Company Ivanhoe Public Utility District Lemon Cove Ditch Company Lemon Cove Sanitary District Mathews Ditch Company Patterson Tract Community Services District Tract 92 Community Services District Wallace Ranch Water Company

I.A.2 Industries, DACs, Municipalities

I.A.2.1 Industries

I.A.2.1.1 Agriculture

The primary industry within the East Kaweah GSA is agriculture, as Tulare County is one of the top largest agricultural-producing counties in the United States. Primary crops grown within the GSA include livestock (ranching), citrus, stone fruits (nectarines, plums), nut crops (almonds, walnuts, pistachios), and row crops (corn, silage, alfalfa, wheat). Dairy is also a significant part of agriculture production within the area. As the primary industry, agriculture is the largest private employer in the county, with farm employment accounting for a quarter of all jobs, including production, processing, and manufacturing. According to the Tulare County Farm Bureau, six of the top 15 employers in the county are fruit packing houses and dairy processing plants, and one in every five jobs in the San Joaquin Valley is directly related to agriculture.

With a substantial amount of East Kaweah GSA acreage in agriculture production, it is important agriculture industry stakeholders are involved and informed during the development and public review phases of the GSP, as implementation will have a significant direct impact on the industry, and ultimately the local, state and national economies.

I.A.2.1.2 Environmental

There are two primary environmental organizations within the East Kaweah GSA boundary, and both entities have a representative on the GSA's Advisory Committee: Sequoia Riverlands Trust (**SRT**) and the Tulare Basin Wildlife Partners (**TBWP**). SRT is a regional nonprofit land trust dedicated to strengthening California's heartland and the natural and agricultural legacy of the San Joaquin Valley, with a vision focused on creating a future where productive land and healthy natural systems are protected to generate community vitality and economic prosperity. The mission of the TBWP is to engage in multi-benefit projects that promote ecological and economic health, sustaining the area's agricultural heritage, and enhancing the quality of life in the Tulare Basin for current and future generations.

In addition to representation on the Advisory Committee, collaboration meetings will be held with these organizations to make sure their organizational visions and groundwater needs for land conservation and a healthy regional watershed with ecologically functional waterways are taken into consideration during GSP development and implementation phases.

I.A.2.2 DACs

Communication and educational outreach efforts with disadvantaged communities (**DAC**) and severely disadvantaged communities (**SDAC**) is essential for the development and implementation of the East Kaweah GSA's GSP, and residents are generally dedicated to bettering their communities, particularly when it comes to their water supplies. Important information that will be essential to communicate to and engage DACs will include an explanation of SGMA, water conservation education, and soliciting feedback from community members on water quantity and water quality challenges their communities may face. A composite listing of the eight DACs and SDACs and their populations within the GSA boundary are listed in **Table I-3** and laid out in **Figure I-2**. Specific issues and infrastructure projects are described in greater detail in **Section II.B**.

By including DACs and SDACs in communication efforts during the development, public review and implementation phases of the GSA, residents will be more likely to participate and provide feedback that could be crucial to long-term solutions for groundwater sustainability within their communities. Any feedback received from DAC residents will be reviewed by the Advisory Committee and Technical Advisory Committee and taken into consideration during the GSP development phase.

Table I-3. Disadvantaged Communities within East Kaweah GSA

Community	Population	DAC/SDAC
Lindsay	12,688	SDAC
El Rancho	16	SDAC
Lindcove	520	DAC
Plainview	858	SDAC
Strathmore	3,626	SDAC
Tooleville	387	SDAC
Tonyville	250	DAC
Elderwood	59	DAC

I.A.2.3 Municipalities

The municipalities within the East Kaweah GSA are rural and district-related and are listed in **Table I-4**. These municipalities will be engaged in outreach efforts throughout the GSP development, public review and implementation phases, as described in **Section II.C**. School districts will be an integral part of outreach efforts, particularly within DACs, and are outlined in **Figure I-4**.

Table I-4. Municipalities within East Kaweah GSA

Municipalities within East Kaweah GSA	
City of Lindsay	Lindsay-Strathmore Irrigation District
Exeter Irrigation District	Stone Corral Irrigation District
Lewis Creek Water District	Strathmore Public Utility District
Lindmore Irrigation District	

I.A.3 East Kaweah GSA's Decision-Making Process

The East Kaweah GSA's decision-making process is broken down by the roles of the Board of Directors, Advisory Committee and Technical Advisory Committee. The roles of these East Kaweah GSA entities and their responsibilities are outlined below and described in more detail in **Section II.A**.

- **Board of Directors –** Adopt general policies regarding development and implementation of the GSP
- **Technical Advisory Committee –** Reviews and analyzes collected data, takes into consideration feedback received from the Advisory Committee and results of stakeholder surveys
- **Advisory Committee –** Representing all beneficial uses and users of groundwater within the GSA boundary, makes recommendations to the Board of Directors and Technical Advisory Committee regarding community outreach and adoption of a GSP that accounts for local interests

B. Goals/Desired Outcomes of GSP Development

The overall, main goal of the East Kaweah GSA is to use a wholistic approach to reach groundwater sustainability by mitigating undesirable results affecting the GSA's jurisdiction within the Kaweah Sub-basin with minimal impacts to industry and everyday life.

C. Communication Objectives to Support the GSP

The ultimate goal of communication objectives during the formation/coordination, GSP development, public review and implementation phases of SGMA compliance, is to encourage active involvement of diverse, social, cultural, and economic elements of the population within the GSA boundary. The East Kaweah GSA will give beneficial users and users of groundwater opportunities to engage in the GSP process, provide educational outreach opportunities for stakeholders while reaching out through specific communication avenues (**Section V**). As primary stakeholders, members of the Board of Directors, Advisory Committee and Technical Advisory Committee are direct representatives of their communities and industries, and it is important for them to continually gather feedback/input, and concerns/needs of their constituents and report back to their respective meetings. Any primary or secondary stakeholder input received was reviewed and taken into consideration during GSP development.

I.C.1 Phase 1: GSA Formation and Coordination

Phase 1: GSA Formation and Coordination has been completed. This phase stretched from 2015 through 2017, and consisted of forming the East Kaweah GSA, establishing and maintaining the List of Interested Parties (**Section II.D**), establishing the Advisory Committee, and creating the Communication & Engagement Plan to outline communication efforts for GSP development, public review and implementation phases. Stakeholder input was utilized during the GSA formation phase, as beneficial users and stakeholders with interests in groundwater usage within the East Kaweah GSA's boundary were notified via public meeting notices as soon as the process began (**Table I-5**).

Table I-5. Public Notices for GSP Public Hearing

Publication	Date Published
Porterville Recorder	May 16, 2017; May 23, 2017
Visalia Times Delta	May 16, 2017; May 23, 2017

I.C.2 Phase 2: GSP Preparation and Submission

Phase 2: GSP Preparation and Submission spanned from 2017 through 2020. With the goal of having the draft GSP ready for review in the third quarter of 2019, 2018 was primarily the technical development of the plan, while working with the Advisory Committee and Technical Advisory Committee, as primary stakeholders (**Section II.A**), for feedback and input. During 2018, the first round of public outreach meetings and interaction with secondary stakeholder groups (**Section II.B**) and other community organizations and entities (**Section II.C**) was held with the purpose of educating and informing stakeholders about SGMA and the GSP process, while also soliciting feedback and input from these groups via the Stakeholder Survey (**Section III.A**) to mitigate the negative impacts to beneficial users of groundwater as much as possible.

I.C.3 Phase 3: GSP Review and Evaluation

During late 2019, Phase 3: GSP Review and Evaluation was the primary focus of communication and engagement efforts. Once the draft of the GSP was complete late in the third quarter of 2019, the public review process began. Initially, an administrative draft was circulated during a 30-day review period. Following the administrative draft comments were received and the GSP draft updated accordingly, it was released again and a 90-day comment period began. The GSP draft posted on the East Kaweah GSA's website for primary and secondary stakeholders to conveniently download and review, and hard copies were available at member agencies' office locations. Outreach meetings were held during this phase at the same locations the meetings during Phase 2 were held. These meetings focused on an overview of the GSP content, while giving stakeholders a public forum to ask questions and provide their feedback and comments. The 90-day public review period concluded with a public hearing regarding the GSP Draft on December 16, 2019. Public notices for the public hearing was published 45 days prior (**Table I-6**), as well as several email notifications.

Table I-6. Public Notices for Draft GSP Public Hearing

Publication	Date Published
The Foothills Sun-Gazette	October 30, 2019; November 6, 2019
Visalia Times Delta	October 31, 2019; November 7, 2019

Once the public review period was completed, public comments were taken into consideration and incorporated into the final version of the East Kaweah GSA's GSP before submitting to the DWR by January 31, 2020. Following submittal, stakeholders will be given a second 60-day comment period through the DWR's SGMA portal at http://sgma.water.ca.gov/portal/. Comments will be posted to the DWR's website prior to the state agency's evaluation, assessment and approval.

I.C.4 Phase 4: Implementation and Reporting

Phase 4: Implementation and Reporting will begin once the plan is submitted in January 2020. Even while the DWR is reviewing the GSP, implementation at the GSA-level must begin. During the implementation phase, communication and engagement efforts will be shifted to educational and informational awareness of the requirements and processes of reaching groundwater sustainability. Active involvement of all stakeholders is encouraged during this phase, and public notices are required prior to imposing, and later increasing, any fees.

D. Overriding Concerns, Major Concerns or Challenges

Through preliminary discussions with primary stakeholders during East Kaweah GSA's Advisory Committee meetings, overriding concerns, major concerns or challenges are centralized around economic impacts to the agricultural industry, which will also have a direct impact on DACs. Economic impacts could include loss of jobs and loss of tax revenue due to the decreased land values of fallowed ground. Many residents within DACs are employed by the agricultural industry, and many infrastructure improvement projects within these communities are facilitated by the County of Tulare and funded through state and federal funding secured with the assistance of technical providers. The agricultural industry and DACs will be the main target audiences for direct outreach meetings because of the significant impact SGMA implementation will have on these two users of groundwater.

A summary of additional top concerning issues affecting groundwater, and the effect of SGMA on agriculture and rural communities/DACs is listed in **Table III-1**.

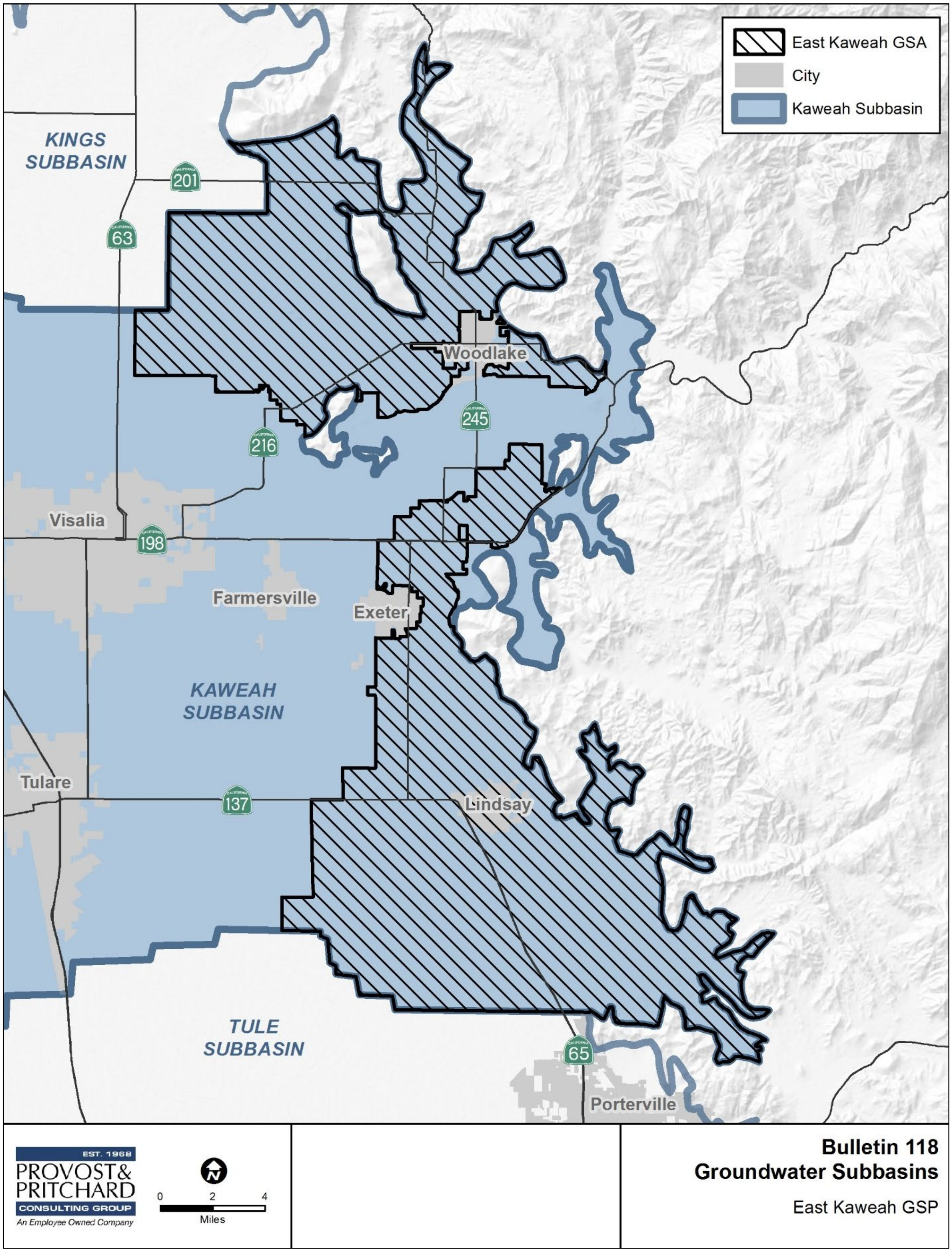


Figure I-1. East Kaweah GSA Boundary

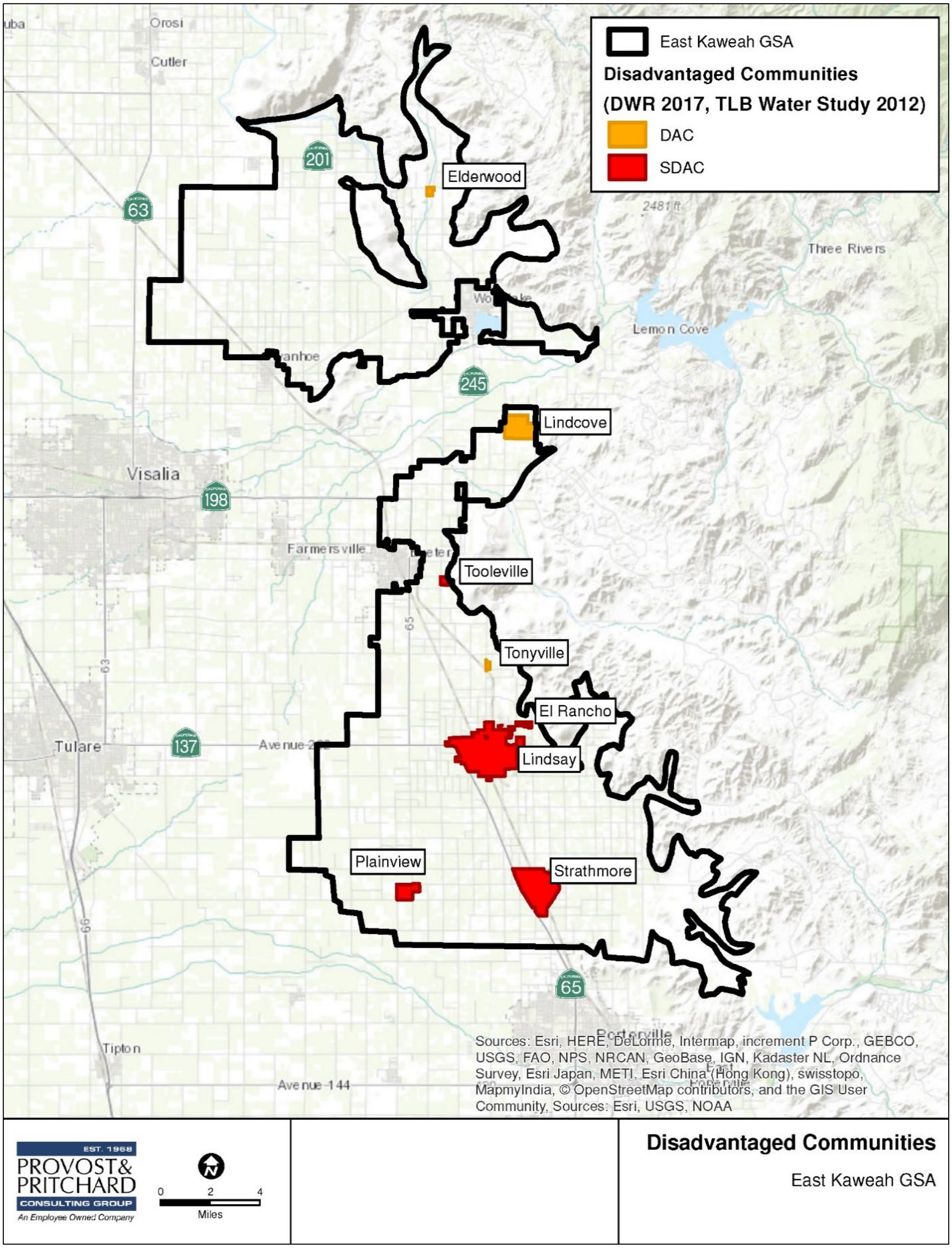


Figure I-2. Disadvantaged Communities within East Kaweah GSA