Sacramento Groundwater Authority

Basin Management Report 2016 Update

Sacramento Groundwater Authority
Managing Groundwater Resources in Northern Sacramento County


SGA

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SGA Basin Management Report

Introduction

This Basin Management Report[1] documents management activities of the Sacramento Groundwater Authority (SGA) and its member agencies from 2013 through 2015. It is the sixth in the series of reports that documents basin conditions as well as management activities undertaken to help ensure the long-term sustainability of the region's groundwater resources. The report also documents the ongoing implementation of the SGA Groundwater Management Plan (GMP) and the status of meeting Basin Management Objectives of the GMP.

SGA Background

The SGA is a joint powers authority (JPA) formed in 1998 to manage the groundwater basin in Sacramento County north of the American River. Known locally as the North Area Groundwater Basin (North Area Basin), the basin encompasses the southern one-third of the North American Subbasin (Basin 5-21.64) as defined by the California Department of Water Resources (Figure 1). Formed as a result of the Sacramento Area Water Forum, SGA is recognized as an essential part of implementing the groundwater management element of the historic Water Forum Agreement[2] (WFA) of 2000. A centerpiece of the agreement is a regional program to manage and conjunctively use groundwater and surface water to help meet water needs through the year 2030, while reducing diversions from the lower American River during environmentally sensitive times.

The joint powers agreement cites the following purposes for establishing SGA:

- To maintain the long-term sustainable yield of the North Area Basin;
- To manage the use of groundwater in the North Area Basin and facilitate implementation of an appropriate conjunctive use program by water purveyors;
- To coordinate efforts among those entities represented on the governing body of the joint powers authority to devise and implement strategies to safeguard groundwater quality; and
- To work collaboratively with other entities, including groundwater management authorities that may be formed in other areas of the County of Sacramento and adjacent political jurisdictions, to promote coordination of policies and activities throughout the region.

The SGA draws its authority from a joint powers agreement signed by the cities of Citrus Heights, Folsom and Sacramento and the County of Sacramento. The signatories chose to manage the basin cooperatively by creating a governing board

[1] This and previous reports are available at http://www.sgah2o.org.

[2] The WFA is available at http://www.waterforum.org.

of directors comprised of representatives of the following water agencies[3] and other water users within their jurisdiction:

- California American Water
- Carmichael Water District
- Citrus Heights Water District
- City of Folsom
- City of Sacramento
- County of Sacramento
- Del Paso Manor Water District
- Fair Oaks Water District
- Golden State Water Company
- Natomas Central Mutual Water Company
- Orange Vale Water Company
- Rio Linda/Elverta Community Water District
- Sacramento Suburban Water District
- San Juan Water District
- Agriculture interests within SGA boundaries
- Commercial/Industrial self-supplied water users within SGA boundaries.

Figure 2 shows the service areas of the water agencies. Some of the agency boundaries extend beyond the SGA boundary. Those areas are not subject to the SGA GMP, because they extend beyond SGA's jurisdictional boundary in northern Sacramento County.

SGA became the exclusive Groundwater Sustainability Agency (GSA) in conformance with the Sustainable Groundwater Management Act (SGMA) of 2014 for its portion of the North American Subbasin in January 2016. This is described further in the Basin Management Activity Highlights section of this report.

[3] For convenience, water purveyors, whether public or private, are referred to as "agencies" throughout this report.

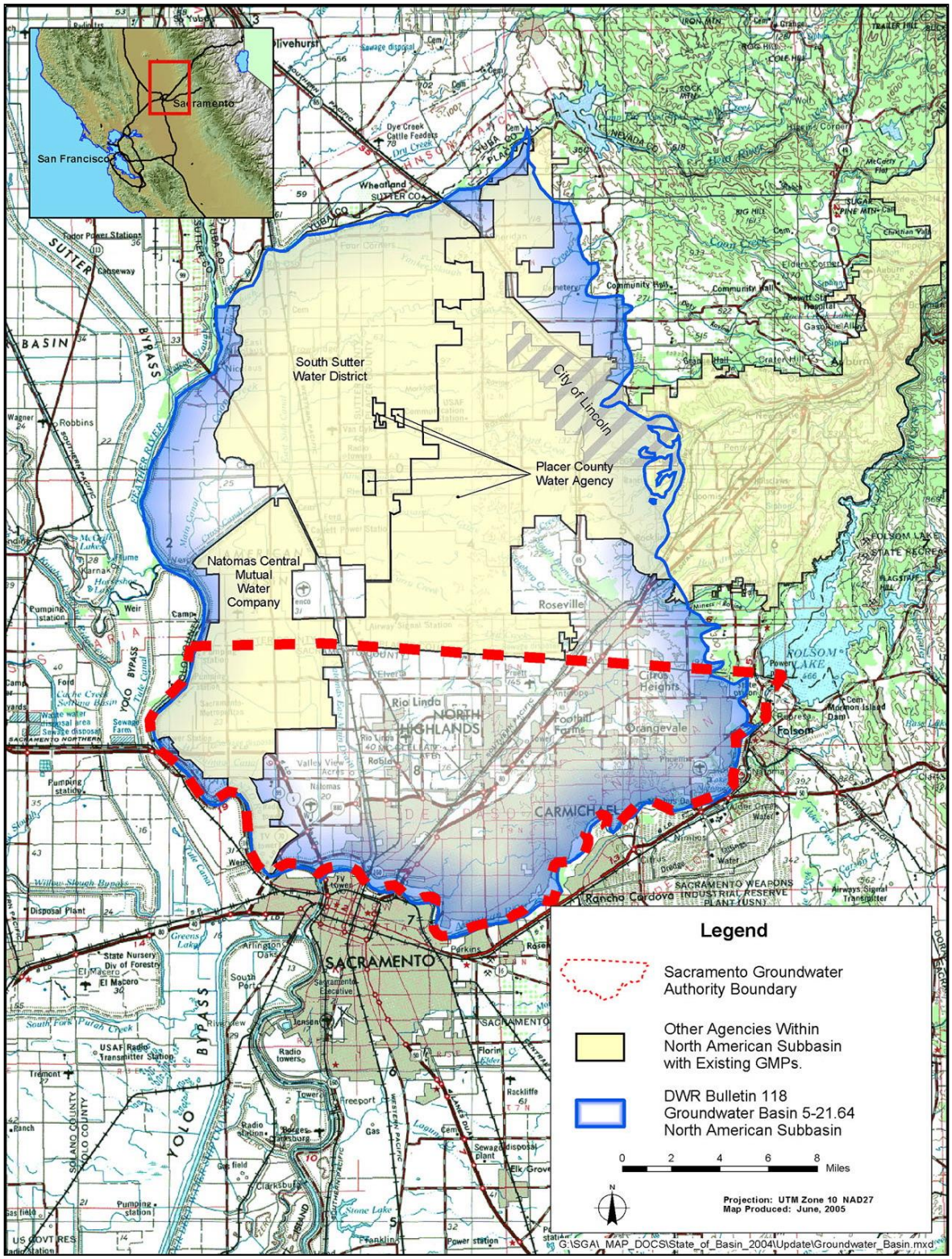

Figure 1. North American Subbasin

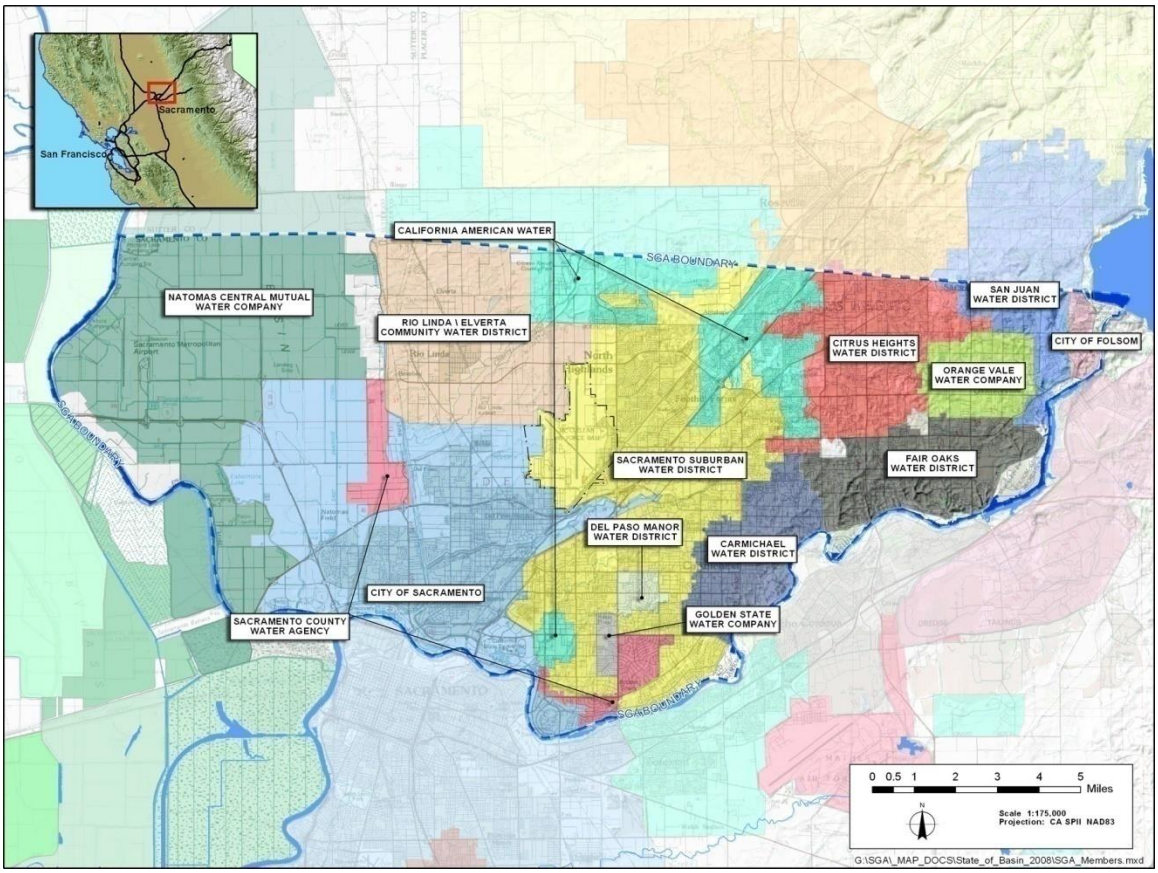

Figure 2. Water Agencies in North Area Basin

SGA Groundwater Management Plan

SGA adopted its initial Groundwater Management Plan (GMP)[4] in 2003 to create a framework for maintaining a sustainable, high-quality groundwater resource consistent with the objectives of the WFA. The GMP was prepared under the authority of the JPA and was consistent with the provisions of California Water Code § 10750 *et seq.* Additionally, the GMP included components recommended by the California Department of Water Resources in its 2003 update of *Bulletin 118: California's Groundwater*. In December 2008, SGA adopted a fully updated GMP as called for in the initial 2003 GMP. Another comprehensive GMP update was completed and adopted in December 2014. The 2014 SGA GMP incorporated many of the new required components of Groundwater Sustainability Plans resulting from passage of SGMA.

A key component of the GMP is to report periodically on the implementation of the GMP itself. Accordingly, this Basin Management Report includes a summary of the actions taken to implement the GMP and an evaluation of how the GMP's objectives are being met.

Report Organization

The remainder of this report is organized into three primary sections:

[4] The most recent SGA GMP is available on-line at http://www.sgah2o.org.

Basin Conditions. This section describes the hydrologic conditions experienced in the basin during the reporting period. Basin conditions also includes water use, resulting changes in groundwater elevations and groundwater in storage in the SGA area. Finally, this section provides an overview of basin conditions with respect to the quality of groundwater.

Basin Management Highlights. This section describes the most significant management actions taken by SGA and other local agencies that affected SGA during the current reporting period.

Evaluation of Basin Management Objectives. This section evaluates whether current basin management objectives are being met by comparing them to criteria, referred to as "indicators," for groundwater extractions, groundwater elevations, and groundwater quality.

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Hydrologic Conditions

Hydrologic conditions during 2013 through 2015 continued the pattern of generally dry conditions that began in 2007 for the Sacramento Valley, as shown by year type in Table 1. As in past reports, three indicators are used to describe the hydrologic conditions for this period: 1) Sacramento River Water Year Index, 2) Water Forum Agreement year type, and 3) Local weather, including precipitation and temperature.

Table 1. DWR Sacramento River Water Year Index Runoff

Water Year	Runoff (million acre-ft)	Year Type
1995	12.89	Wet
1996	10.26	Wet
1997	10.82	Wet
1998	13.31	Wet
1999	9.80	Wet
2000	8.94	Above Normal
2001	5.76	Dry
2002	6.35	Dry
2003	8.21	Above Normal
2004	7.51	Below Normal
2005	8.49	Above Normal
2006	13.20	Wet
2007	6.19	Dry
2008	5.16	Critical
2009	5.78	Dry
2010	7.08	Below Normal
2011	10.54	Wet
2012	6.89	Below Normal
2013	5.83	Dry
2014	4.07	Critical
2015	4.01	Critical

Year Type	Water Year Index (million acre-feet)
Wet	Equal to or greater than 9.2
Above Normal	Greater than 7.8, and less than 9.2
Below Normal	Greater than 6.5, and equal to or less than 7.8
Dry	Greater than 5.4, and equal to or less than 6.5
Critical	Equal to or less than 5.4

Sacramento River Water Year Index

This is a broad indicator of the hydrology experienced in the Sacramento Valley as a whole. The Department of Water Resources (DWR) maintains a record of water year types based on a calculated index using Sacramento River and tributary runoff in the Feather, Yuba, and American Rivers. The index classifies hydrologic conditions in the Valley for each water year period, October 1 through September 30, as wet, above normal, below normal, dry, or critical, as shown in Table 1.

The 2013 water year was classified as dry and the 2014 and 2015 water years were classified as critical. The 2015 water year runoff was the lowest recorded since the 1977 water year[5]. After the wet year of 2006, eight of the nine water years through 2015 were classified as below normal, dry or critical. Table 1 lists the classification

[5] The Sacramento River Index is maintained at http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST. Annual runoff dating back to the 1906 water year is available at the site.

for water years 1995 through 2015. The classifications are defined at the bottom of the table.

Water Forum Agreement Year Type

A more local indicator of hydrologic conditions is calculated unimpaired inflow into Folsom Lake. Inflow into Folsom represents runoff of the American River Watershed to the east of the SGA area and largely represents runoff of the snowpack of the watershed. March-through-November total unimpaired inflows into Folsom Lake determine the amount certain Sacramento area water agencies may divert from Folsom Lake and the lower American River as specified in their purveyor-specific agreements under the Water Forum Agreement (WFA). Table 2 lists the definitions of WFA water year types.

Table 2. Water Year Types as Defined by Water Forum Agreement

Year Type	Unimpaired Inflow to Folsom Lake, March through November (acre-ft)
Wet (No Restrictions)	Greater than 1,600,000
Average (Hodge Year)	Greater than 950,000 and less than 1,600,000
Drier (Wedge Year)	Greater than 400,000 and less than 950,000
Driest (Conference Year)	Less than 400,000

The exceedance probability curve in Figure 3 was calculated using values of full natural flow below Folsom Dam from 1901 through 2015. These flow values were obtained via the link http://cdec.water.ca.gov/cgi-progs/queryMonthly?AMF and may vary from the final estimates in the Water Forum Successor Effort's Runoff and Allocation Reports, which are derived as discussed in the document at http://www.waterforum.org/water-supply/runoff-report/.

From the local hydrologic perspective, the three year period is among the lowest ever recorded. Each of the years ranked in the bottom 10% of flows in the record. The 2013 and 2014 water years were drier than the previous 10 years of tracking by SGA as shown on Figure 3. These years were classified as Wedge Years according to the Water Forum Agreement, which resulted in actions to reduce surface water diversions by certain water purveyors. The 2015 water year was the driest, only surpassed by the 1977 water year, and was classified by the Water Forum as a Conference Year in which the Water Forum convenes meetings to confer on how to best meet demands and protect the lower American River.

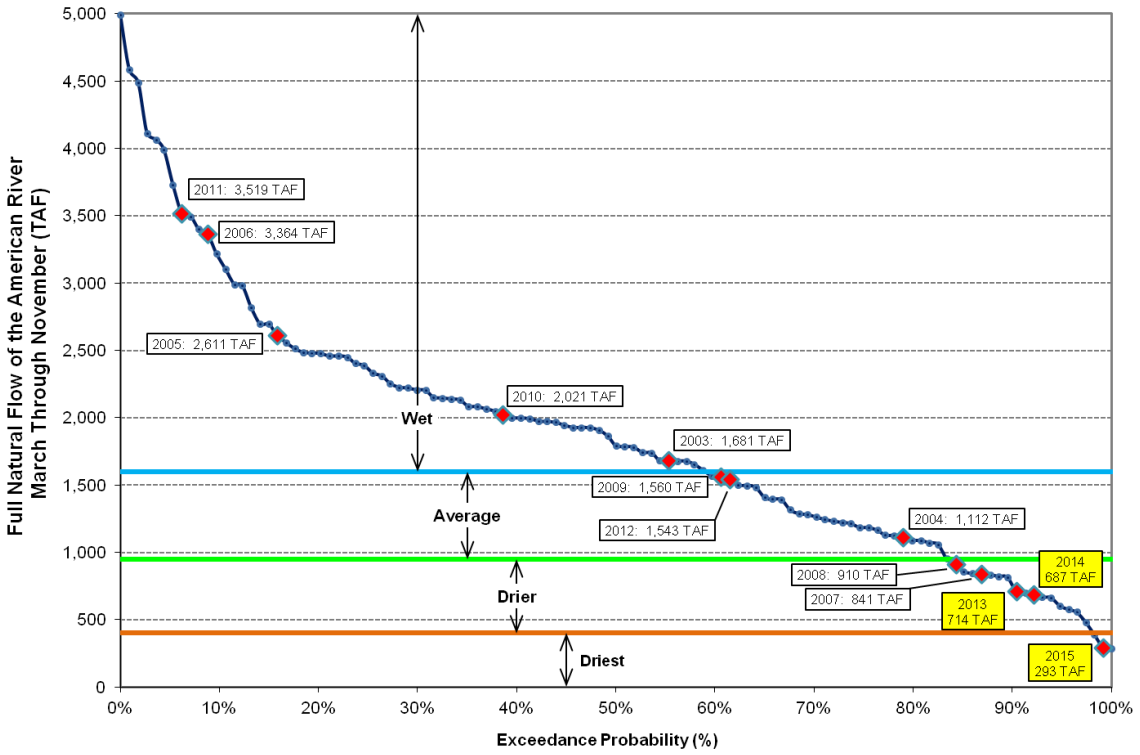

Figure 3. Calculated Unimpaired Inflow to Folsom Lake, March-November

Local Weather

Local weather conditions are represented by monthly and annual precipitation and temperature. Past Basin Management Reports relied on a six-station average to compare precipitation to long-term average conditions. However, during the reporting period there were several data gaps, so an average could not be calculated. Instead, the current report uses the station *Sacramento 5 ESE*, which is a cooperative station to the National Climate Data Center, to represent local precipitation and temperature conditions. The location of the station is shown on Figure 4.

The reporting period was marked by significantly below average local precipitation. Figure 5 shows the monthly precipitation totals and the long-term monthly average precipitation (1981-2010) at station *Sacramento 5 ESE* for 2013 through 2015. All annual totals were below the long-term average precipitation for the station, which is 19.87 inches. Annual rainfall totals were 6.12 inches, 18.44 inches, and 8.15 inches for 2013, 2014, and 2015, respectively. Over the three-year period, the region had only 55% of expected rainfall (32.71 total inches versus 59.61 total inches over three years).

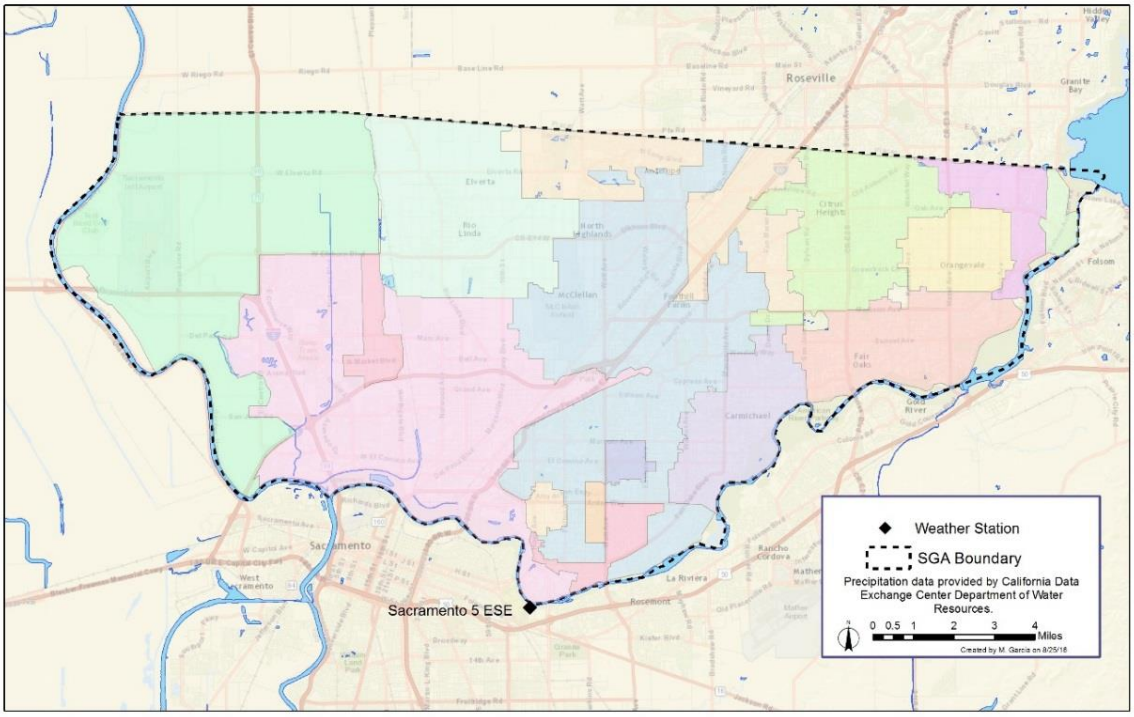

Figure 4. Location of "Sacramento 5 ESE" Weather Station.

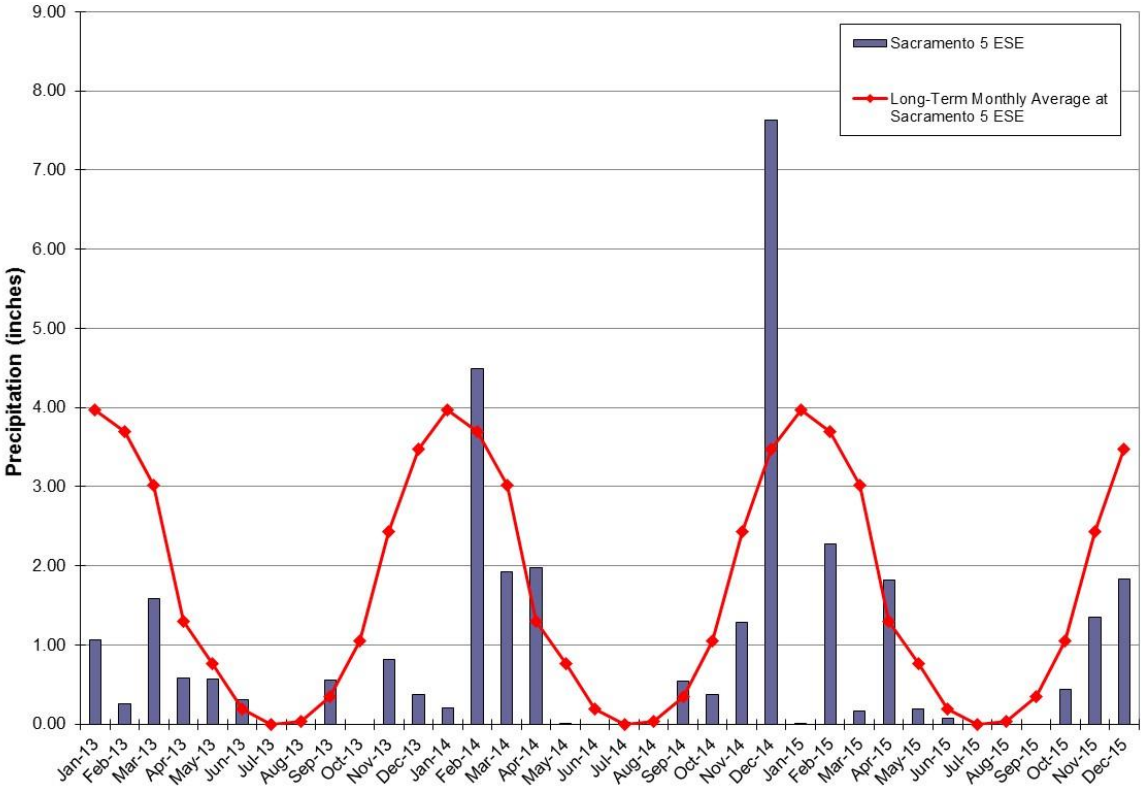

Figure 5. Average Monthly Precipitation at Station "Sacramento 5 ESE"

The reporting period was marked by significantly above average annual local temperatures. A plot of the average monthly temperature for 2013 through 2015 compared to the long-term average (1981-2010) is shown in Figure 6 for station *Sacramento 5 ESE*. Temperatures were above average in each year. The long-term average annual (1981-2010) temperature is 63.3 degrees Fahrenheit (F) while the respective average annual temperatures were 63.7, 65.9, and 65.1 degrees F for the years 2013, 2014, and 2015.

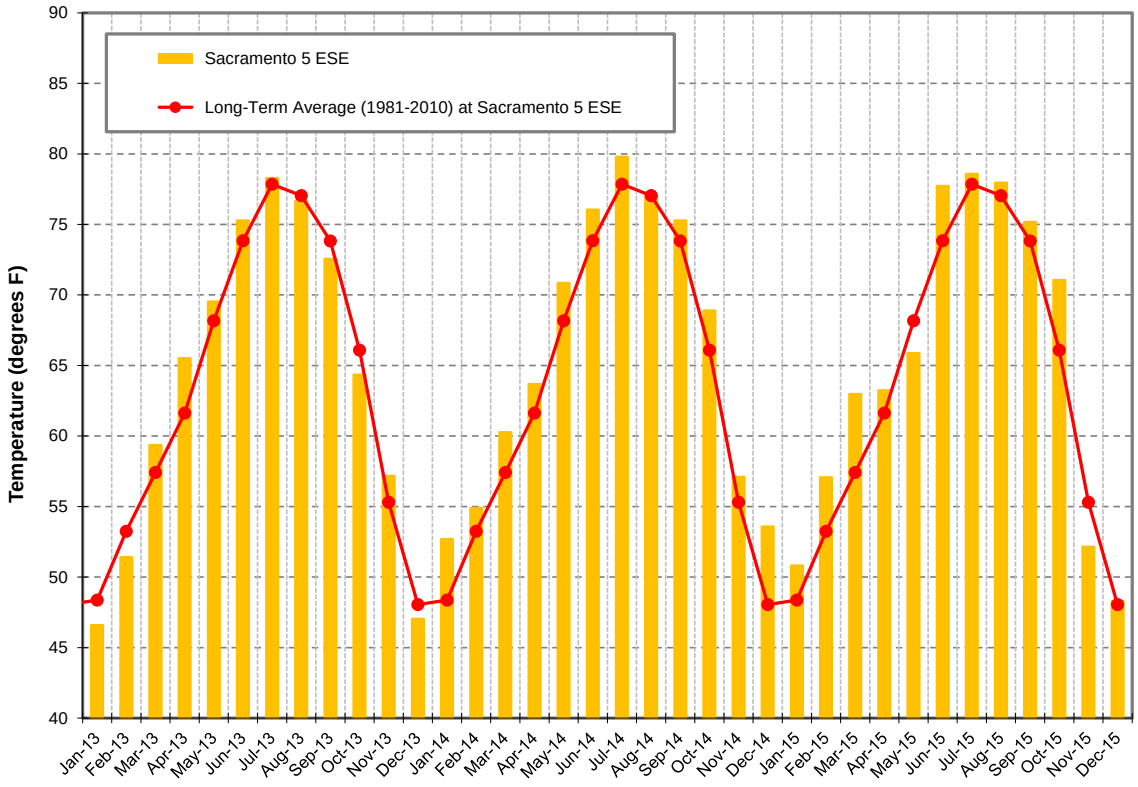

Figure 6. Average Monthly Temperature at Station "Sacramento 5 ESE"

Regional Water Use

Both surface water and groundwater support municipal and industrial (M&I), agricultural, and domestic activities. Additionally, some groundwater is extracted as part of contamination cleanup activities. With respect to groundwater, each public supply well for M&I use is metered and that information is reported annually to SGA. Most of the self-supplied industrial users (those not permitted as public supply wells), agricultural, and domestic users do not measure their groundwater extractions. SGA does not request the extraction information from these users, because it does not appear to contribute to its ability to successfully manage the basin. SGA has not requested annual reporting of groundwater extraction for groundwater remediation[6] purposes. Instead, SGA has used its groundwater model, Sacramento Area Integrated Water Resources Model (SacIWRM), to estimate the groundwater extractions by these other users. Based on a 2007 model update and re-calibration effort, groundwater extractions in 2004 consisted of about 85% M&I pumping, 8% independent agricultural pumping, 4% private domestic pumping, and 3% groundwater contaminant cleanup pumping. Independent agricultural and domestic pumping is estimated at 18,000 acre-feet per year.

Groundwater production in the North Basin increased during 2013 and then decreased thereafter to a volume nearly equal to 2011, which was lower than any year during the SGA review period (2000 through 2015). This reduction was in large part due to conservation efforts during the middle of the recent drought conditions.

Local water agencies extracted a total of 79,264 acre-feet during 2013, an increase of nearly 15% over 2012. During 2014 and 2015, groundwater production decreased to 74,508 and 62,055 acre-feet, respectively. The latter volume is quite similar to the 2011 volume of 61,954 acre-feet. Table 3 (bottom) provides for the total volumes of groundwater and surface water for M&I uses, along with the annual volumes for each agency[7]. Table 4 provides a summary of recent groundwater remediation volumes for the former McClellan Air Force Base and for the Aerojet Superfund Site within the SGA area. The combined metered extraction for M&I uses and remediation activities account for approximately 80% of groundwater extraction in the SGA area.

A new requirement for management reports resulting from DWR's completion of GSP Emergency Regulations in 2016 is the inclusion of a map that illustrates the general location and volume of groundwater extractions. Figure 7 below depicts the service areas of the water agencies in the SGA area. Each service area is color coded with respect to its 2015 groundwater extractions. Extractions by purveyors ranged from 0 acre-feet by the City of Folsom, Orange Vale Water Company and San Juan Water District up to 15,707 acre-feet in the Sacramento Suburban Water District's North Service Area. The extraction shown in Figure 7 at the former McClellan Air Force is for remediation of contaminated groundwater at the site.

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[6] Beginning with this report, SGA began collecting groundwater extraction volumes for major remediation operations within the SGA area.

[7] This data does not include surface water supplies for portions of the San Juan Water District in Placer County, the City of Folsom south of the American River, and the Natomas Central Mutual Water Company delivered to agriculture. Surface water for the City of Sacramento is estimated, because the City is located both north and south of the American River.

Table 3. Reported M&I Surface Water and Groundwater Supplies (acre-feet) by Agency

Water Purveyor	Year	Surface Water	Ground Water	Total Water Deliveries
California American Water	2015	0	9,581	9,581
	2014	0	11,260	11,260
	2013	0	14,110	14,110
	2012	591	13,595	14,186
	2011	2,099	11,605	13,704
Carmichael Water District	2015	4,598	2,755	7,353
	2014	4,942	3,575	8,517
	2013	8,369	2,031	10,400
	2012	8,315	1,580	9,895
	2011	7,850	1,469	9,319
Citrus Heights Water District	2015	9,133	841	9,974
	2014	10,008	1,930	11,938
	2013	14,193	465	14,658
	2012	13,355	583	13,938
	2011	12,095	962	13,057
Del Paso Manor Water District	2015	0	1,052	1,052
	2014	0	1,246	1,246
	2013	0	1,571	1,571
	2012	0	1,499	1,499
	2011	0	1,428	1,428
Fair Oaks Water District	2015	7,257	873	8,130
	2014	7,261	2,330	9,591
	2013	10,939	1,320	12,259
	2012	9,987	1,563	11,550
	2011	9,597	1,516	11,113
Folsom, City of	2015	963	0	963
	2014	1,230	0	1,097
	2013	1,462	0	1,410
	2012	1,529	0	1,279
	2011	1,293	0	1,279
Golden State Water Company	2015	0	778	778
	2014	0	896	896
	2013	0	1,184	1,184
	2012	0	1,119	1,119
	2011	0	1,041	1,041
Orange Vale Water Company	2015	3,257	0	3,257
	2014	3,932	0	3,932
	2013	5,139	0	5,139
	2012	4,658	0	4,658
	2011	4,108	0	4,108

Table 3 (Cont'd). Reported M&I Surface Water and Groundwater Supplies (acre-feet) by Agency

Water Purveyor	Year	Surface Water	Ground Water	Total Water Deliveries
Rio Linda/Elverta CWD	2015	0	2,109	2,109
	2014	0	2,449	2,449
	2013	0	3,053	3,053
	2012	25	2,857	2,882
	2011	0	2,544	2,544
Sacramento, City of	2015	15,196	12,682	27,878
	2014	18,122	13,602	31,724
	2013	27,336	11,732	39,068
	2012	24,530	13,554	38,084
	2011	18,656	17,607	36,263
Sacramento, County of	2015	0	3,887	3,887
	2014	0	4,559	4,559
	2013	0	5,316	5,316
	2012	0	5,211	5,211
	2011	0	4,663	4,663
Sacramento Suburban WD	2015	80	27,422	27,502
	2014	0	32,561	32,561
	2013	409	38,482	38,891
	2012	10,559	27,530	38,089
	2011	16,709	19,119	35,828
San Juan Water District	2015	2,139	0	9,666
	2014	2,560	0	11,077
	2013	3,643	0	14,945
	2012	3,421	0	3,421
	2011	3,046	0	3,046
Total for SGA Area	2015	42,623	62,055	104,678
	2014	48,055	74,508	122,563
	2013	71,490	79,264	150,754
	2012	76,970	69,091	146,061
	2011	75,453	61,954	137,407

Table 4. Total Estimated Groundwater Extraction Volumes (acre-feet)

Year	M&I Metered Extraction	Remediation Metered Groundwater	Estimated Ag, Domestic and Other Self-Supplied	Total Estimated Groundwater Extraction
2013	79,264	5,313	18,000	102,577
2014	74,508	4,979	18,000	97,487
2015	62,055	5,939	18,000	85,994

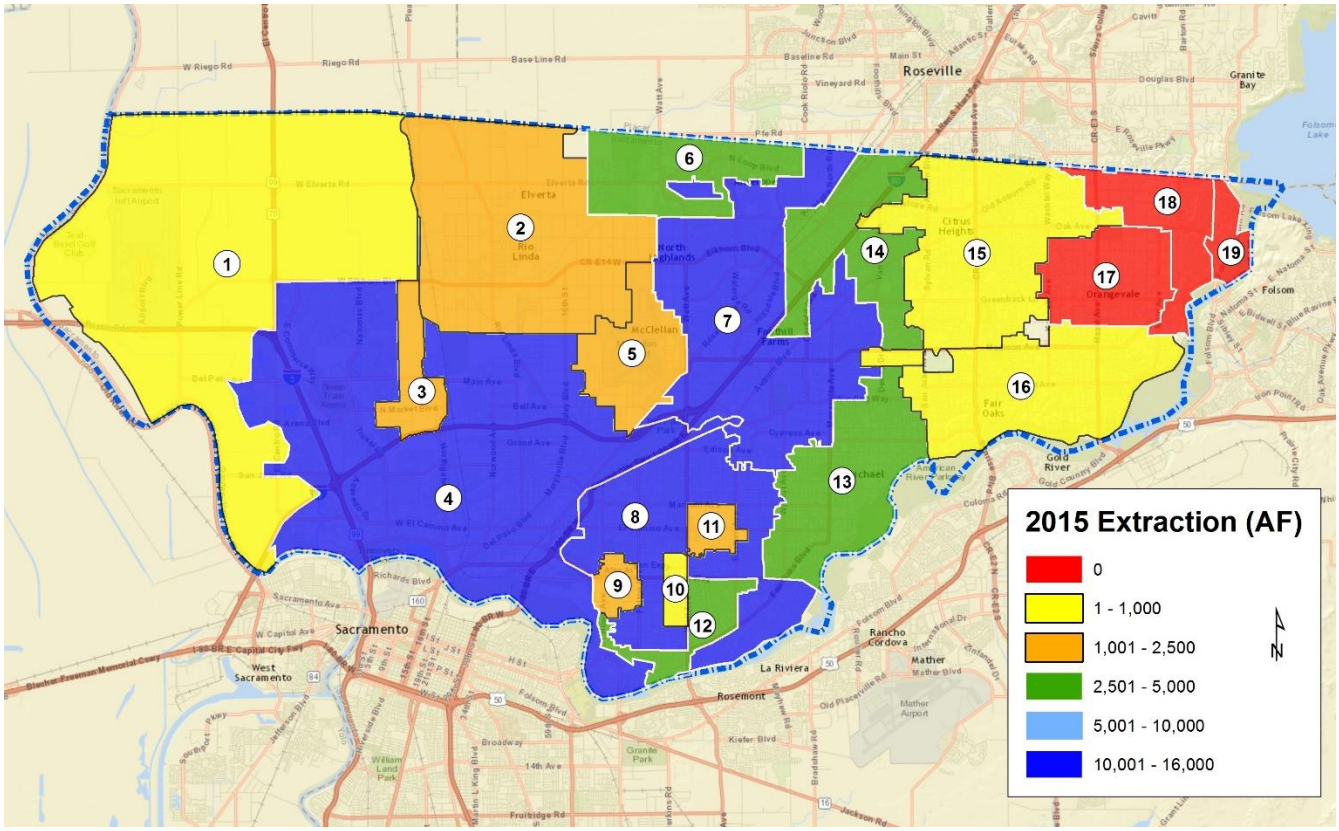

Figure 7. Total Groundwater Extraction by Service Area in Calendar Year 2015

Key:
1 – Natomas Central Mutual Water Company
2 – Rio Linda Community Water District
3 – Sacramento County Water Agency Northgate Service Area
4 – City of Sacramento
5 – Former McClellan Air Force Base Groundwater Remediation Extraction
6 – California American Water Antelope Service Area
7 – Sacramento Suburban Water District North Service Area
8 – Sacramento Suburban Water District South Service Area
9 – California American Water Arden Service Area
10 – Golden State Water Company Arden Service Area
11 – Del Paso Manor Water District
12 – Sacramento County Water Agency Arden Park Vista Service Area
13 – Carmichael Water District
14 – California American Water Lincoln Oaks Service Area
15 – Citrus Heights Water District
16 – Fair Oaks Water District
17 – Orange Vale Water Company
18 – San Juan Water District
19 – City of Folsom Ashland Service Area

Figure 8 shows the annual volumes of surface water to groundwater for M&I uses since 2000. Overall, water agencies in the North Area Basin, as a whole, meet about half of their water supply needs with groundwater and about half with surface water for M&I uses. Also shown on the graph is total M&I water use and the water year classification as defined by the Water Forum Year Type. The region has been moving toward more conjunctive use of surface water and groundwater depending on hydrologic conditions. This is not as evident between 2000 and 2010. For example, significantly more surface water was used in 2008, which classified as a drier year. In 2010, additional Water Forum requirements related to surface water use came into effect. Since that time, conjunctive use operations are more noticeable on the graph. For example, 2010, 2011, and 2012, which classified as wet or average used more surface water than groundwater. The three latest dry years, 2013, 2014, and 2015 all saw more groundwater used than surface water. Also of note on Figure 8 is the downward trend in overall water use, which is related to increases in water use efficiency in the region. The additional conservation measures in response to drought conditions in 2014 and 2015 are also evident. The region conserved approximately 20% in 2014 and 30% in 2015 compared to 2013.

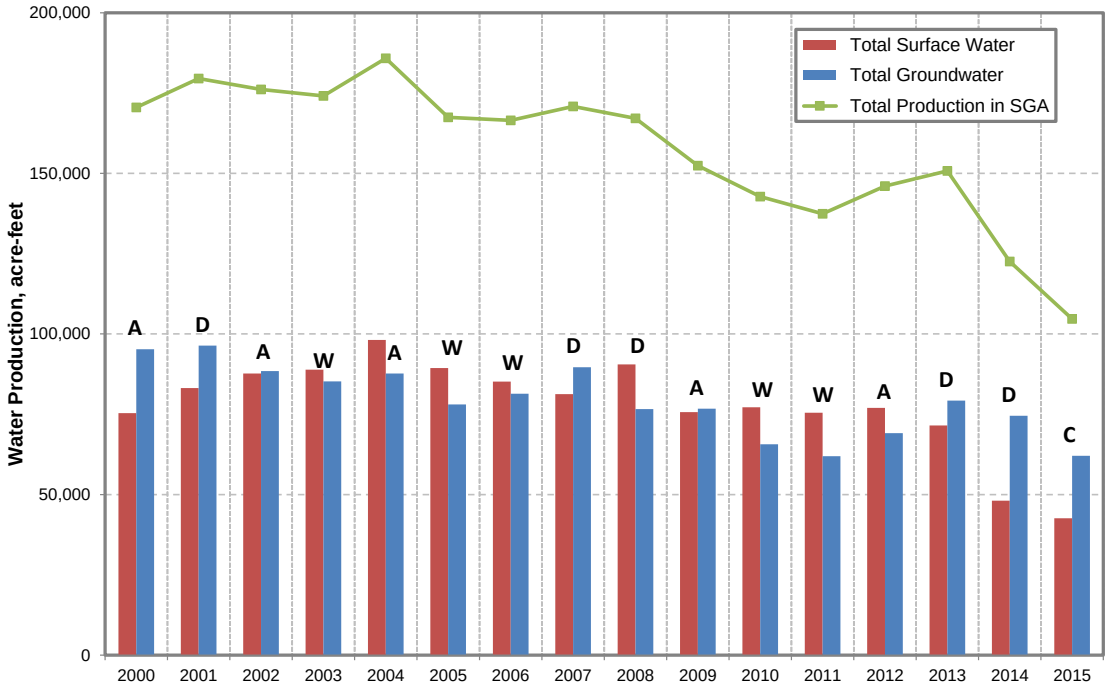

Figure 8. Total M&I Water Production, Surface Water and Groundwater, and Water Year Classification in the North Area Basin 2000-2015

Surface Water Used for Groundwater Recharge

A new requirement for management reports resulting from DWR's completion of GSP Emergency Regulations in 2016 is the inclusion of surface water used or available for use for groundwater recharge. As described previously, the amount of surface water available for recharge is largely related to the water year type as defined in the Water Forum Agreement. Because 2013 through 2015 were among the driest ever recorded years, the amount of surface water that was used for recharge was limited to those volumes taken by Sacramento Suburban Water District. As shown in Table 3 above, those volumes were 409 acre-feet in 2013 and 80 acre-feet in 2015.

Groundwater Elevations

DWR and Sacramento County Water Agency have maintained a network of wells throughout Sacramento County. Water level records for some of the wells date back to the 1950s. Long-term hydrographs from those wells track the groundwater elevation trends during the major period of development of the underlying aquifer system. Additionally, multiple-completion or nested monitoring wells and well clusters have been installed within the basin and can monitor more than one discrete depth at the same overall location. Data from the multiple-completion wells show the vertical gradients that exist between different depth intervals within the aquifer system as well as groundwater elevation trends.

Long-term Hydrographs

Figure 9 shows the locations and hydrographs of selected long-term monitoring wells in the basin and Figure 10 shows the locations and hydrographs of four selected nested monitoring wells. The hydrographs show annual variations in water levels due to the seasonal occurrence of precipitation and pumping, on top of longer periods of water level variation due to water use and climatic conditions. For purposes of further discussion, the North Area Basin is divided into the following three sub-areas as shown in figures 9 and 10.

Western Area

The western portion of the North Area Basin is bounded by the Sacramento River on the west and extends east to approximately the boundary between Natomas Central Mutual Water Company and Rio Linda/Elverta Community Water District (Figure 9). This area is served almost exclusively by surface water. Hydrographs for wells 10N03E35A1 and 10N04E23A1 show that groundwater elevations for 2013 through 2015 were comparable to previous measurements, even though the values were declining somewhat during the recent period of critically dry weather. The groundwater elevations ranged between 3 and 13 feet above MSL at these two wells. The average depth to water was approximately 18 feet below ground at well 10N03E35A1 and 8 feet below ground at well 10N04E23A1. These values are somewhat deeper than the previous 10-year averages (9 and 5 feet below ground, respectively).

Water levels were not measured at well 09N04E27F1 during this reporting period and only sporadically since 2007. Nevertheless, the average depth to water was approximately 21 feet below ground at well 09N04E27F1 between 2003 and 2012.

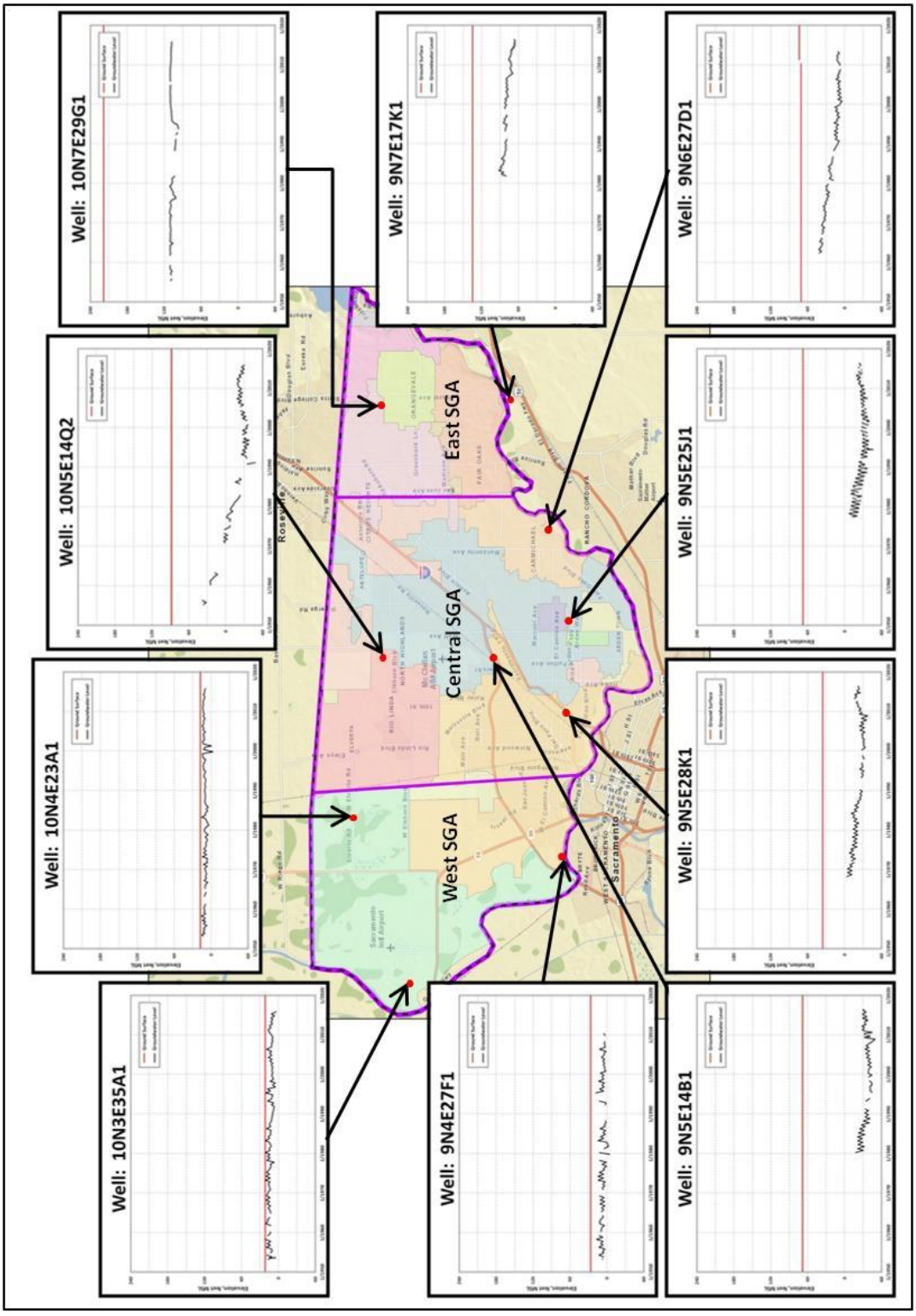

Figure 9. Long-Term Hydrographs for the North Area Basin

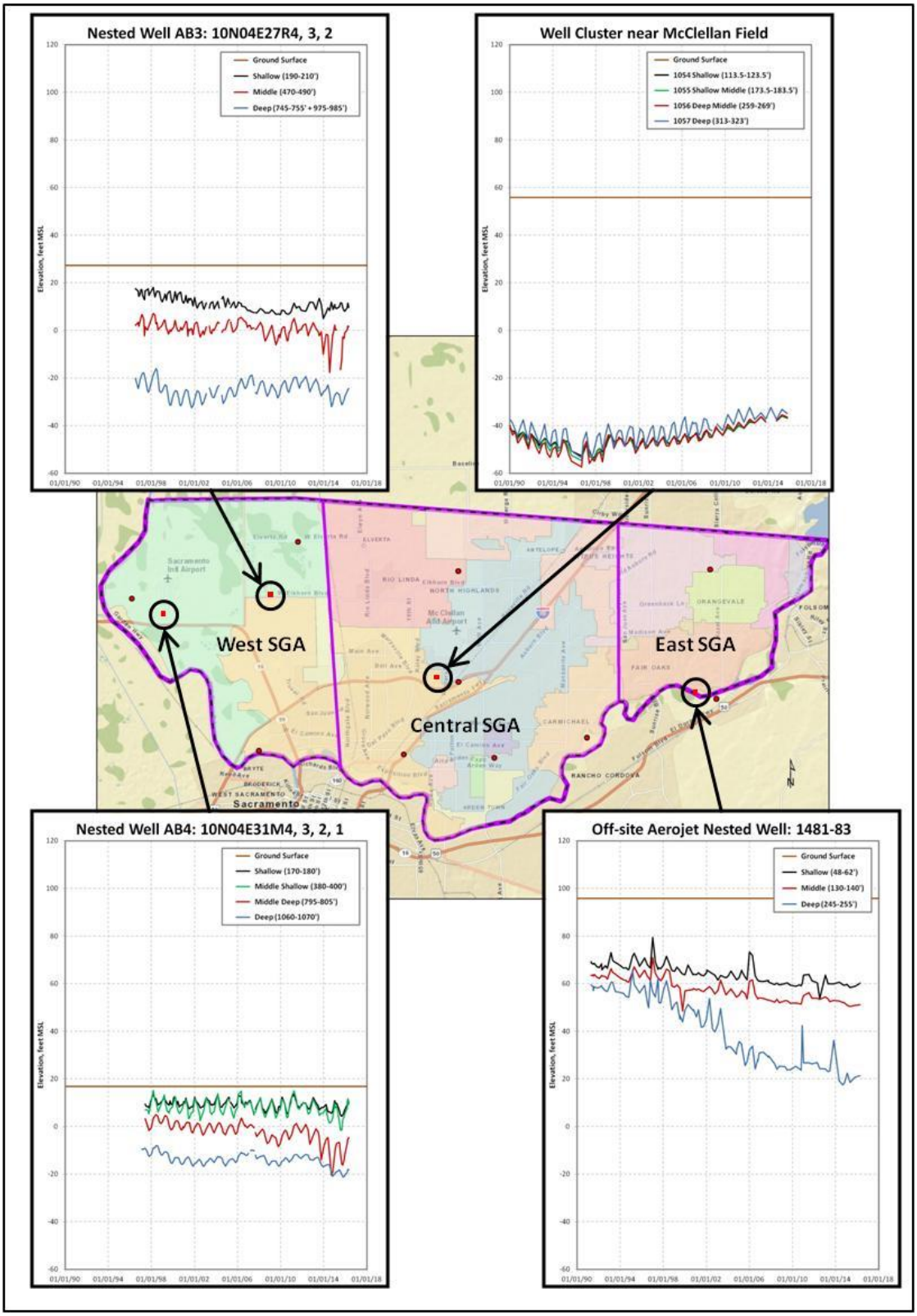

Figure 10. Hydrographs of Multiple-Completion Well Locations in the North Area Basin

Figure 10 shows the locations and water level trends in two multiple-completion monitoring well (AB3 and AB4) that were constructed by DWR in 1996 and 1997. These wells provide groundwater data for three or four depth-specific zones extending to 985 and 1070 feet below ground. Both well locations show a downward vertical flow gradient, from shallow to middle to deep. The water level elevations vary seasonally, but overall, show a somewhat downward trend, based on annual high water level elevations. This trend is likely due to variations in annual precipitation but is also affected by pumping, as shown by the much lower water levels in the middle to deep wells since late 2013.

For well AB4, the annual high water elevations in the shallow and middle shallow wells have been similar since 1998 and have varied over a range of approximately 3 feet, where the shallow water elevations have been higher than the middle shallow elevations and vice versa. For the annual low, the middle shallow elevations have always been less than the shallow elevations, which suggests some utilization of the middle shallow groundwater. The middle deep and deep water level elevations vary in a similar pattern as the overlying groundwater but the annual high levels occurs later by several weeks. For the middle deep zone, the water level elevations have been 9 to 16 feet lower than the middle shallow and the deep zone elevations have been 11 to 15 feet lower than middle deep zone. Since 2012, the annual low water level elevations have declined in the middle deep zone in particular but also in the deep zone to a lesser extent. These lower water levels may be due to the utilization of this groundwater plus less recharge during a prolonged period of below normal precipitation. Overall, the annual high groundwater elevations have decreased since 1998 – by approximately 2.3 feet in the shallow zone, 3.6 feet in the middle shallow zone, 9.6 feet in the middle deep zone, and 10.0 feet in the deep zone.

For AB3, the annual high groundwater elevations have decreased since 1998 – by approximately 6.8 feet in its shallow zone, 5.3 feet in its middle zone, and 8.4 feet in its deep zone. The shallow zone water level elevations have been 6 to 12 feet higher than the middle zone, and the middle water level elevations have been 21 to 30 feet higher than the deep zone. In addition to the typical groundwater highs during winter/spring, the shallow zone exhibited a summer groundwater high elevation during each year, except 2006 through 2010. The summer groundwater highs were comparable to the winter/spring highs, which is likely due to the irrigation of numerous rice fields to the north of AB3. The utilization of middle groundwater is apparent at AB3, as shown by the substantial decrease in water levels elevations since late 2013, similar to the trend at AB4.

Central Area

The central portion of the North Area Basin is bounded roughly on the west by the boundary between Natomas Central Mutual Water Company and Rio Linda/Elverta Community Water District and to the east by a line running approximately along San Juan Avenue (Figure 9). This area currently uses a combination of surface water and groundwater, but historically relied predominantly on groundwater. Hydrographs for 09N05E28K1, 09N05E14B1, 09N05E25J1, and 10N05E14Q2 show that, during 2013 through 2015, groundwater elevations ranged between 16 and 38 feet below MSL. The average elevations varied from 22.6 to 31.2 feet below MSL, which are somewhat lower than average elevations for the previous reporting period at three of four locations. Well 09N05E14Q2 showed the greatest decline while well 09N05E14B1 show a slight rise. Average depths to water at these four wells varied from 56 to 115 feet from 2013 through 2015.

Well 09N06E27D1, located in the southeastern corner of this area near the American River, did not have any water measurements for the last fall soundings (2013-2015) and notes for two of the fall soundings stated the well was dry at 90 feet or -17 feet below MSL. During the spring soundings, the water level elevations decreased from 11 feet above MSL to 3 feet below MSL. Depths to water varied from 62 to 77 feet below ground. Significant drawdown was observed in 10N05E14Q2M, about 85 feet in 36 years, between 1955 and 1991. Similar declining groundwater level trends were seen in other area wells when groundwater level measurements began. Groundwater levels in this area continued to decline until around the mid-1990s, when water levels stabilized due, in substantial part, to expanded conjunctive use operations. Water levels have risen overall since that time, with slight downticks during the 2007 through 2009 dry conditions in the State and during the current reporting period due to the recent, critically dry conditions.

Figure 10 shows the location of a cluster of monitoring wells constructed at different depths during the late 1980s by the Air Force Real Property Agency near the former McClellan Air Force Base and maintained thereafter. This well cluster provides groundwater data for four depth-specific zones extending to 323 feet below ground. The hydrograph of this well cluster is consistent with other longer-term hydrographs – seasonal fluctuations while groundwater elevations decline into the mid-1990s and then a gradual and steady recovery to present time. The deepest well has the highest groundwater elevations, indicating a slight upward gradient, especially for the annual high elevations. The average water level elevations vary from 35 feet below MSL at well 1057 to nearly 37 feet below MSL at wells 1054 and 1055. These water elevations are somewhat deeper (6 to 9 feet) than the lowest elevation on the map (Figure 13) of groundwater contours. This difference could be a characteristic of the basin or could be related to the nearby groundwater remediation effort and the higher resolution of the four 10-foot screen interval versus longer screen wells that are monitored for the basin.

Groundwater production may be occurring from the deep zone because: 1) the average water level difference between the deep and deep middle zones was less during the current reporting period (2013-2015) than during the previous period (2011-2012); and 2) the annual low elevations of the deep zone are similar to the elevations of the shallow and middle wells.

Eastern Area

The eastern portion of the North Area Basin extends roughly east of San Juan Avenue to the American River, which is the eastern edge of the basin (Figure 9). This area has historically relied primarily on surface water. The hydrographs for wells 09N07E17K1 and 10N07E29G1 illustrate the variability of conditions in the eastern area. For well 10N07E29G1, the hydrograph shows that groundwater elevations have not changed greatly with time, reflecting the limited use of groundwater in the area. Groundwater elevations at well 10N07E29G1M have varied only three feet around an average elevation of approximately 109 feet MSL since October 1995. The average depth to water was 110 feet below ground during this recent 20-year period, which is quite similar to the average depth of nearly 111 feet for March 1955 to April 1981. The average depth increased to 119 feet below ground for the less frequent soundings between October 1981 and April 1995, possibly due to the utilization of groundwater during this time period.

For well 09N07E17K1, the depth to water has increased from 42 feet below ground during March 1983 to 68 feet below ground in December 2015. The slope of the

decline was higher between 2011 and 2015, but has flattened during the initial soundings for 2016, due to more typical amounts of precipitation during the wet season of 2015 and 2016. Well 09N07E17K1 is just north of the American River, opposite numerous municipal wells on the south side of the river that serve Rancho Cordova. In addition, Aerojet installed several groundwater extraction and treatment (GET) facilities in this area during the 2000s, including GET K on the south side of the river GET L on the north side.

Figure 10 shows the location and hydrograph for a multiple-completion monitoring well constructed in 1991 by Aerojet north of the American River in connection with its American River GET facility (ARGET). This nested well provides groundwater data for three depth-specific zones extending to 255 feet below ground. The nested well shows a downward gradient, from shallow to middle to deep, and during the first five years (1991-1995) of monitoring, the average water level elevations for the three zones water were different by approximately 5 feet, and varied between 38 and 57 feet above MSL. The average depths to water varied between approximately 27 and 37 feet below ground during 1991.

Aerojet started ARGET operations in late 1997 and the water elevation difference for the second 5-year period increased to 6 feet for the shallow-middle zones and 8 feet for the middle-deep zones. Thereafter, the shallow-middle difference has varied by approximately 7 to 8 feet even though the water elevations continued to decline. Conversely, the middle-deep difference increased to 18, 26, and 29 feet for each successive 5-year period, as the deep water elevations continued to decline. This decline in the deep water elevations is undoubtedly related to the operation of the ARGET facility. The average depth to water in 2015 was 37, 45, and 75 feet below ground for the shallow, middle, and deep zones, respectively, and the average 2015 water elevations were 59, 51, and 21 feet MSL, respectively.

Recent Hydrographs

Since Spring 2012, SGA has maintained a DWR-approved California Statewide Groundwater Elevation Monitoring (CASGEM) Network of more than 40 wells. All of those wells are monitored on a minimum of a semi-annual basis. Since the region recognized the onset of drought conditions in early 2013, a subset of those wells has been monitored more frequently to ensure that undesirable results do not occur in the basin. Figure 11 shows the locations and hydrographs of the monitoring wells that have been subject to increased monitoring.

The red points on each of the hydrographs represents the Spring (or annual high) groundwater level measurement. While declines were observed over the period, the basin is demonstrating itself to be very resilient to the extreme dry climate conditions experienced. Following the recent wet winter in 2016, Spring groundwater elevations are generally observed as being higher than in the same time last year.

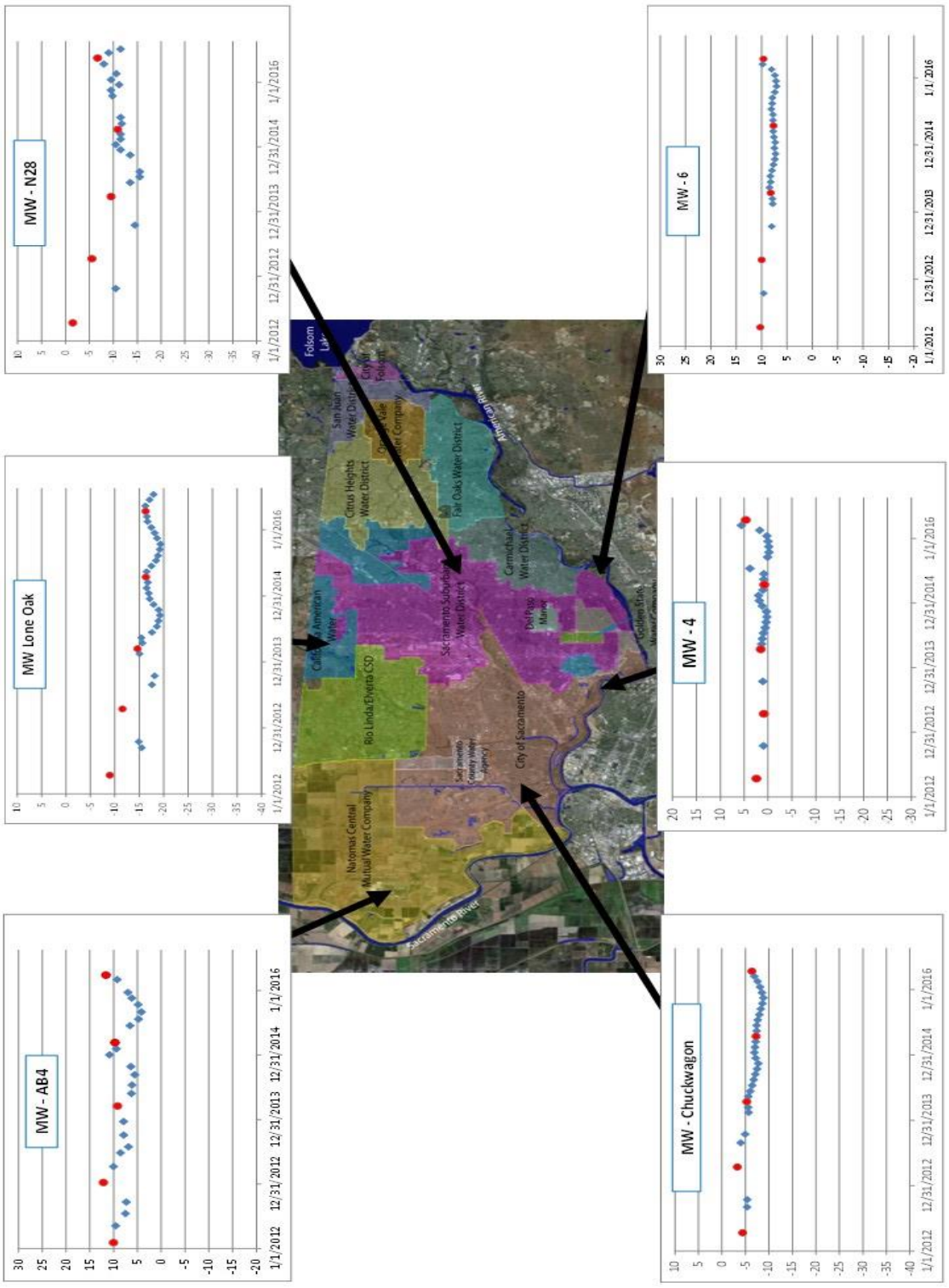

Figure 11. Hydrographs of Wells Monitored More Frequently During Drought Conditions

Regional Groundwater Elevation Contour Maps

Since at least the 1950s, groundwater extraction was concentrated in the central part of the North Area Basin. This extraction resulted in a regionally-extensive cone of depression. Water agencies in the region have worked diligently over more than a decade to finance and construct facilities to bring more surface water into the region when available, allowing groundwater levels to recover from their historical low elevations.

Figure 12 is a contour plot of equal elevations of groundwater in the North Area Basin for Spring 2014. Figure 13 is a contour plot of Spring 2016. Note the continued presence of a cone of depression in the central part of the North Area Basin. The low elevation in the area, located within the -20 foot contour, is approximately 29 feet below mean sea level (MSL). Groundwater flows toward the depression from all locations within the North Area Basin and especially from the recharge area on the east side of the basin. Flow from this area is westward under substantial gradients, as shown by the closely-spaced contour lines. Groundwater flows from the west under lesser gradients, as shown by the wider-spaced contour lines.

Change in Groundwater in Storage

A new requirement for management reports resulting from DWR's completion of GSP Emergency Regulations in 2016 is the inclusion of annual change in storage information. Because SGA has typically prepared groundwater elevation maps on a biennial basis, change in storage in this report represents a two year period. Using the groundwater elevations for 2014 and 2016 at each of the wells shown in the SGA area shown in figures 12 and 13, a change in groundwater in storage was calculated for the two-year period[8]. A raster surface with pixels of 995 feet per side was developed, with an interpolated elevation using a Kriging method in ESRI ArcGIS Spatial Analyst assigned at each pixel. The elevations at each pixel for 2014 and 2016 were then compared to calculate the average change in groundwater elevation over the entire SGA area. The groundwater elevation difference comparing 2014 to 2016 was an average increase of 0.5 feet. Assuming an average specific yield of 7% and a surface area of 124,517 acres results in a positive change of groundwater in storage of 4,358 acre-feet. This positive change in storage is consistent with the observed improvements in Spring 2016 groundwater elevations in the recent hydrographs shown in Figure 11.

[8] Future SGA Basin Management Reports will calculate annual change in storage.

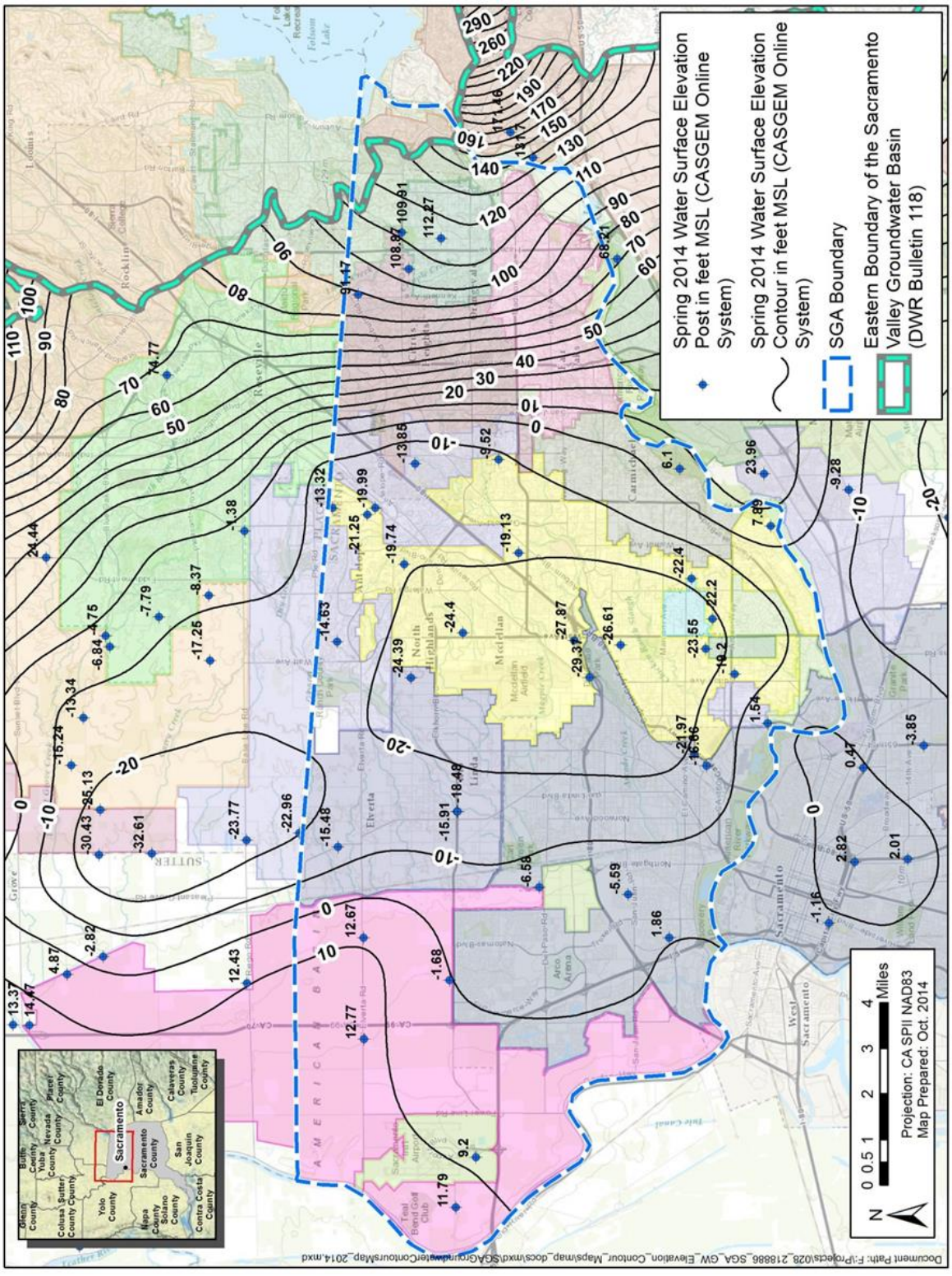

Figure 12. Groundwater Elevations in Spring 2014

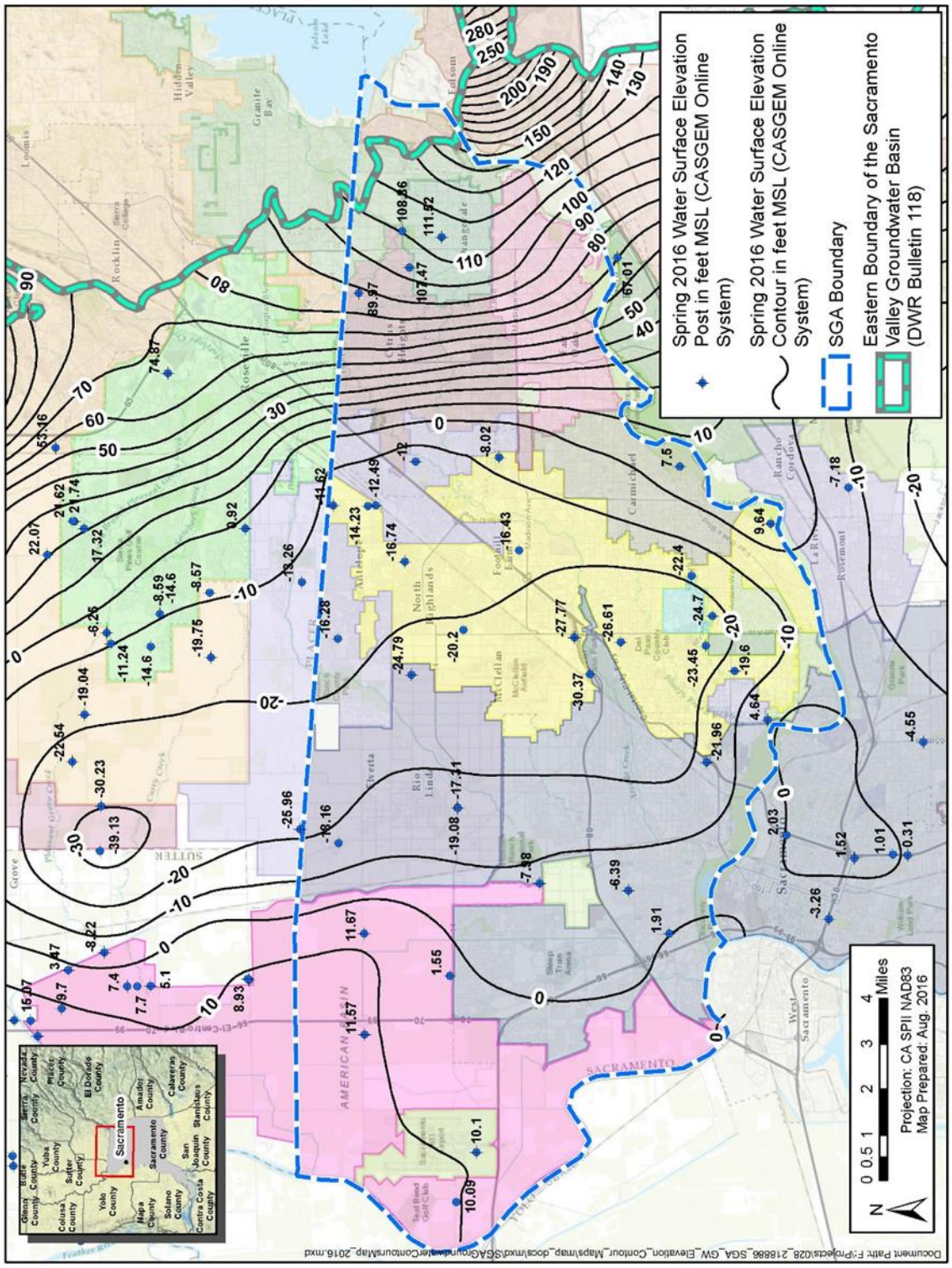

Figure 13. Groundwater Elevations in Spring 2016

Groundwater Quality

Generally, the quality of groundwater in the basin is suitable for nearly all uses, with the exception of documented areas of contamination and localized quality issues discussed later in this section.

Water Quality in Public Supply Wells

There are more than 200 active and standby public supply wells operated by SGA member agencies in the North Area Basin. Additionally, there are 22 independent small water systems relying on groundwater that are monitored by the Sacramento County Environmental Management Department. To evaluate groundwater quality, SGA reviewed water quality data reported by SGA members. While each member agency is responsible for its own compliance with drinking water regulations, SGA utilizes this information to evaluate regional conditions with respect to water quality parameters of interest.

This Basin Management Report describes available data from public supply wells for total dissolved solids, arsenic, nitrate, radon, iron, manganese, hexavalent chromium, and tetrachloroethylene (PCE). Each of the parameters is described further below. Also note that the much of the water quality data summary data described below was assembled and reviewed as part of a Groundwater Quality Vulnerability Assessment completed by SGA in 2011.

Total Dissolved Solids

Total dissolved solids (TDS) is a measure of all dissolved constituents in water, resulting primarily from rocks and sediments with which the water comes in contact. TDS has a secondary maximum contaminant level (MCL) drinking water standard (associated with the aesthetics of the water) of 500 milligrams per liter (mg/L). With respect to TDS, the quality of water in the basin is excellent, with an average TDS of 268 mg/L and only six wells exceeding the secondary MCL of some 255 distinct wells sampled.

Arsenic

Arsenic is a naturally occurring element in the earth's crust. The MCL for arsenic is 10 micrograms per liter (µg/L). Of the 236 distinct arsenic samples from the period, 67 were at or below the analytical detection level of 2 µg/L. Of the remaining wells with values above the detection level, the average was 3.6 µg/L, with one well exceeding the MCL.

Nitrate

Nitrate is a naturally occurring element, but elevated concentrations are often associated with human activities such as wastewater discharge, urban runoff of applied fertilizers, and agricultural activities. The primary MCL for nitrate (as NO3) in drinking water is 45 mg/L. Tests have shown that nitrate levels in public supply wells are generally not of concern in the SGA area. Of 252 samples from public supply wells tested, the average concentration was 11.5 mg/L with a maximum observed concentration of 51 mg/L.

Radon

Radon is a naturally occurring radioactive gas believed to cause lung cancer in humans. Although radon from drinking water sources contributes only a small percentage of overall exposure to radon from all sources, EPA issued a proposed rule for a maximum concentration of 300 picoCuries per liter (pCi/L) in 1999. That rule has yet to be finalized, and there is no updated estimate for its release. Therefore, there is no current standard for radon in drinking water. Relative to the proposed

rule, radon could be a potential future concern for local public water suppliers in the North Area Basin. Of 101 samples from public supply wells collected between 1994 and 2002, the average concentration of radon exceeded 395 pCi/L. Fifty-nine of the wells (58%) exceeded 300 pCi/L, with 16 of the wells exceeding 600 pCi/L.

Iron

Iron is a naturally occurring element in the earth's crust and is found in groundwater as a metallic ion. Iron has a secondary MCL of 300 µg/L because at elevated concentrations, it tends to have a bad taste and can precipitate as a red-brown solid on plumbing fixtures. In general, dissolved iron is not considered a significant problem in SGA-area public supply wells, but it is fairly routinely encountered. Of 196 distinct wells sampled, six wells were below the detection level of 10 µg/L. Of the wells with detections, 56 wells had concentrations exceeding the secondary MCL. Note that these represent the maximum detections observed in a given well, so the well may not routinely sample above these concentrations.

Manganese

Manganese is a naturally occurring element in the earth's crust and is found in groundwater as a metallic ion. Manganese has a secondary MCL of 50 µg/L because at elevated concentrations, it can have a bad taste and can precipitate as a black solid on plumbing fixtures. In general, dissolved manganese is not a significant issue in SGA-area public supply wells, but it is fairly routinely encountered. Of the 183 distinct wells sampled, 55 wells were below the detection level of 10 µg/L. Of the remaining wells, 35 wells had concentrations exceeding the secondary MCL.

Hexavalent Chromium

Hexavalent chromium (CrVI) is a heavy metal that is commonly found in low concentrations in drinking water. It can occur naturally, but has also been sourced historically from industrial operations. A State of California MCL was established at 10 µg/L effective July 1, 2014.

The occurrence of CrVI is widespread in the SGA area. Figure 14 shows the general distribution of CrVI concentrations in public supply wells. Of the 215 distinct wells sampled between 2001 and 2014, 15 were below the detection level of 1 µg/L, 116 wells were between 1 µg/L and 5 µg/L, 65 had concentrations from 5 µg/L up to 10ug/L, and 19 had concentrations greater than 10ug/L. The average concentration of well above the detection level is 5.2 µg/L.

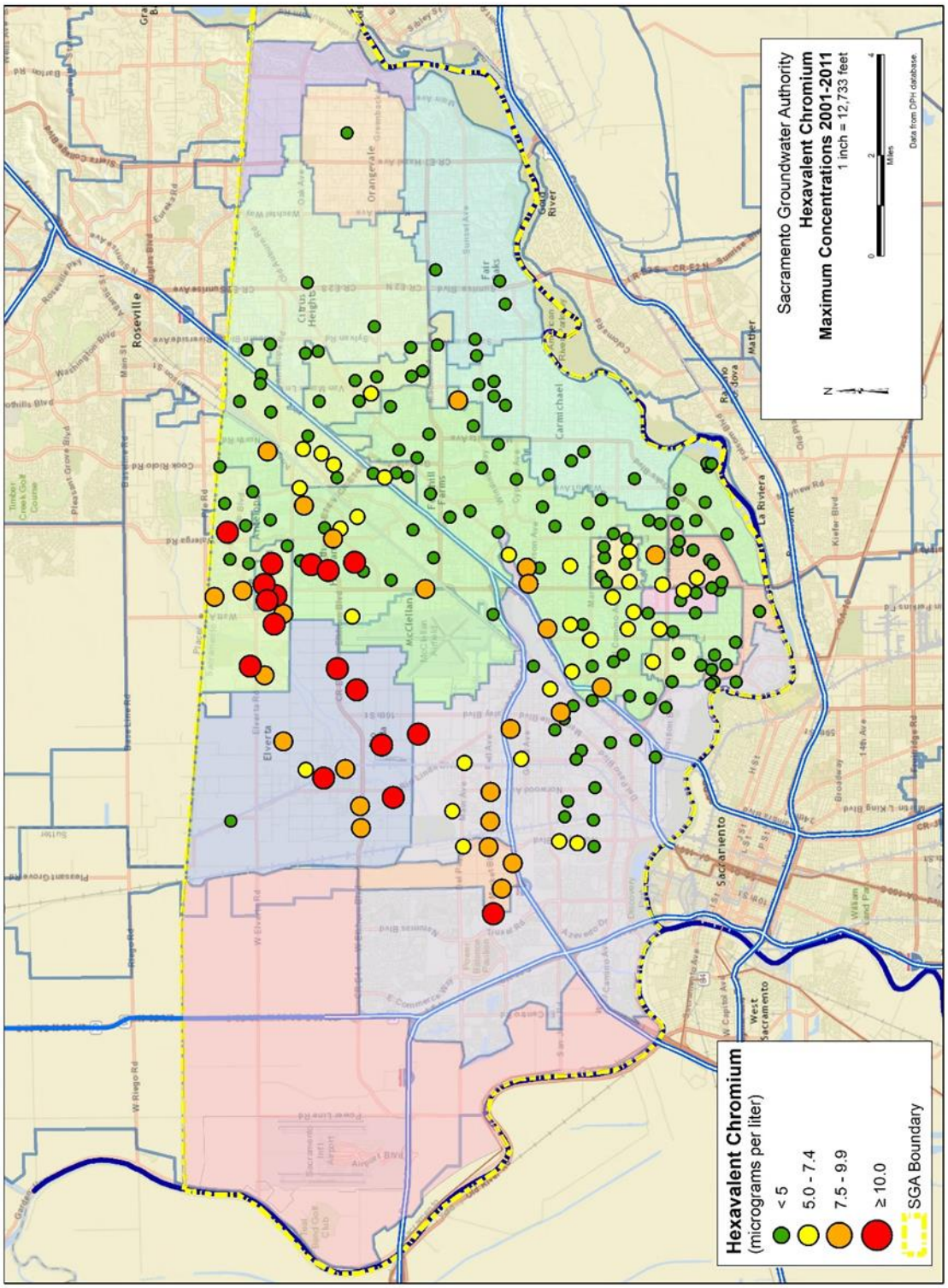

Figure 14. Hexavalent Chromium Concentrations in Public Supply Wells

Tetrachloroethylene

Tetrachloroethylene (PCE) is a volatile organic compound (VOC) used as a component of solvents, hydraulic fluids, paint thinners, and dry cleaning agents. PCE

currently has an MCL of 5 µg/L, but could be lowered in the future. Of 142 wells sampled from the period, 118 wells were below the detection level of 0.5 µg/L. Of the remaining wells with detections, six had concentrations exceeding the MCL. Notably, a number of wells with relatively high concentrations are being detected in the northern part of Sacramento County adjacent to Interstate 80 in the Citrus Heights area. The number of detections is increasing through time downgradient from this area, which is a source of concern to SGA. SGA has been studying this issue with a local groundwater assistance grant from DWR awarded in July 2013. Results of the study are expected in late 2016.

Known Contaminant Plumes in SGA and Vicinity

Groundwater contaminant plumes within or near the North Area Basin are present from source areas at the former McClellan Air Force Base, the former Mather Air Force Base, Aerojet Superfund Site, the Union Pacific Railroad site in Sacramento, and a number of industrial sites in north Sacramento. The extent of these plumes, based on available data through 2008, is shown in Figure 15. The presence of these plumes is an ongoing concern to SGA members as it may impact their ability to fully develop conjunctive use programs to implement the Water Forum Agreement. Further identification and tracking of these plumes and other more localized sources of groundwater contamination will continue to be a major focus of SGA.

Former McClellan Air Force Base

SGA has been focused on the contamination at McClellan for the past decade. Since the Regional Contamination Issues Committee began meeting in 2004, SGA has joined representatives of regulatory agencies and responsible parties as regular participants in those meetings. The Air Force Real Property Agency provides quarterly update reports to SGA on progress of cleanup activities at McClellan.

Through December 2015, the groundwater treatment system has removed an estimated 60,919 pounds of contaminants from groundwater over the life of the project. As of early 2016, the groundwater treatment system processes about 1,400 gallons per minute (gpm) through about 80 extraction wells. The treated water is discharged into Magpie Creek to the west of McClellan. The discharged water routinely meets discharge requirements imposed by the regulatory agencies.

Aerojet Superfund Site North of the American River

SGA has tracked the remediation efforts for the leading-edge contamination from the Aerojet Superfund Site, including the volatile organics beneath Sailor Bar Park and the nitrosodimethylamine in the vicinity of Ancil Hoffman Park. Groundwater is pumped from extraction wells, located in Sailor Bar Park, and conveyed to a treatment facility (ARGET) on the Aerojet Site, south of the river. The treated water is discharge to Buffalo Creek to the American River, pursuant to the requirements of a permit from the National Pollutant Discharge Elimination System (NPDES). An extraction well and treatment facility (GET L-A) are located with Ancil Hoffman Park and the treated groundwater is discharged to the American River under the NPDES permit when the golf course does not utilize the treated water for irrigation. An extraction well and treatment facility (GET L-B) are located at the Carmichael Water District Bajamont Way filtration plant for river water. The Aerojet treated water is discharged to the American River under the NPDES permit. Aerojet completes a capture zone analysis of these facilities each year and, as a result, is currently evaluating locations for additional extraction wells to improve the capture of the GET L facilities and to address a residual presence of NDMA beyond the capture zone of the existing wells. These GET facilities process an average flow of 2,290 gpm during

2015, including 880 gpm from the ARGET wells, and 750 gpm from GET L-A and 660 gpm from GET GET L-B. The average flow in the previous five years varied from approximately 1,700 to 2,200 gpm (median: 1,900 gpm).

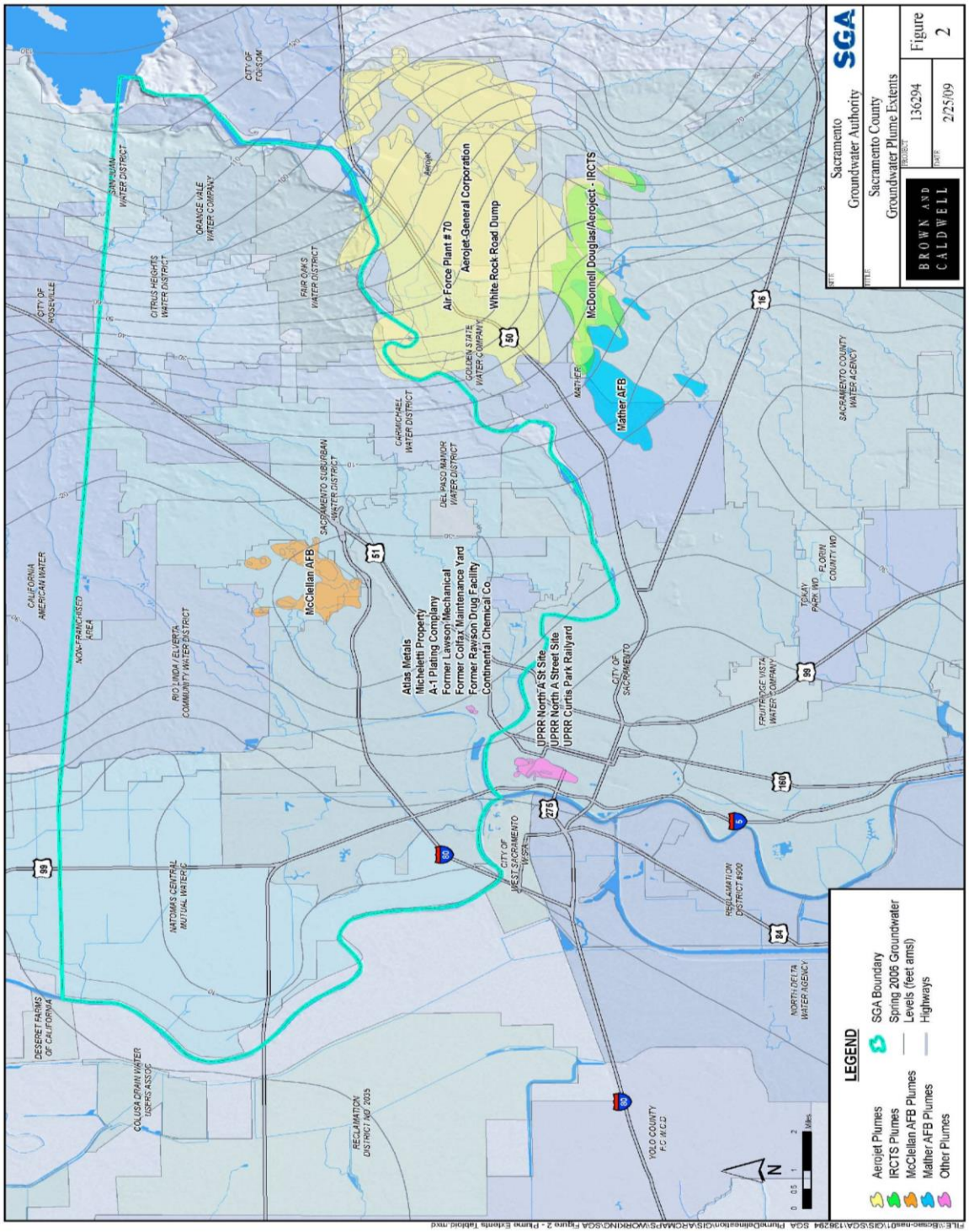

Figure 15. General Locations of Contaminant Plumes in the North Area Basin and Vicinity

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Basin Management Activity Highlights

Key management activities in the basin from 2013 through mid-2016 are described in this section.

Development and Implementation of the SGA GMP

In April 2013, SGA formally began the process to comprehensively update its GMP. The original SGA GMP, adopted in 2003, called for review and update of the GMP every five years. The GMP was updated and re-adopted in December 2008. While the original intent was to adopt an update the GMP by December 2013, it became clear that comprehensive legislative reform for groundwater management was in progress. Therefore, SGA chose to defer its GMP update until 2014 when the legislation was further developed. Ultimately, the Sustainable Groundwater Management Act (SGMA) was signed in September 2014. At that time, the SGA GMP update was nearly complete. SGA subsequently incorporated many of the required management components resulting from SGMA, and the SGA GMP update was adopted in December 2014.

The 2014 GMP update benefited from more than a decade of active SGA GMP implementation, so it resulted in a significantly streamlined set of activities that had proven to be most effective over the past years. Additionally, for the first time, SGA was able to define measurable objectives with quantifiable numeric targets to assess progress in meeting the objectives. As a result of the update, the number of management objectives was reduced from eight in the 2008 version down to four. The number of management actions was reduced from 79 in the 2008 version down to 20 in the 2014 version. By focusing on a smaller group of higher priority objectives and management actions, implementation is streamlined and more effectively tracked.

Table 5 below lists the 2014 GMP activities and the status of each specific identified action. In general SGA has made excellent progress in completing the identified action items. The updated 2014 GMP objectives are identified in the last section of this report, which compares threshold values established for various parameters as a way of determining whether management objectives are being met.

Table 5. Status of SGA 2014 GMP Management Activities

Management Activity	Status
Monitoring	
Groundwater Elevation Monitoring	
1. Continue ongoing semi-annual monitoring of SGA CASGEM network. 2. Conduct more frequent monitoring as conditions warrant (e.g., monthly monitoring in a subset of wells during 2014 drought conditions.	Current. Latest data collected in April 2016. Continuing monitoring as of August 2016.
Groundwater Quality Monitoring	
1. Request results from public supply well water quality monitoring for any MCL exceedance or well with TDS of 450 mg/L or greater from the previous year by March 31 of each year.	Complete through 2016. No new exceedances or TDS of greater than 450 mg/L reported for year.
Land Surface Elevation Monitoring	
1. No current action required unless water level thresholds are exceeded or potential damage to infrastructure from possible subsidence is reported.	Evaluated through 2016. No threshold levels exceeded.
Other Monitoring	
1. Collect additional monitoring data from CDEC on an as-needed basis (e.g., during preparation of BMR).	Current. Collected for 2016 Basin Management Report.
Protocols for the Collection of Groundwater Data	
1. Meet with SSWD staff (an SGA cooperator on the CASGEM monitoring) by March 31, 2015 to ensure they are continuing to follow proper monitoring protocols for groundwater elevation monitoring.	Briefed SSWD staff on March 31, 2015.
Data Management	
1. Upload groundwater elevation data on an ongoing basis to CASGEM by the end of each month in which monitoring occurs. 2. Develop spreadsheet of water quality data submitted by water suppliers for MCL exceedances and TDS of 450 mg/L or greater and update data by May 31 of each year. 3. Update SGA database with monthly groundwater production data and any data on newly constructed wells by May 31 of each year.	Current. Latest data uploaded in April 2016. Table has not been developed. No exceedances have been reported. Production data has been collected in spreadsheets. Entry into a database is being deferred until decisions are made about proceeding with GSP development for basin.
Data Analysis	
Basin Management Objective Indicators	
1. Review total reported extractions from SGA agencies by April 30 of each year. Compare extractions to the total North Basin sustainable yield and the SGA Central Area sustainable groundwater basin extraction balance. 2. Collect water levels from Threshold Wells by April 30 of each year. 3. Analyze results from public supply well water quality data of any MCL exceedance or well with TDS of 450 mg/L or greater from the previous year by April 30 of each year.	Completed for 2016. No threshold values exceeded. Completed for 2016. No threshold values exceeded. Completed for 2016. No threshold values exceeded.
Recurring Basin Management Report	
1. Continue to complete recurring BMR on a biennial basis by June 30 of the year following the period being reported (Note: the next BMR will cover 2013-2014 and will be completed by June 30, 2015).	The report for 2015 was delayed. Current 2016 version covers 2013 through 2015 conditions.
SGA Groundwater Model	
1. No current action is required. SGA will evaluate its modeling needs after guidance and regulations related to the Sustainable Groundwater Management Act are developed.	Action being deferred pending coordination with other GSAs in the basin.
Management Response Options	
Management Response Operational Actions	
1. Track and report on implementation of the SGA WAF to the SGA Board by April 15 of each year. 2. Evaluate the in-lieu conjunctive use potential of the North Basin by December 31, 2016. 3. Review the effectiveness if the WAF toward meeting basin sustainability goals and make any recommended modifications to WAF through the SGA Board by December 31, 2017. 4. Coordinate annually with the RWA WEP to evaluate region's progress toward compliance with meeting 20 percent per capita water demand reductions by 2020. 5. Coordinate through the SGA RCIC to identify and report on potential uses of remediated groundwater within the North Basin.	Current. WAF update through 2015 was provided to SGA Board on April 14, 2016. Ongoing. Evaluation expected by mid-2017. To commence in 2017. Met with RWA WEP in early 2016. Region is meeting interim 2015 per capita reduction target. Ongoing. No current proposals.
Management Response Protective Actions	
1. Work with local water agencies to update status of public supply wells as active, standby, abandoned, or destroyed by May 31 of each year. 2. Provide copies of groundwater recharge area information to appropriate local planning agencies by January 31, 2015. 3. Continue facilitating ongoing recurring quarterly meetings of the SGA RCIC.	Data collected for wells through 2015. Map provided to Sacramento County in January 2015. Ongoing. RCIC meets on quarterly basis.

Other SGA Management Activities

A few key management actions completed by SGA during the period warrant more description. These include the following activities: 1) SGMA implementation and coordination, 2) SGMA participation, 3) tracking implementation of the Water Accounting Framework, and 4) evaluating the presence of PCE contamination.

SGMA Implementation and Coordination

Since passage of SGMA, SGA has been actively engaged in implementing its provisions and coordinating with other potential Groundwater Sustainability Agencies (GSA) within the North American Subbasin of the Sacramento Valley Groundwater Basin. For implementation, SGA adopted an updated GMP in December 2014. Since SGMA was signed into law in September 2014, SGA was able to incorporate most of the groundwater management elements resulting from SGMA into the GMP update. Another significant implementation action was to submit a notice of intent to DWR to become the GSA for its management area in northern Sacramento County. The notice was posted on the DWR on the DWR website on October 27, 2015 for a 90-day comment period. Following the comment period, SGA was designated as the exclusive GSA for its management area in late January 2016.

For coordination, SGA convened a SGMA workshop for representatives in Placer, Sutter, and Sacramento counties on October 30, 2015. SGA intends to coordinate with representatives throughout the North American Basin to ensure effective GSAs are formed covering the entire subbasin by June 30, 2017. Also being discussed is the possibility of preparing a single GSP for the North American Subbasin. The group will continue to meet on a quarterly basis or more frequently as necessary to maintain compliance with various SGMA requirement deadlines.

SGMA Participation

SGA has been an active participant in the SGMA process since legislation was initially proposed. Upon passage of SGMA, the SGA Executive Director was appointed to the DWR Practitioner Advisory Panel, which has provided input on the GSP Emergency Regulations development, the Basin Boundary Modifications process, and the report on surface water available for replenishment. SGA staff has also participated on the Technical Advisory Group for developing a guidance framework for preventing undesirable results in groundwater-dependent ecosystems. SGA will also participate in the development of Best Management Practices under SGMA currently under development by DWR.

Water Accounting Framework Tracking

The Water Accounting Framework (Framework) adopted by the SGA Board establishes policies and procedures to encourage and support conjunctive use operations within the SGA area. The Framework was developed in three phases between 2006 and 2010. All three documents associated with the Framework phases are available at http://www.sgah2o.org/sga/programs/groundwater/.

The first official year of tracking of the Framework was calendar year 2012. Based on data collected in early 2013, nearly all of the agencies subject to the Framework were at or near their annual target pumping goal as shown in Table 6.

Table 6. Cumulative Sustainability Balance through 2015

Agency	Annual Target Pumping Goal (acre-feet)	Sustainability Balance through 2015 (acre-feet)
Carmichael WD	6,646	16,643
City of Sacramento	20,591	30,794
California American	17,995	23,434
Del Paso Manor WD	1,465	492
Golden State WC	1,098	415
Rio Linda/Elverta CWD	2,882	1,061
Sacramento County WA	4,288	-1,821
Sacramento Suburban WD	35,035	14,296

Study of PCE Contamination in Northern Sacramento County

SGA was awarded $224,969 from the California Department of Water Resources' Local Groundwater Assistance Program in 2013. The grant is allowing SGA to analyze potential impacts of tetrachoroethylene (PCE) contamination to the region. The study includes the following objectives:

1) better define the extent of the PCE
2) better define the nature of PCE
3) better define the potential source areas
4) better define where PCE could go in the future

The study will be completed in late 2016.

Evaluation of Basin Management Objectives

SGA has continued to make significant strides toward ensuring a reliable and sustainable groundwater basin for future generations and advancing successful implementation of the Water Forum Agreement. With available monitoring and management tools, SGA has had a solid foundation for managing the basin.

During the revision of its 2014 GMP, SGA updated its Basin Management Objectives (BMOs) and established quantifiable indicators that could be used to evaluate if the objectives are being met. The four adopted objectives are:

1) Maintain groundwater elevations in the SGA area that provide for sustainable use of the groundwater basin.
2) Protect against adverse impacts to surface water or groundwater resulting from interaction between groundwater in the basin and surface water in the American River, the Sacramento River, and other surface water bodies within the SGA area.
3) Maintain groundwater levels to prevent inelastic land surface subsidence that would damage infrastructure or exacerbate flooding.
4) Maintain or improve groundwater quality in the SGA area to ensure sustainable use of the groundwater basin.

SGA Basin Management Objective Indicators

Three key indicators are used to assess if the BMOs are being met. These include groundwater extractions, groundwater elevations, and groundwater quality. Each of these is described below. More detailed descriptions of the development and purposes of these BMOs is available in the 2014 SGA GMP (see Section 3.3), which can be found on-line at www.sgah2o.org.

BMO Indicator 1. Groundwater Extraction

Two distinct values are compared for the purpose of evaluating groundwater extraction. The first value is whether the SGA is at or below the average annual sustainable yield for its area that was determined during the process of developing the Water Forum Agreement. This value was established as 131,000 acre-feet per year. The second value is whether extractions by M&I purveyors in the SGA Central Area (as shown in Figure 8) are at or below 90,000 acre-feet per year. This value was established for the Central Area to ensure relatively stable water levels in order to allow for optimal conditions for groundwater remediation operations at the former McClellan Air Force Base. Table 7 below shows total groundwater extraction in the SGA area and extraction by M&I purveyors in the SGA Central Area for the years 2013 through 2015. In each case, the extractions were well below the indicator values.

Table 7. 2013 through 2015 Total Groundwater Extraction

Year	Estimated Total Groundwater Extraction in SGA Area (acre-feet)	Reported Groundwater Extraction by M&I Purveyors in SGA Central Area (acre-feet)
2013	102,577	77,478
2014	97,487	69,997
2015	85,994	60,266

BMO Indicator 2. Groundwater Elevations

For evaluating groundwater elevations, ten wells were selected from an extensive network as being representative of various parts of the SGA area. At these wells, threshold values were established at elevations that SGA would not want to see groundwater elevations drop below. These values were based on a review of past groundwater elevation data. The primary intent of the wells is to ensure that groundwater elevations will not drop below historic lows. The wells are located to ensure monitoring at boundaries with other groundwater management agencies, near areas of the surface water/groundwater interface, and in areas that could potentially experience subsidence. The locations of these wells, referred to as Threshold Wells, are shown in Figure 16 below.

At each well, the Spring elevation is used for comparison purposes to the threshold value. There is an upper and a lower threshold value at each well. Dropping below an upper threshold would result in additional monitoring and planning in the event water levels should continue to decline. Dropping below the lower threshold would result in implementing actions identified when the upper threshold was exceeded or in implementing mitigation measures to reduce impacts. Based on an evaluation of groundwater levels through Spring 2016, none of the threshold wells are at levels that would trigger any action. Levels in 2016 are typically higher than they were at the same time in 2015. Hydrographs for each of these wells and their associated threshold values are included in Appendix A of this report.

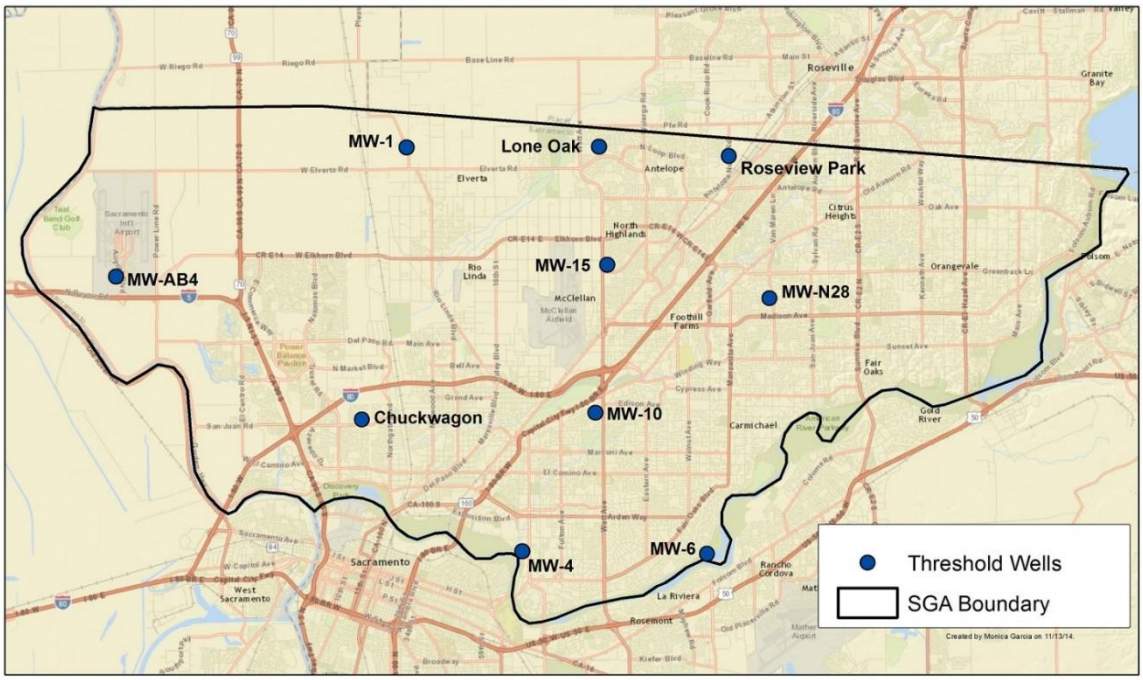

Figure 16. Locations of Threshold Wells Used to Evaluate SGA Management Objectives

BMO Indicator 3. Groundwater Quality

For evaluating groundwater quality, newly detected MCL exceedances and TDS trends are used as indicators. Each year, purveyors report to SGA on any recent detections for any constituent above an MCL and on wells with a TDS concentration of 450 mg/L or higher. During the reporting period, no new MCL exceedances were

reported by the M&I purveyors[9]. Additionally, no new well water quality data during the period indicated TDS concentrations above 450 mg/L.

SGA Basin Management Objectives Evaluation

Based an evaluation of the BMO indicators described above, an evaluation of whether each of the BMOs are being met is discussed below.

BMO 1. Maintain groundwater elevations in the SGA area that provide for sustainable use of the groundwater basin

This objective is being met. As described above, groundwater long-term groundwater elevations have been relatively stable and all well level indicator wells are all above established thresholds. In most cases, water levels in monitoring wells in Spring 2016 are higher than they were in Spring 2015. This despite one of the driest hydrologic periods on record. Finally, since all groundwater extraction volumes are below established values, it can be reasonable concluded that groundwater elevations will remain at sustainable levels.

BMO 2. Protect against adverse impacts to surface water or groundwater resulting from interaction between groundwater in the basin and surface water in the American River, the Sacramento River, and other surface water bodies within the SGA area

This objective is being met. The most significant indicator of this is wells within the vicinity of the American River (MW-4 and MW-6). These wells showed limited drawdown during the recent dry conditions, indicating that there was limited variability in the established gradient between the groundwater basin and the American River. Additionally, groundwater extraction volumes were within volumes that were established, in part, to ensure protection of the lower American River during development of the Water Forum Agreement.

BMO 3. Maintain groundwater levels to prevent inelastic land surface subsidence that would damage infrastructure or exacerbate flooding

This objective is being met. The upper and lower threshold values at monitoring wells (see Appendix A and Figure 16) were established following a review of historic low groundwater elevations in the basin. Assuming that groundwater levels remain above these levels, and that drawdown in any given area does not occur too rapidly, we would expect to not observe subsidence related to groundwater use. Additionally, there were no reported occurrences of damage infrastructure from water purveyors.

BMO 4. Maintain or improve groundwater quality in the SGA area to ensure sustainable use of the groundwater basin

This objective is largely being met. With the noted exception of regional contamination plumes, groundwater quality is very good in the basin and suitable for public water supply needs. SGA has taken a proactive approach to improving the basin's groundwater quality through its Regional Contamination Issues Committee. The committee meets regularly with regulatory agencies and responsible parties to ensure that the basin's importance as a public water supply is considered in developing clean-up strategies. Actions by this committee have helped ensure that clean-up efforts remain on track at McClellan and that effective clean-up strategies

[9] It should be noted that the MCL for hexavalent chromium in July 2014 resulted in a number of wells exceeding the MCL as described in the previous section of this report. However, these concentrations were already known prior to the MCL effective date.

are aggressively pursued for recently detected contaminants associated with Aerojet. Through this committee, the issue of PCE contamination was raised that led SGA to apply for local groundwater assistance grant funding to help assess the problem as described in the Basin Management Activity Highlights section of this report.

Appendix A: Groundwater Elevations at Threshold Wells

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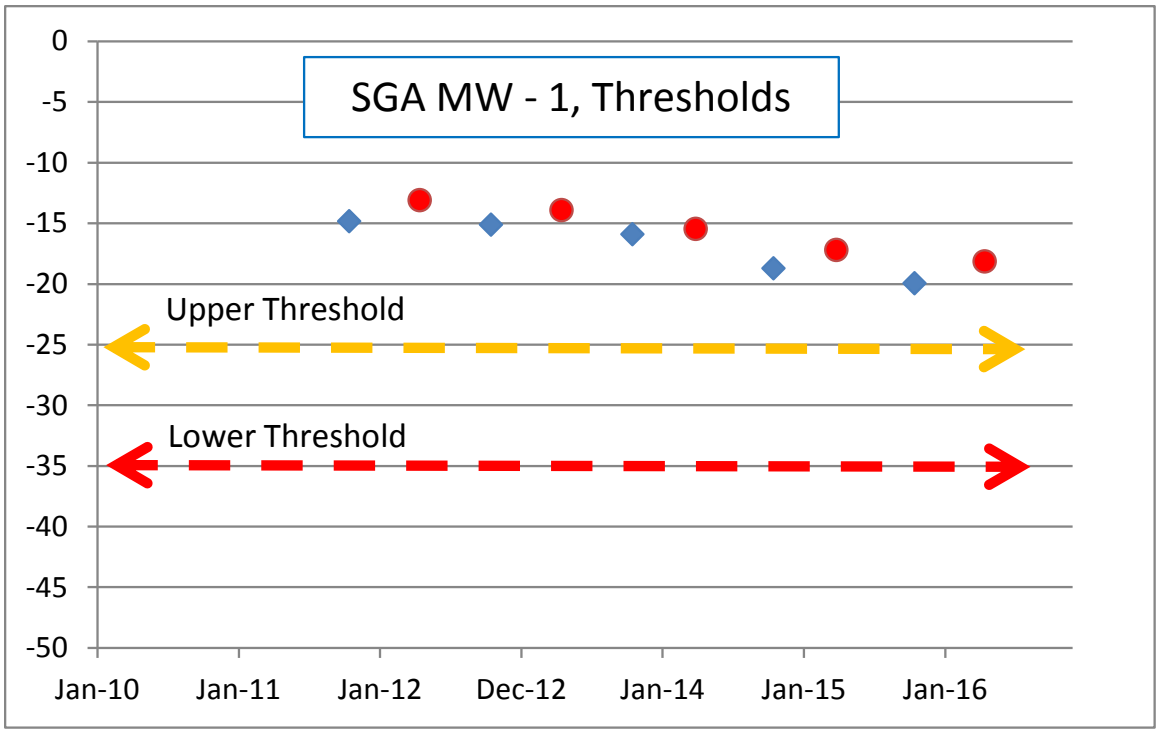
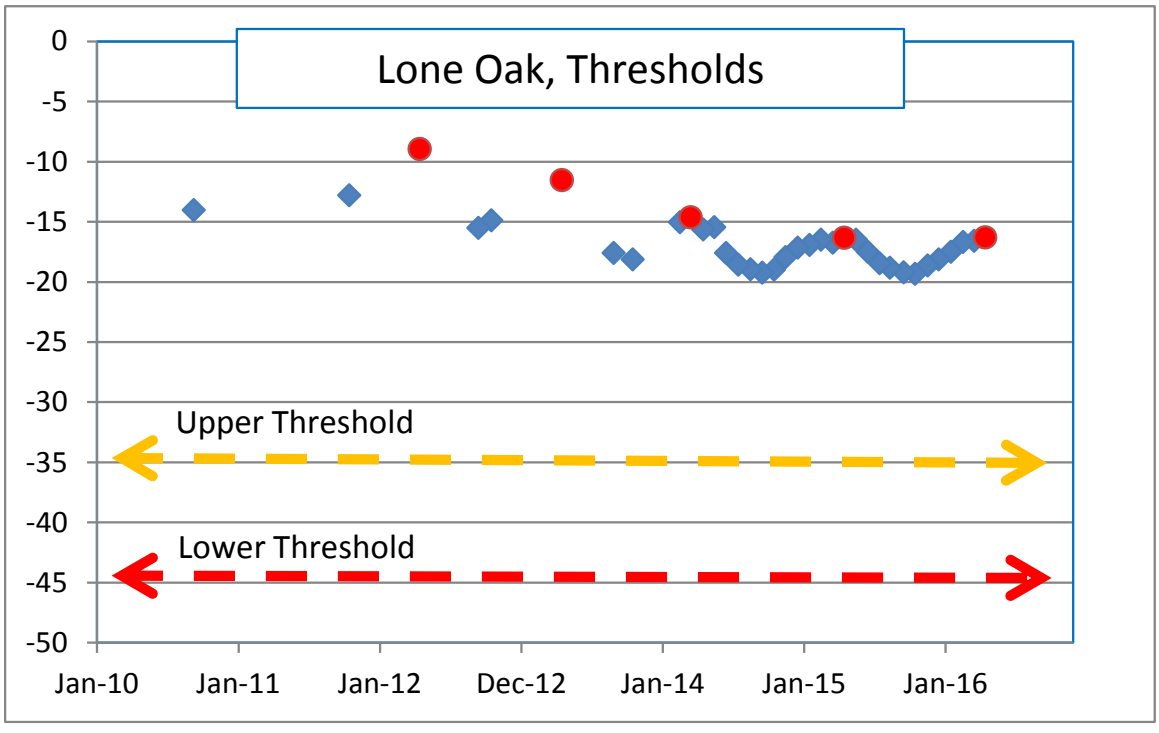
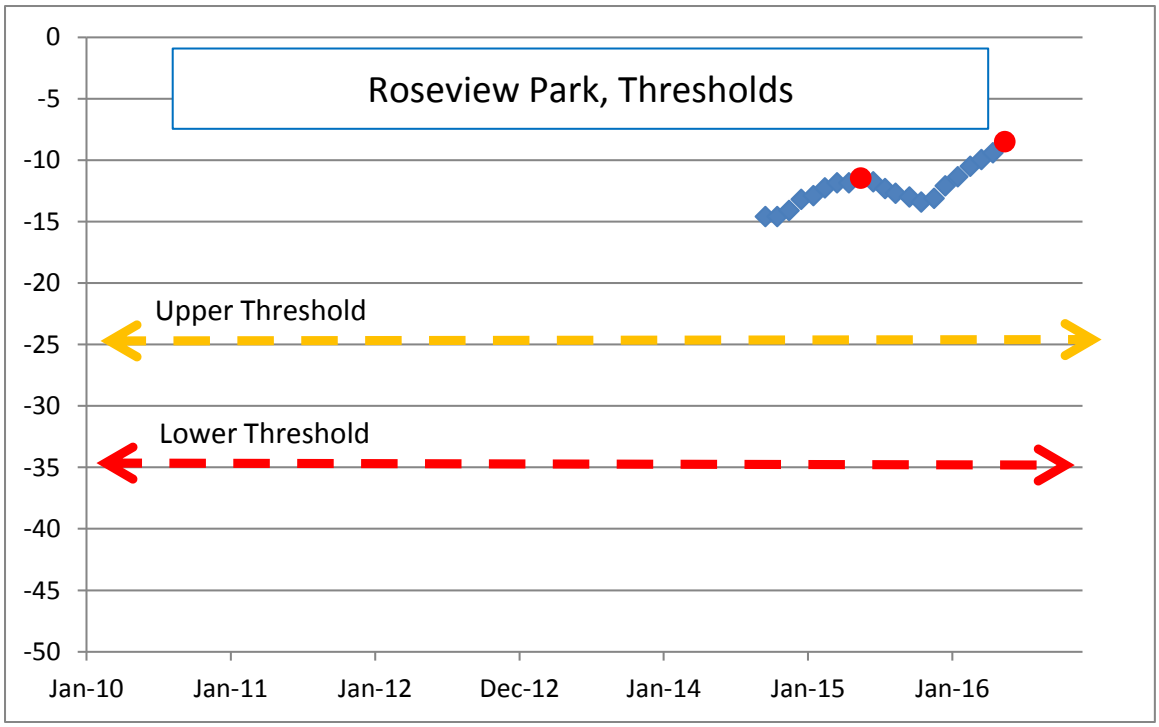
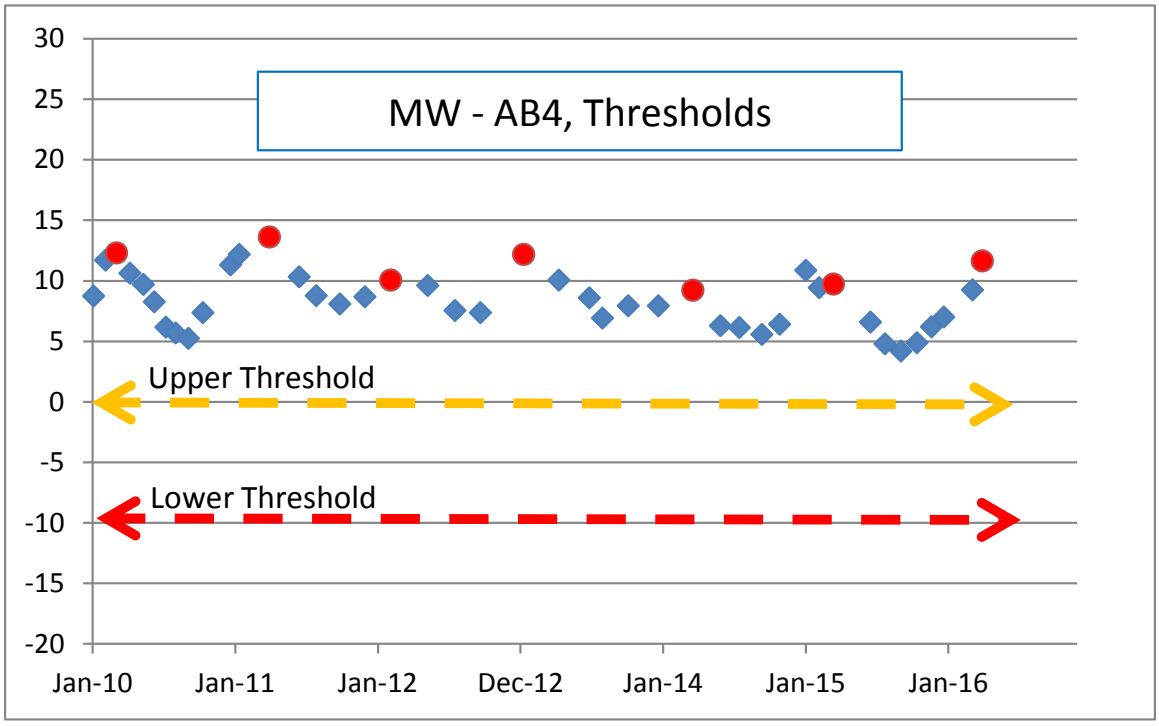
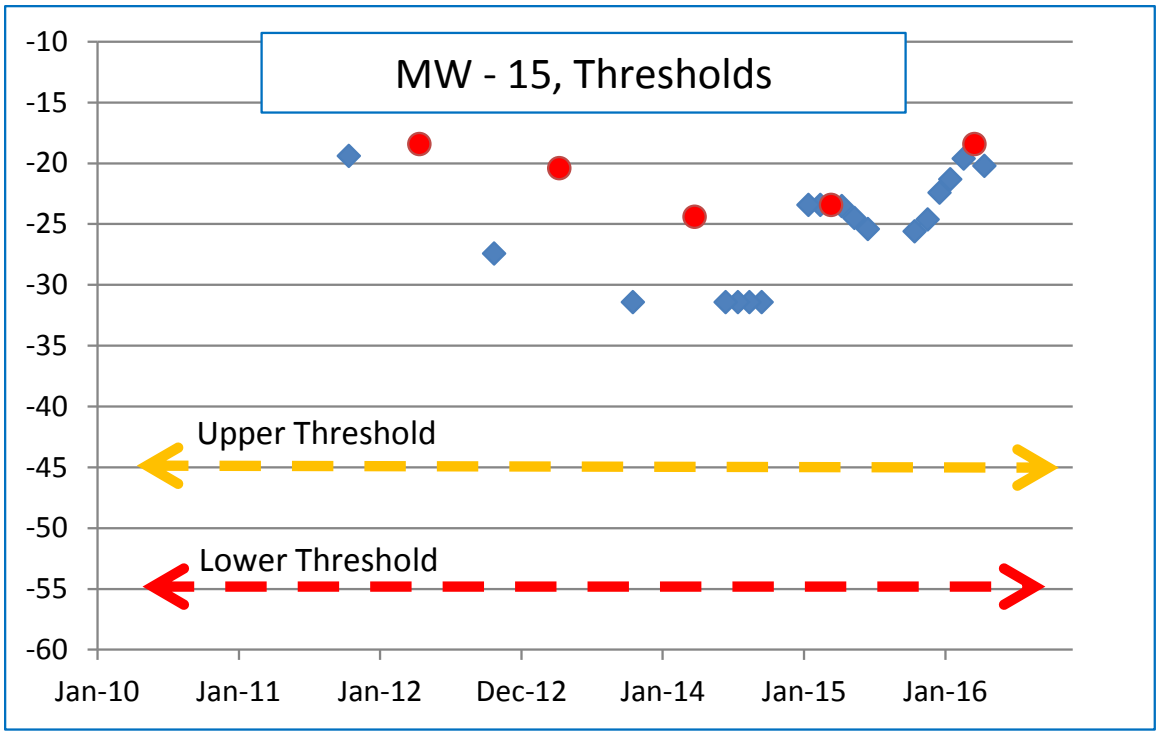
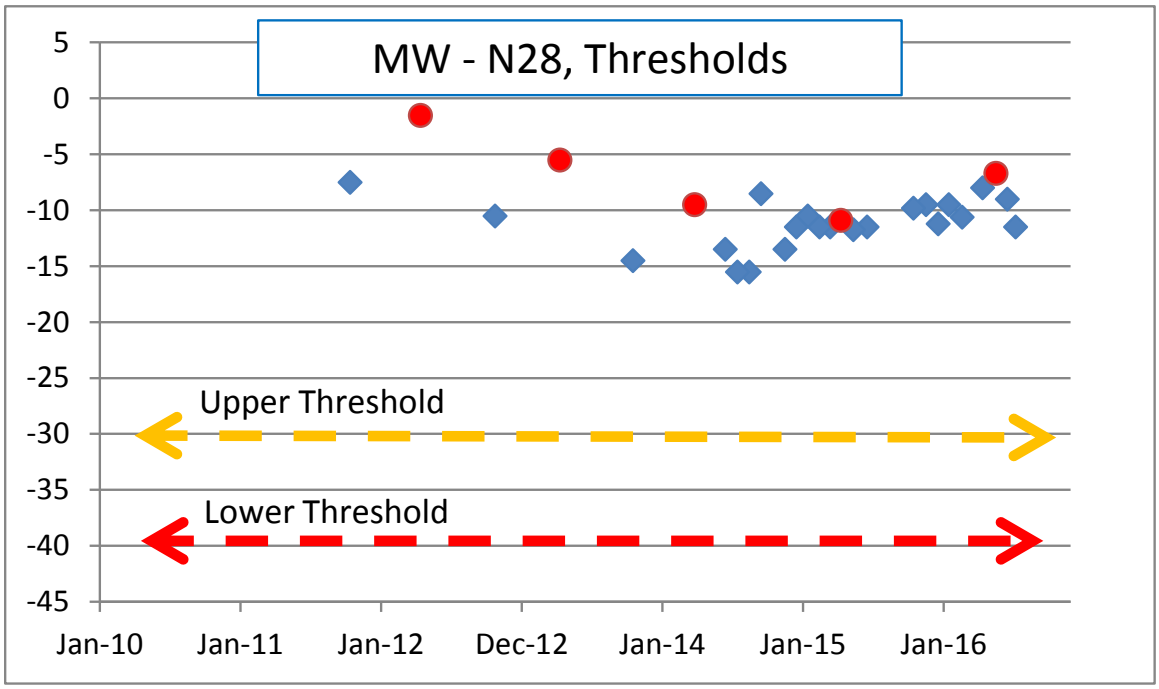

SGA MW - 1, Thresholds
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16

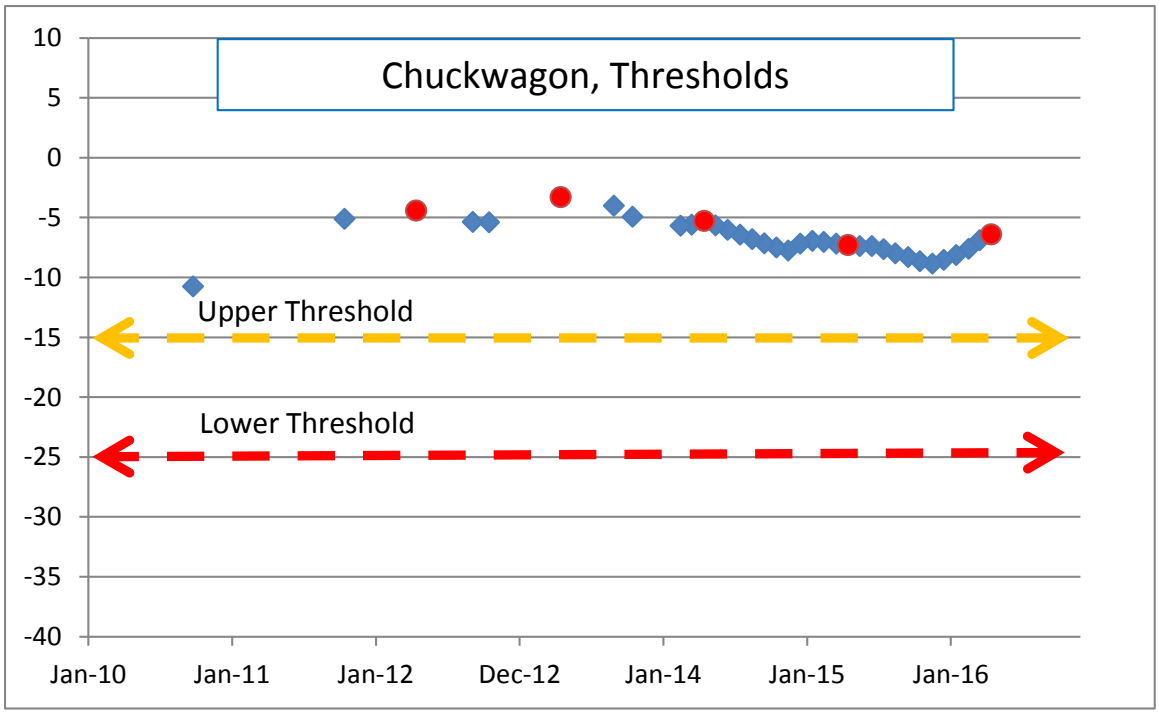

Lone Oak, Thresholds
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16

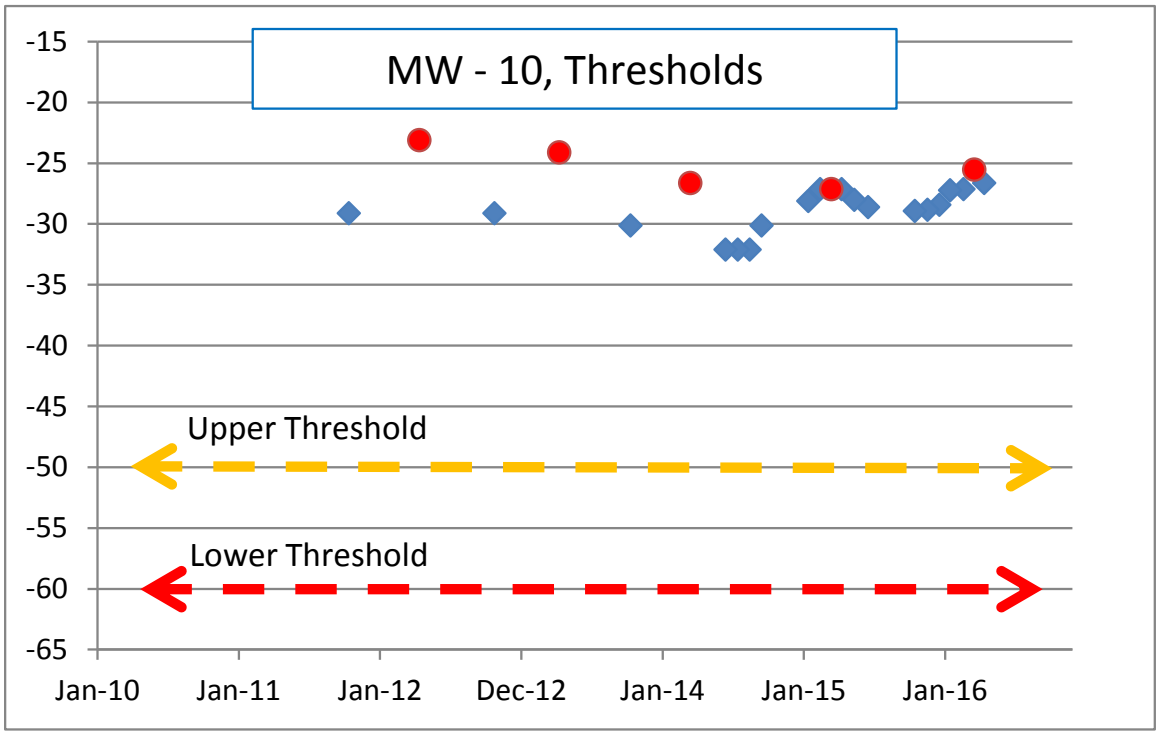

Roseview Park, Thresholds
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16

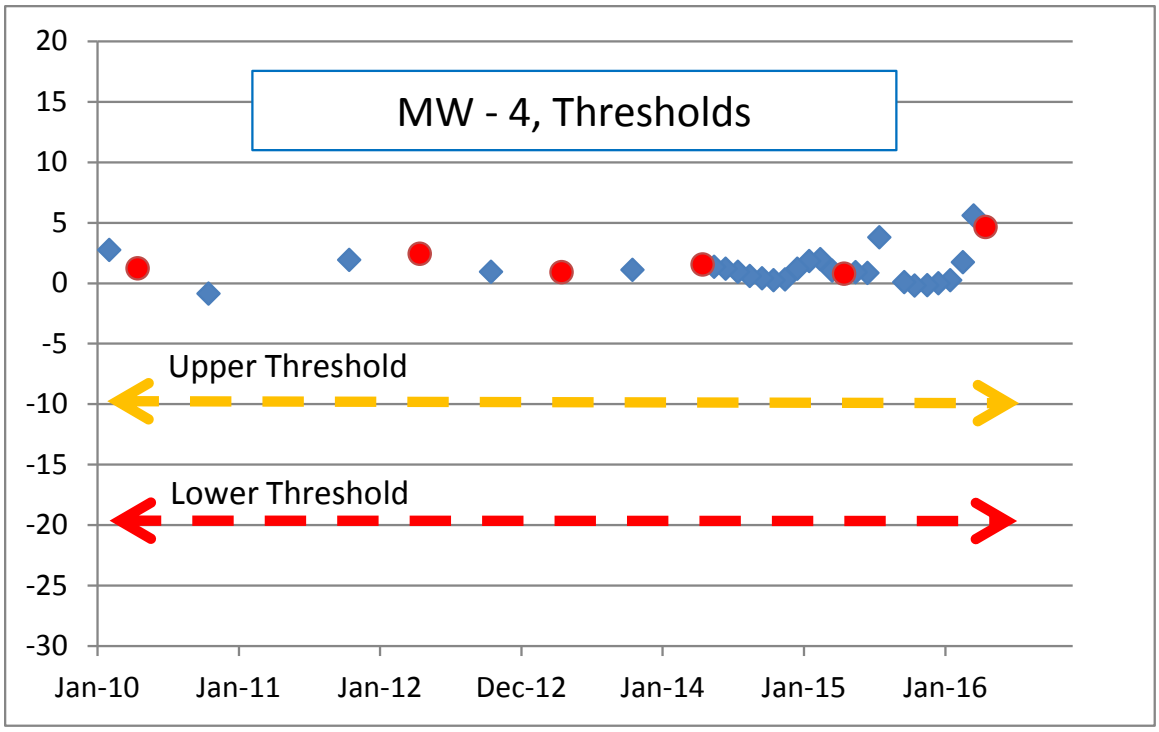

MW - AB4, Thresholds
30
25
20
15
10
5
0
-5
-10
-15
-20
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16

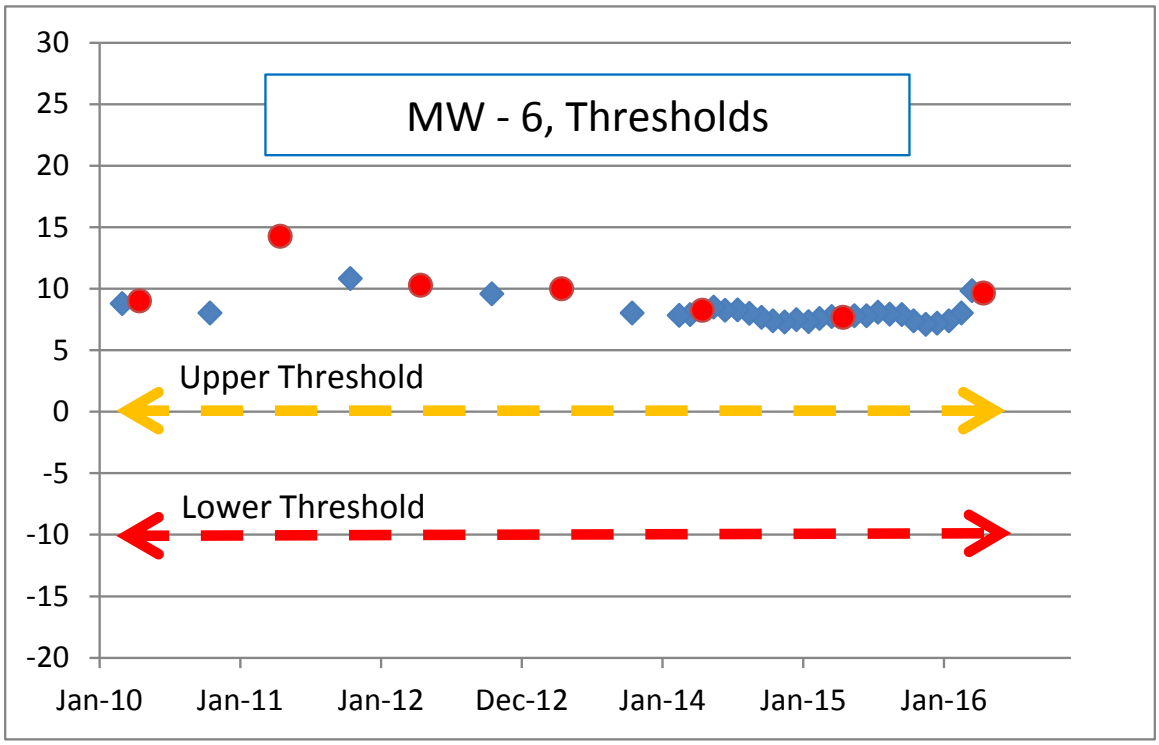

MW - 15, Thresholds
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16


MW - N28, Thresholds
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16


Chuckwagon, Thresholds
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16


MW - 10, Thresholds
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16


MW - 4, Thresholds
20
15
10
5
0
-5
-10
-15
-20
-25
-30
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16


MW - 6, Thresholds
30
25
20
15
10
5
0
-5
-10
-15
-20
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16

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SGA