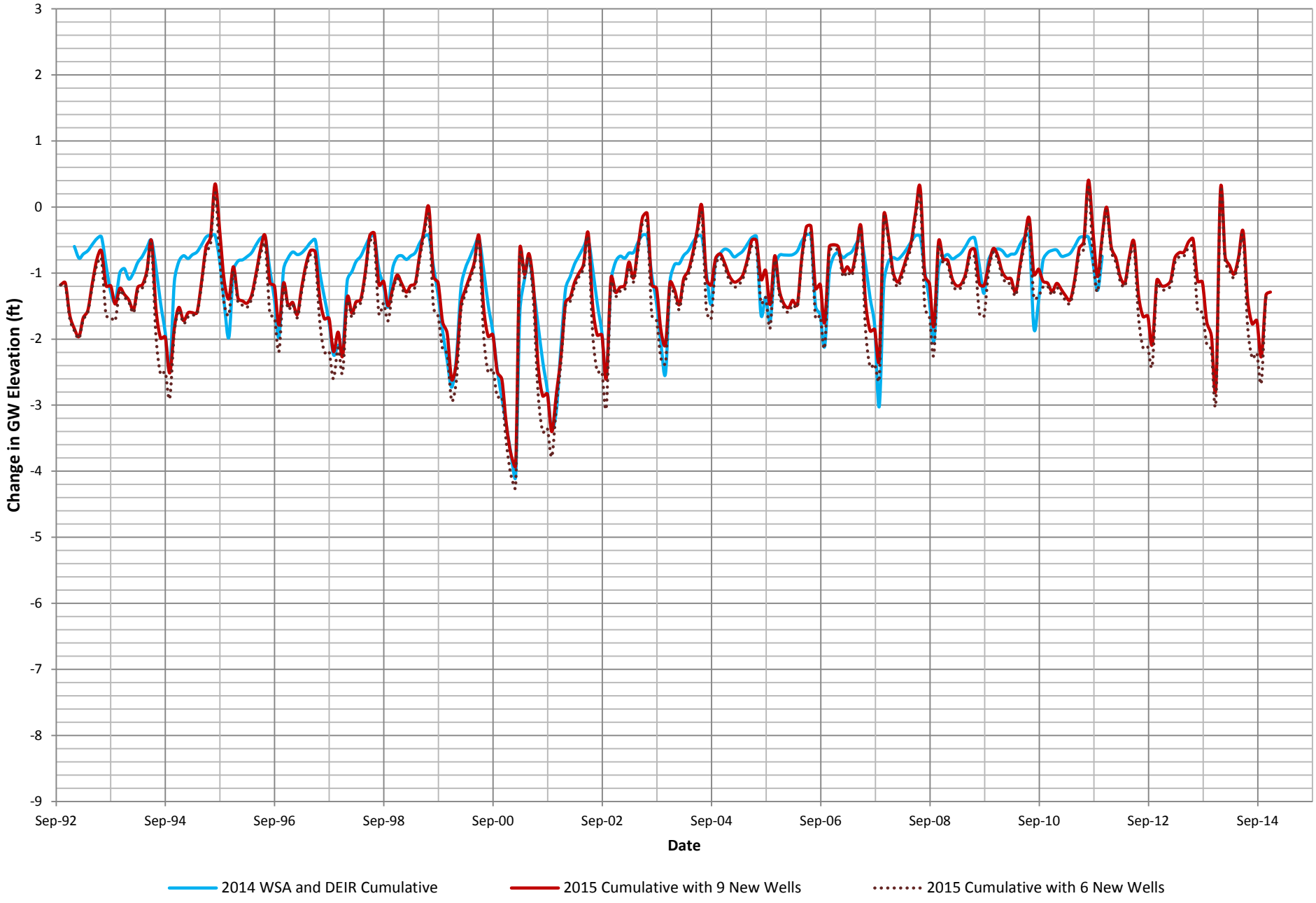
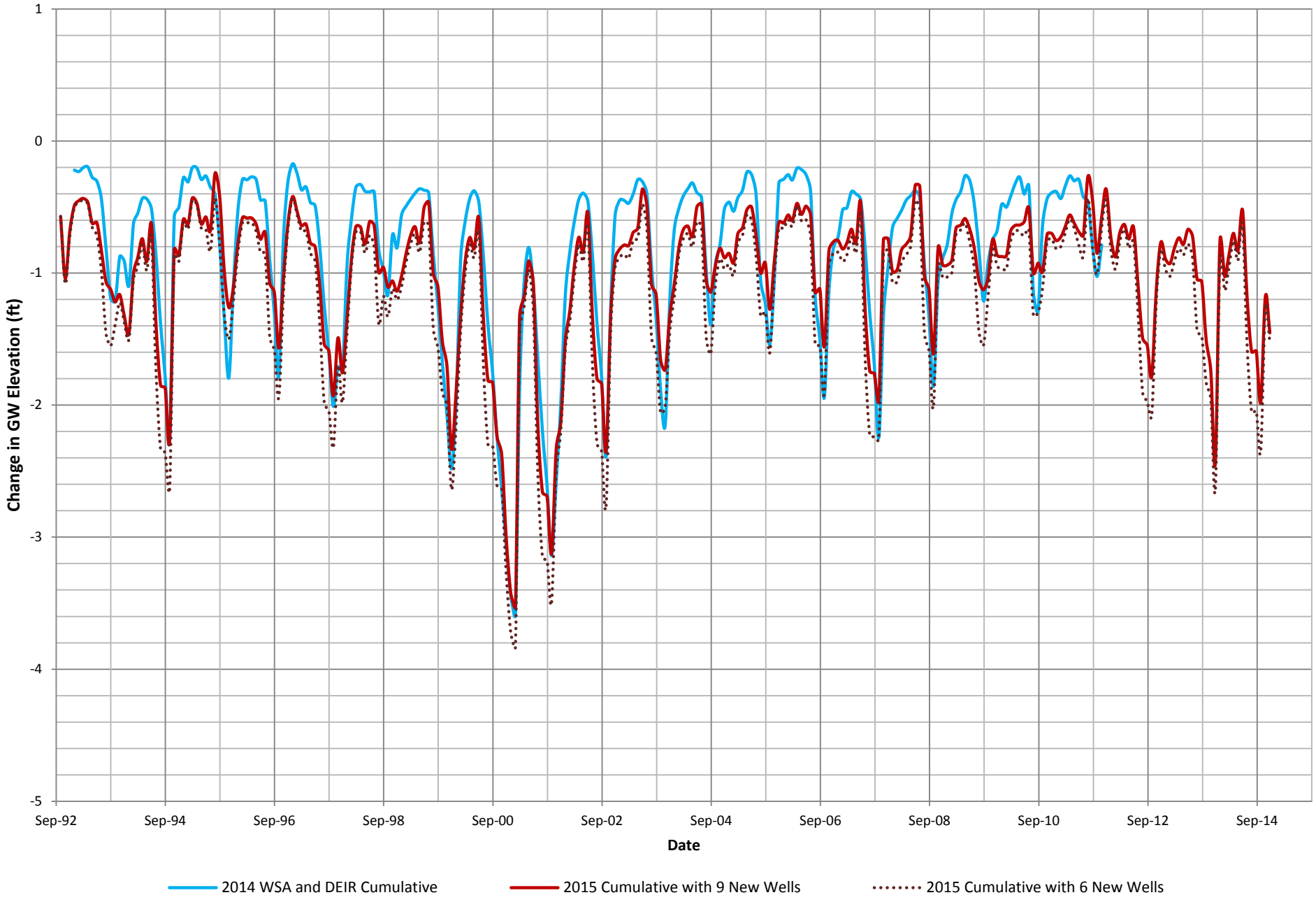
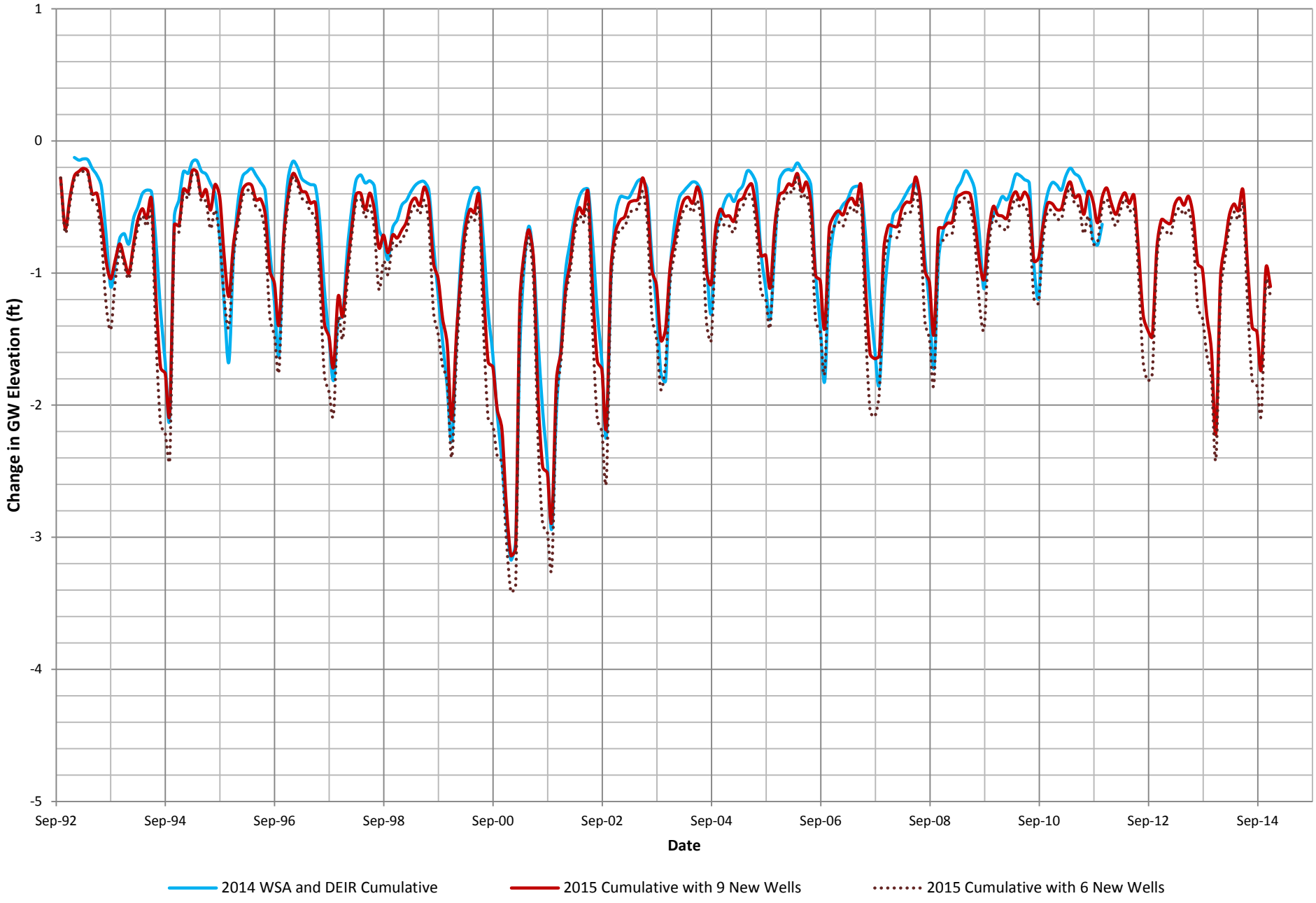
West Cell J Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



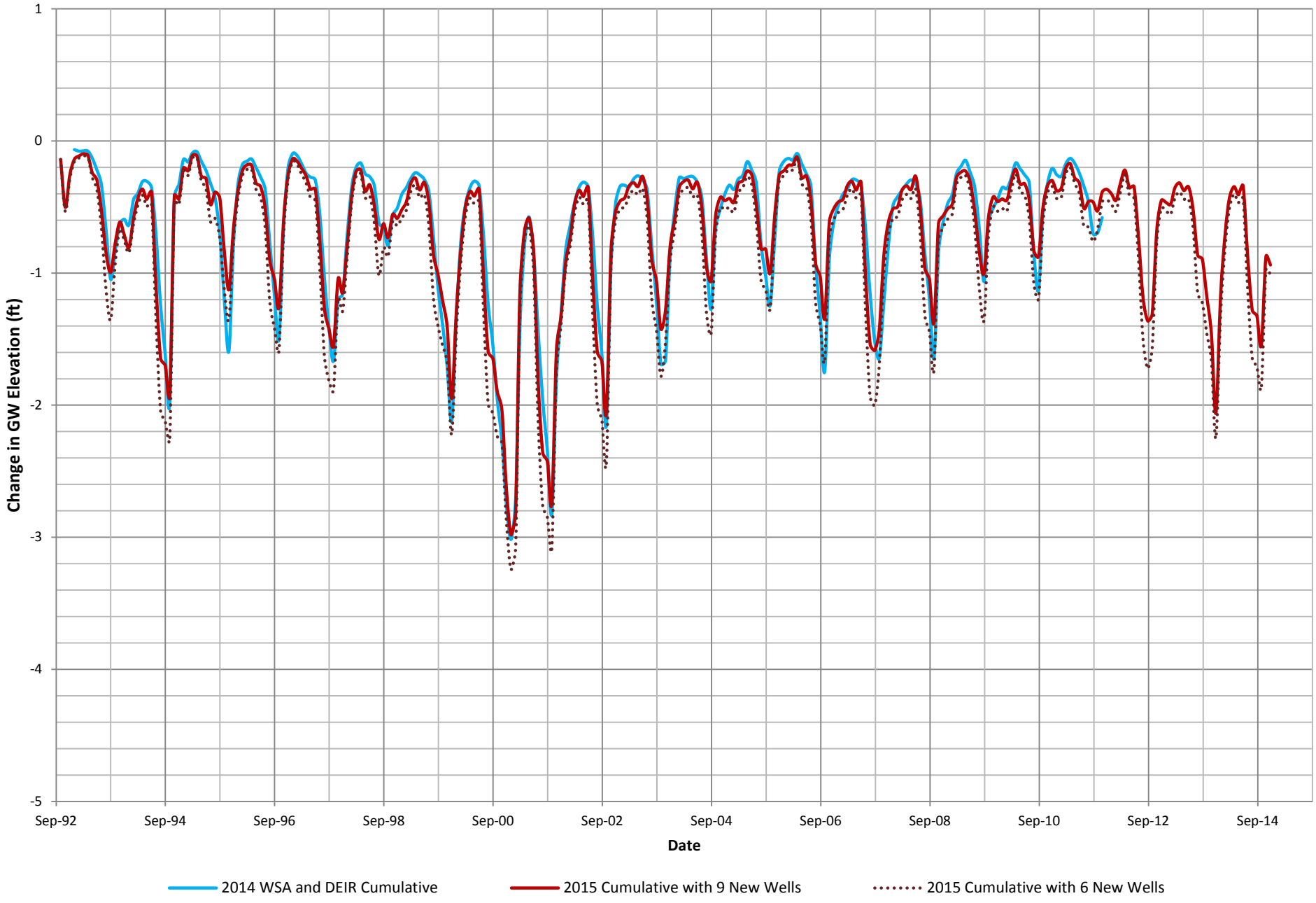
East Cell A Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



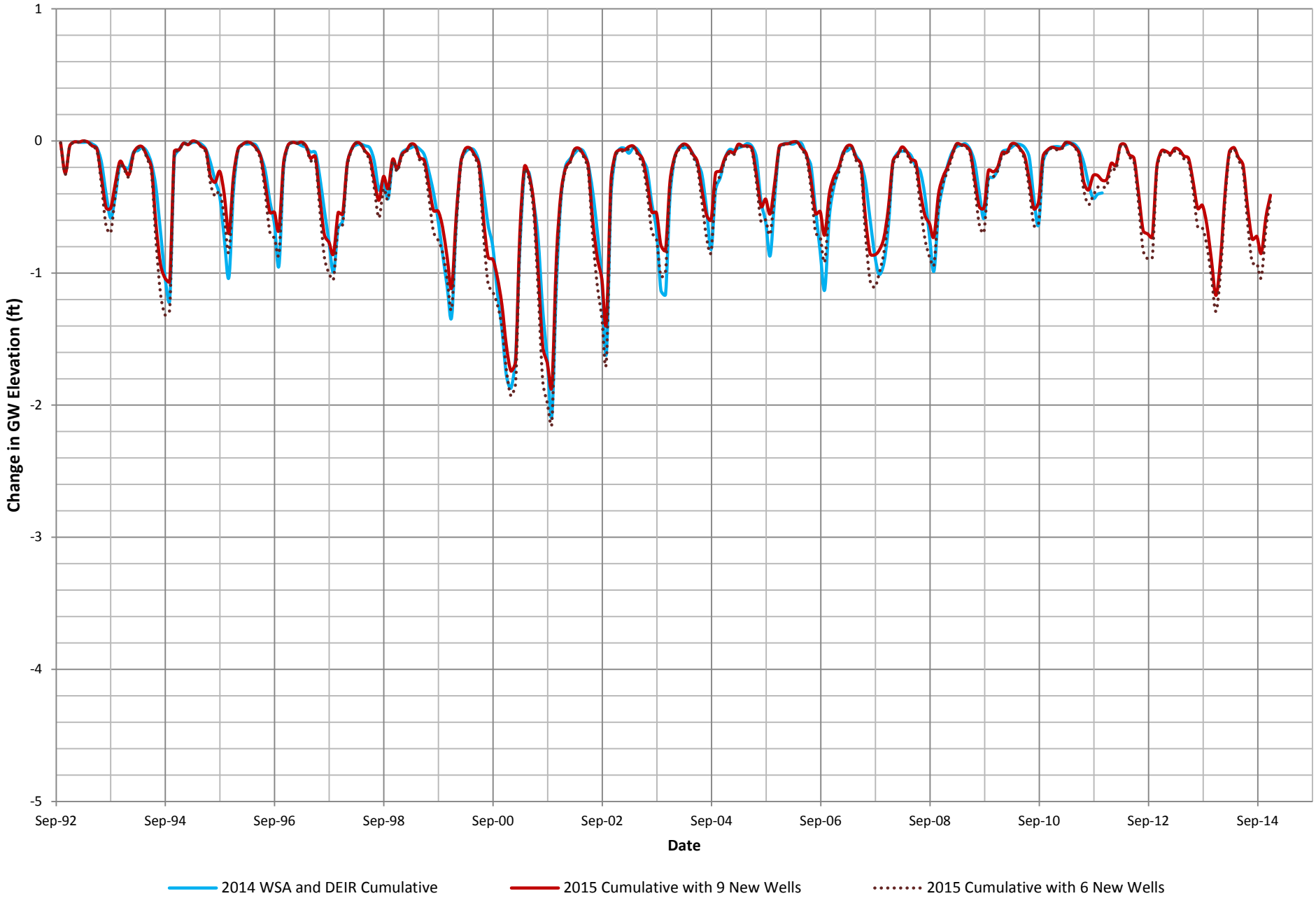
East Cell B Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



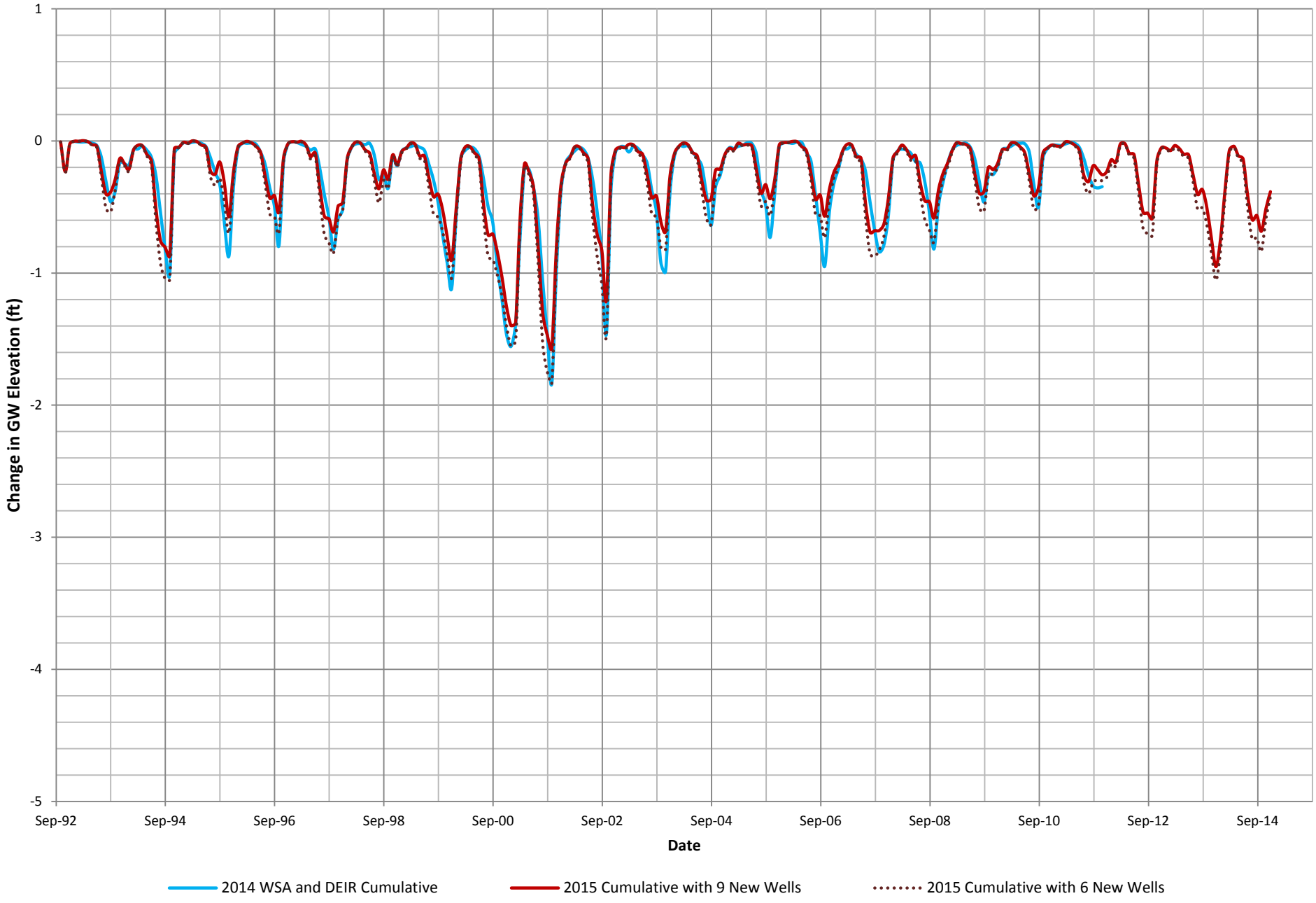
East Cell C Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



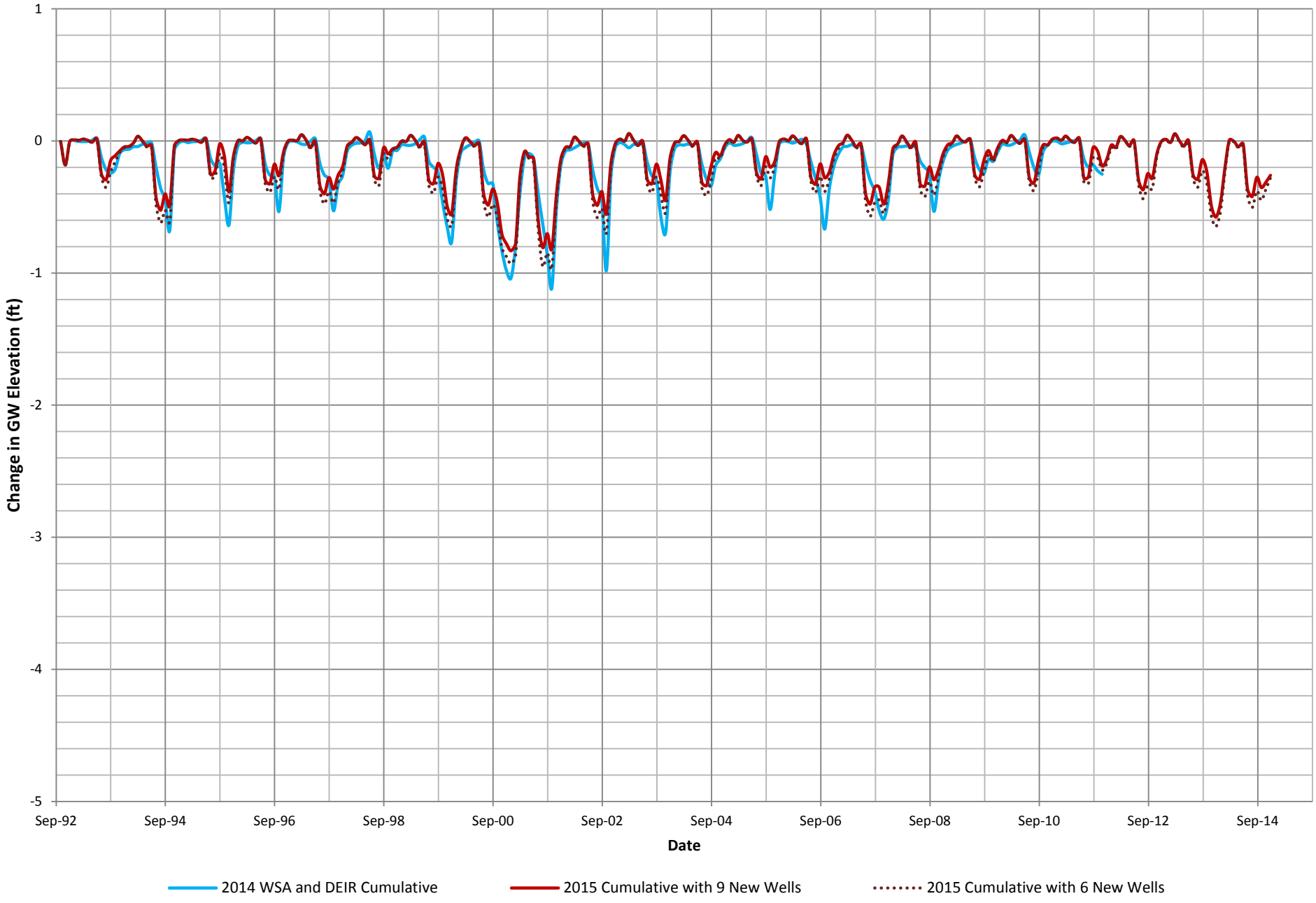
East Cell D Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



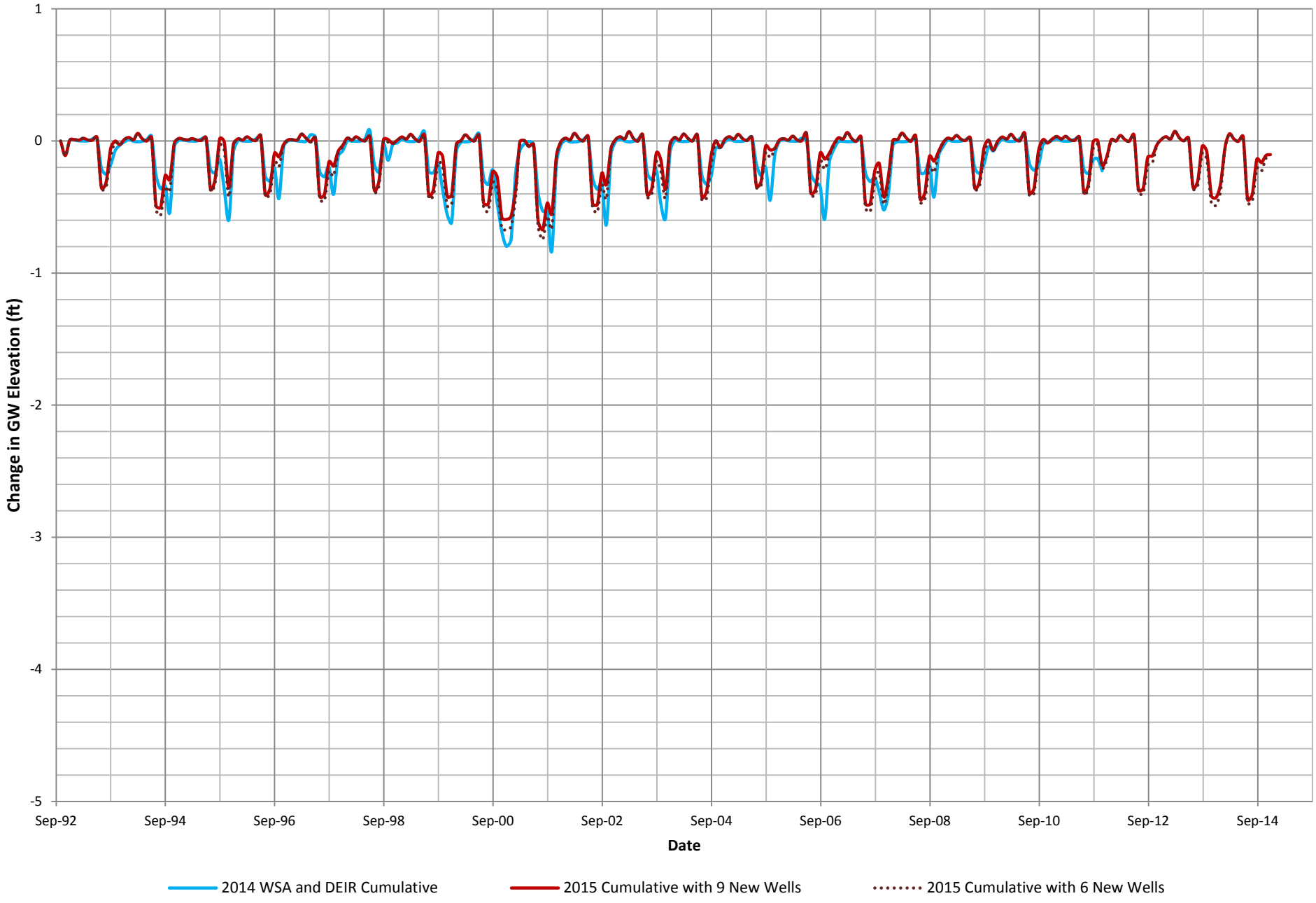
East Cell E Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



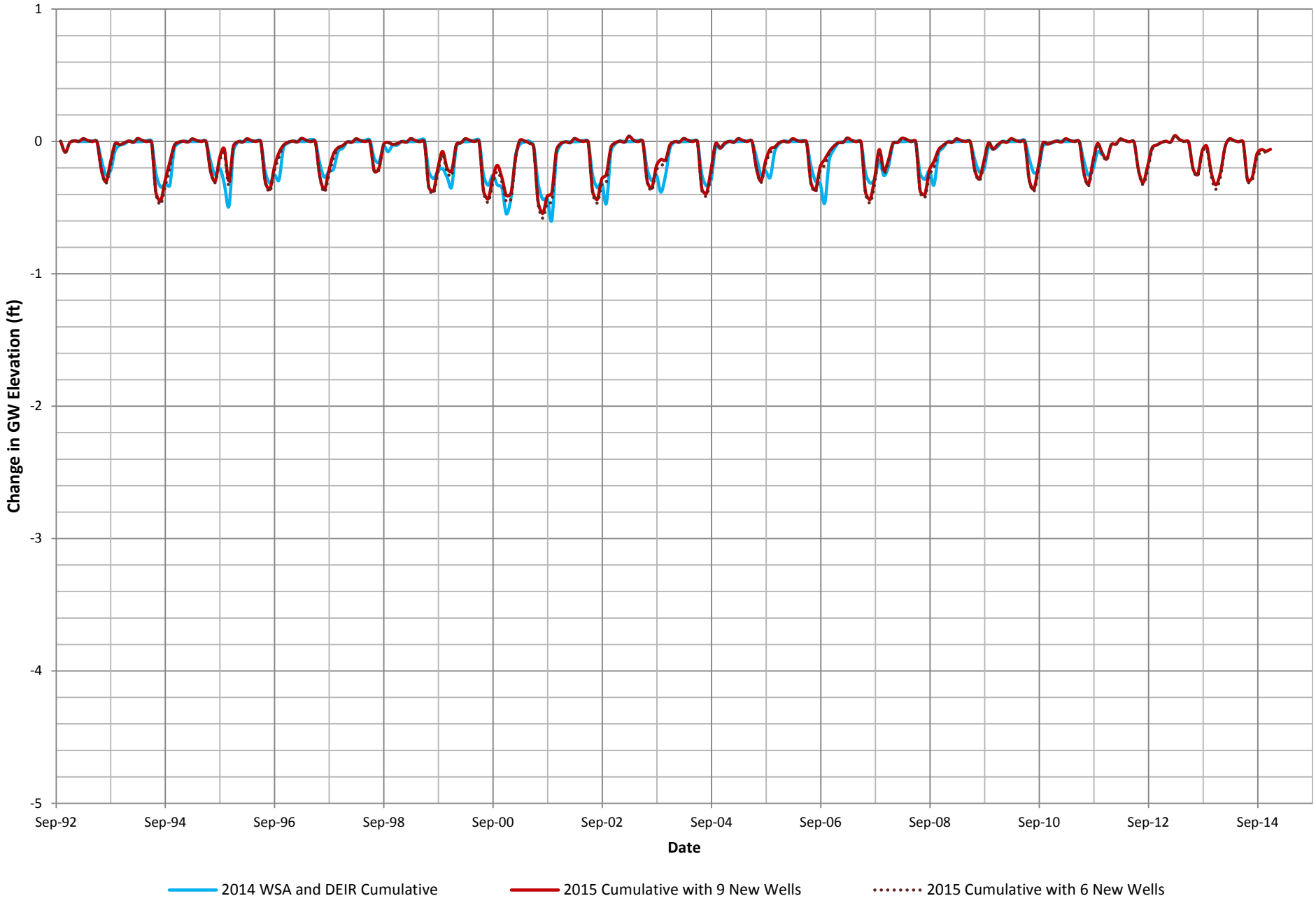
East Cell F Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



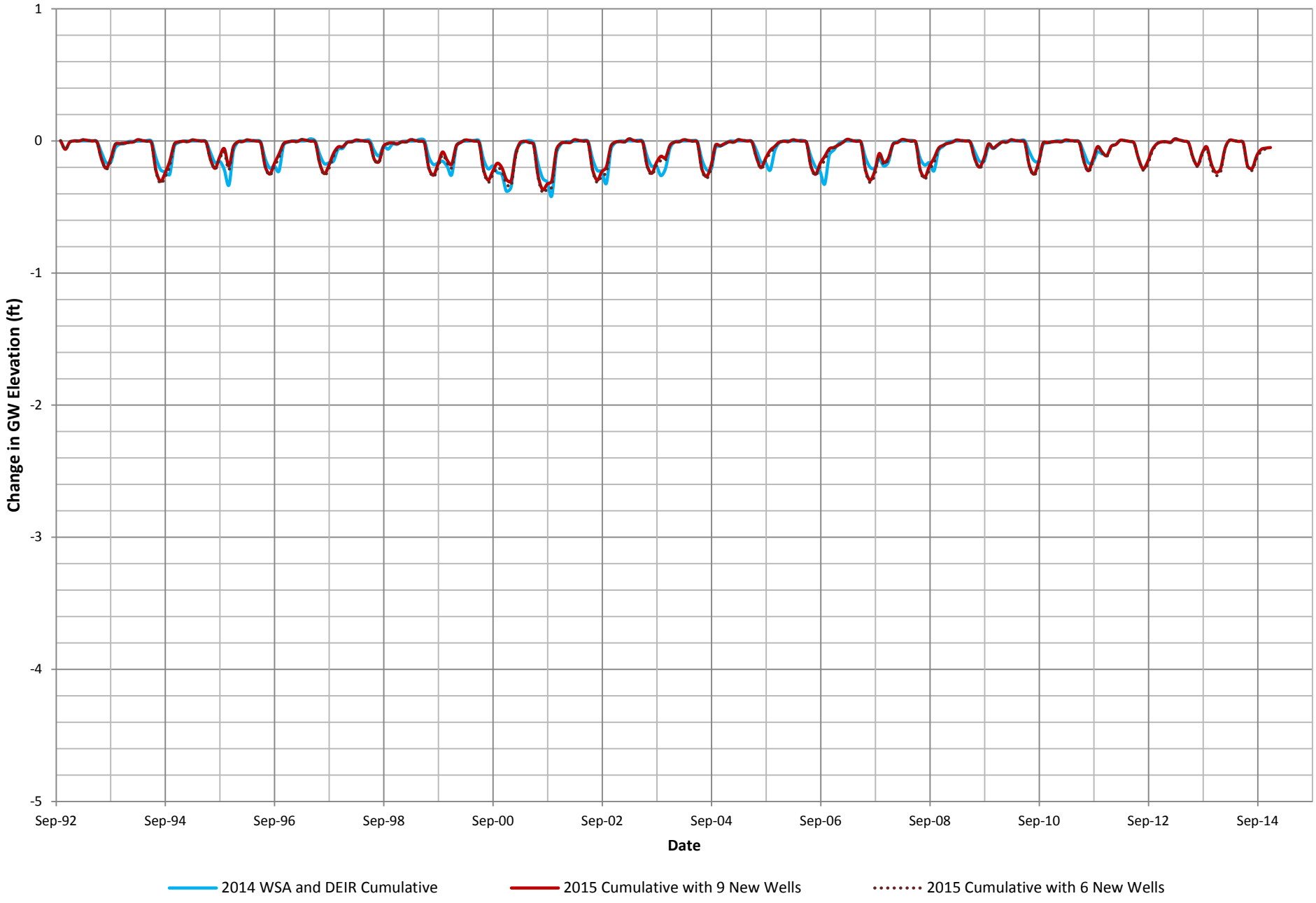
East Cell G Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



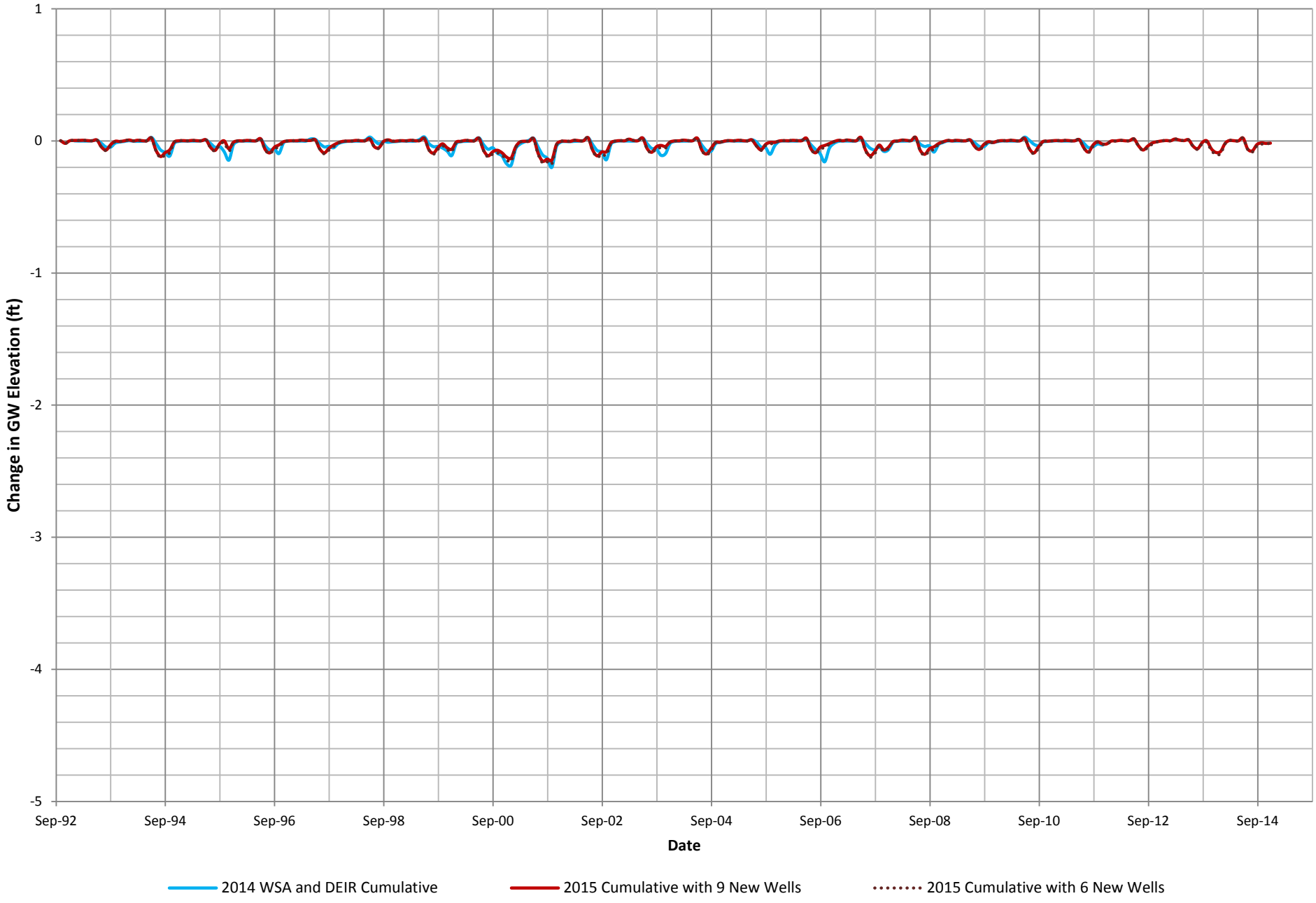
East Cell H Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



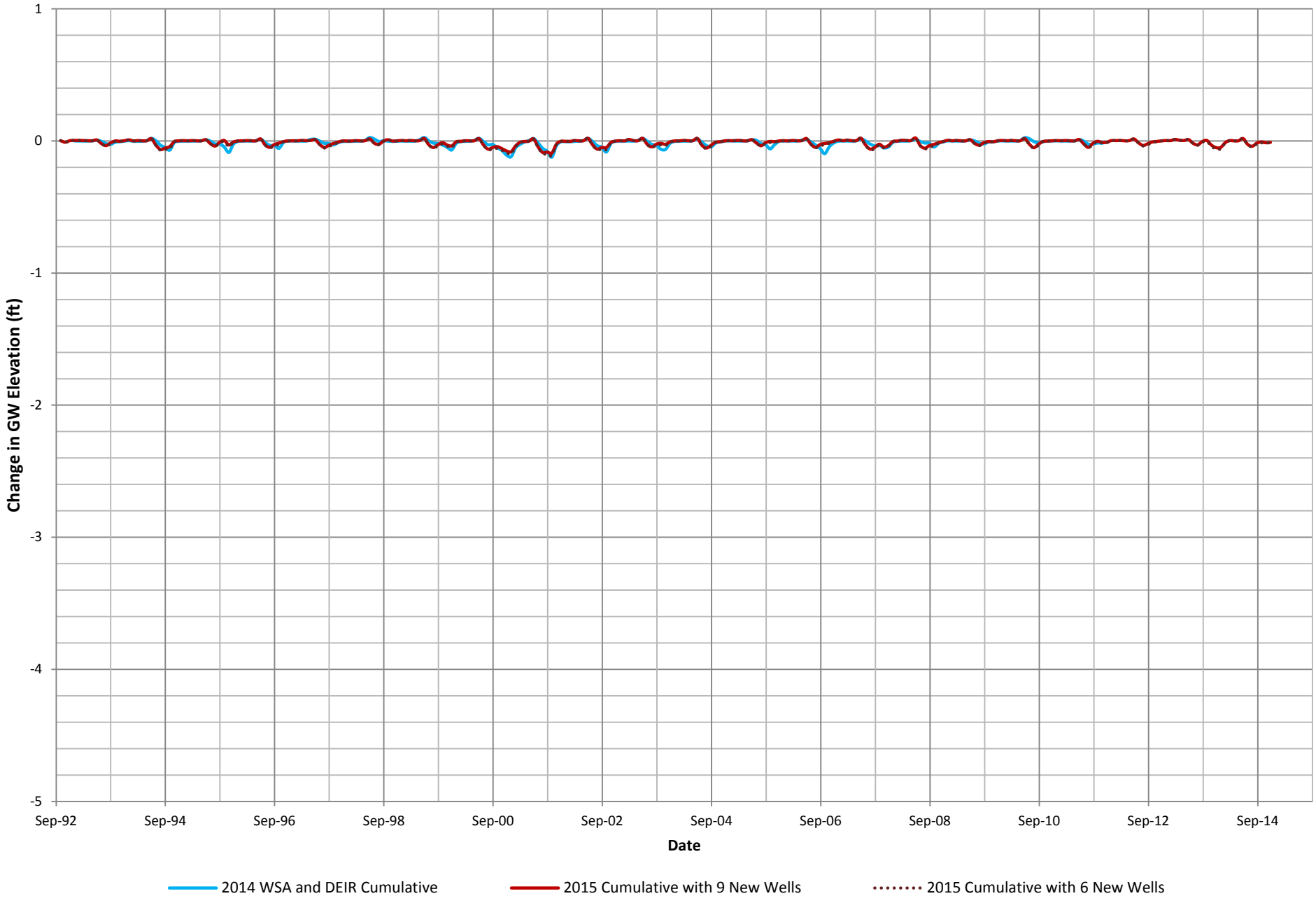
East Cell I Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



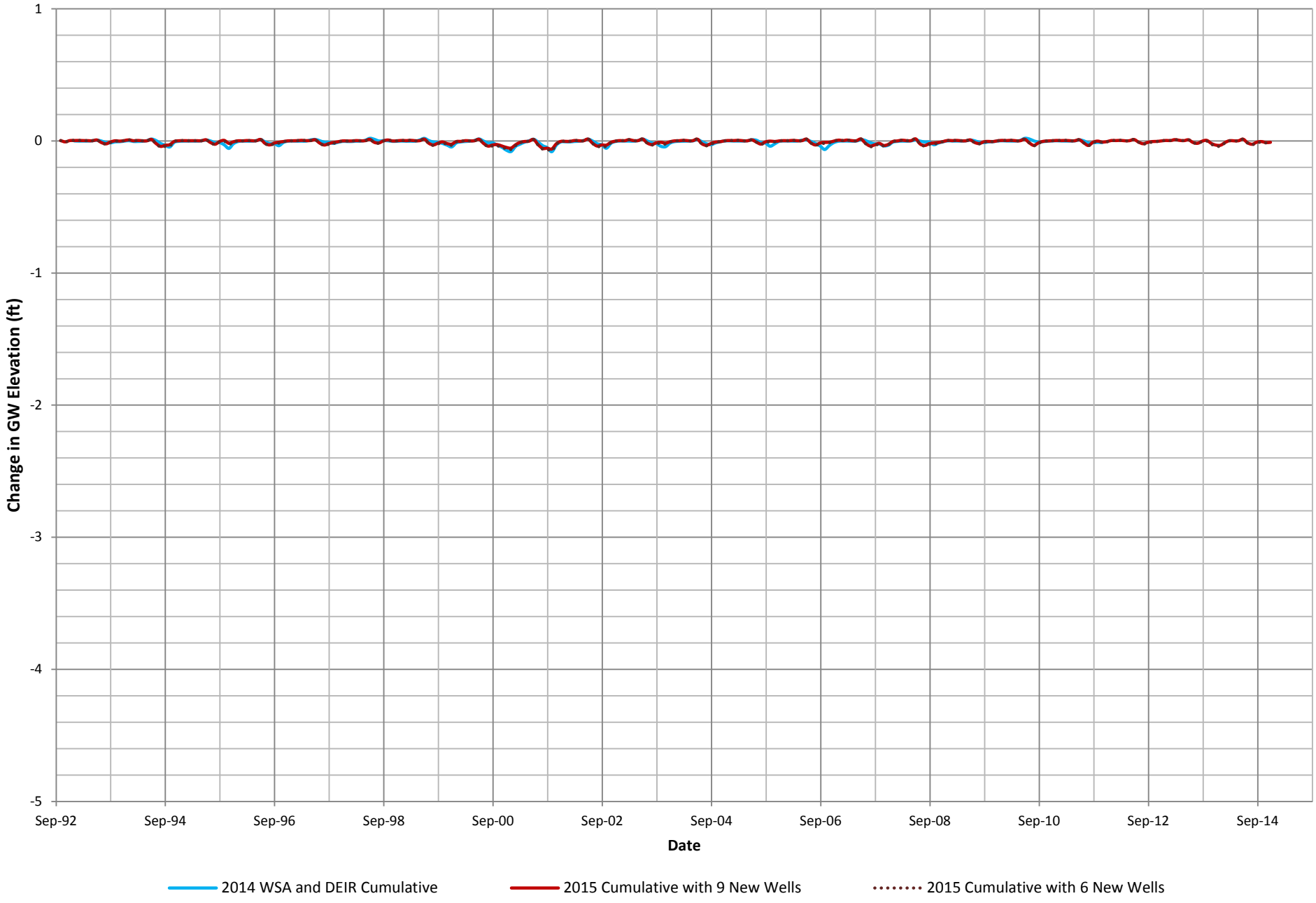
East Cell J Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



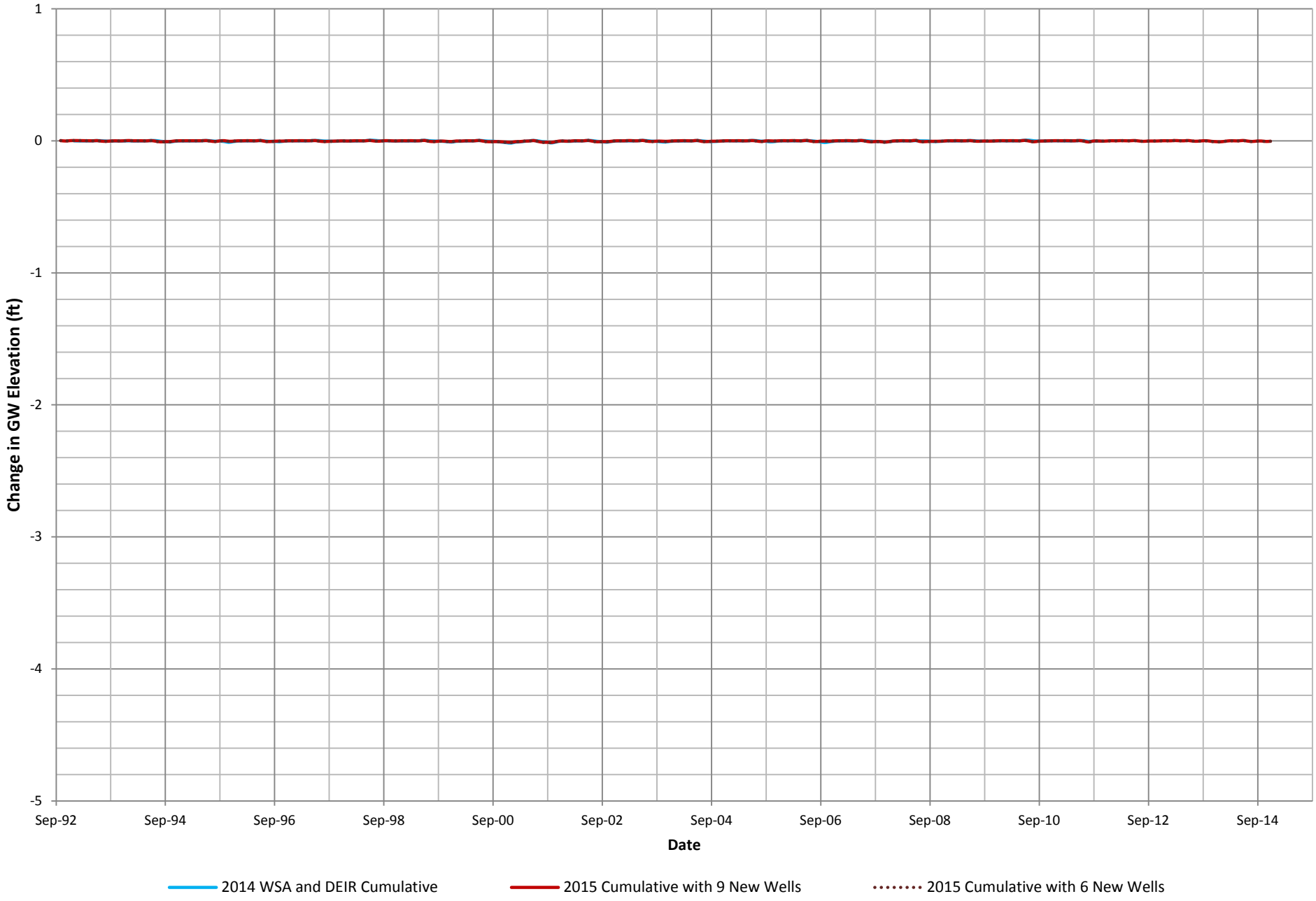
East Cell K Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



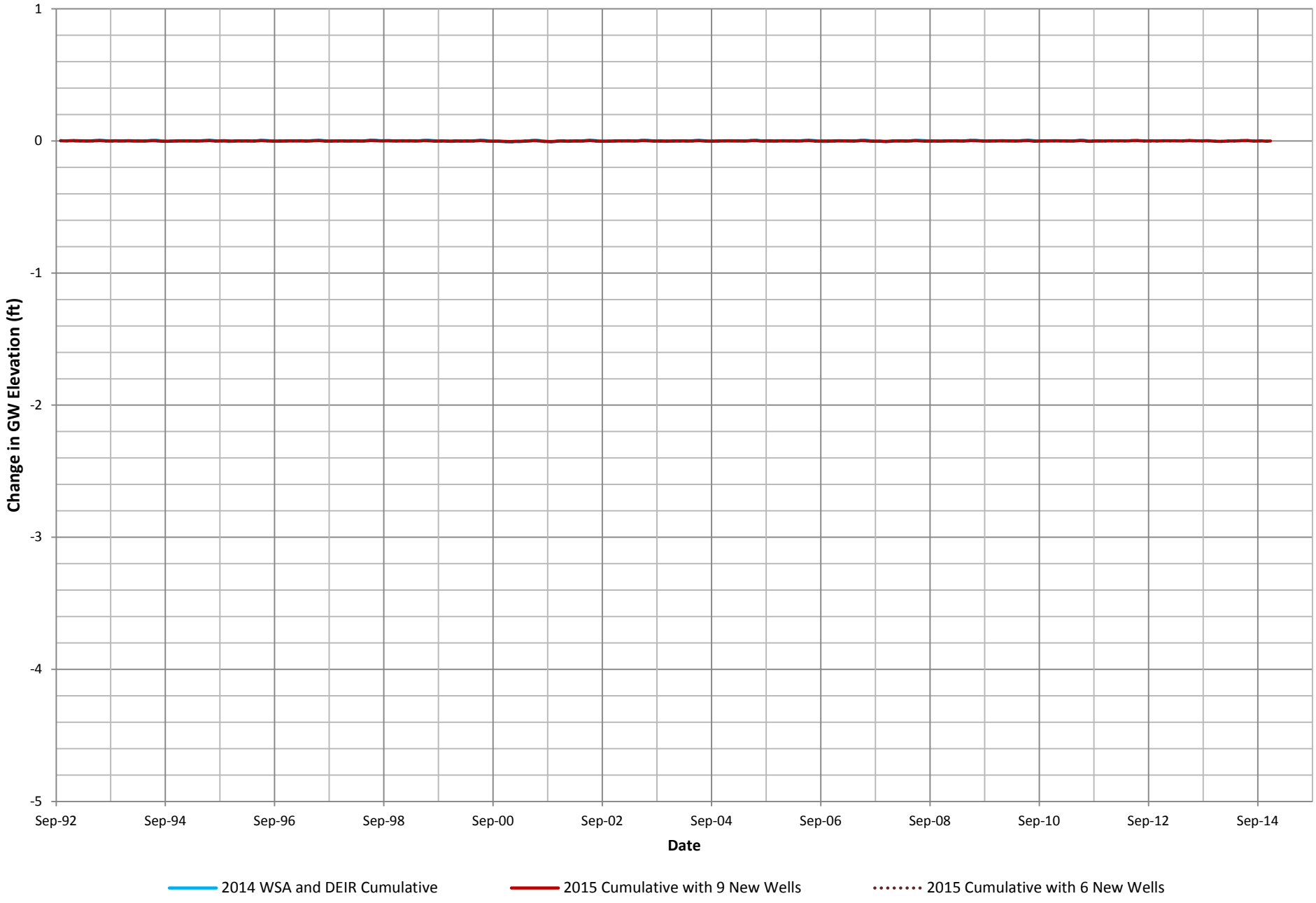
East Cell L Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



East Cell M Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



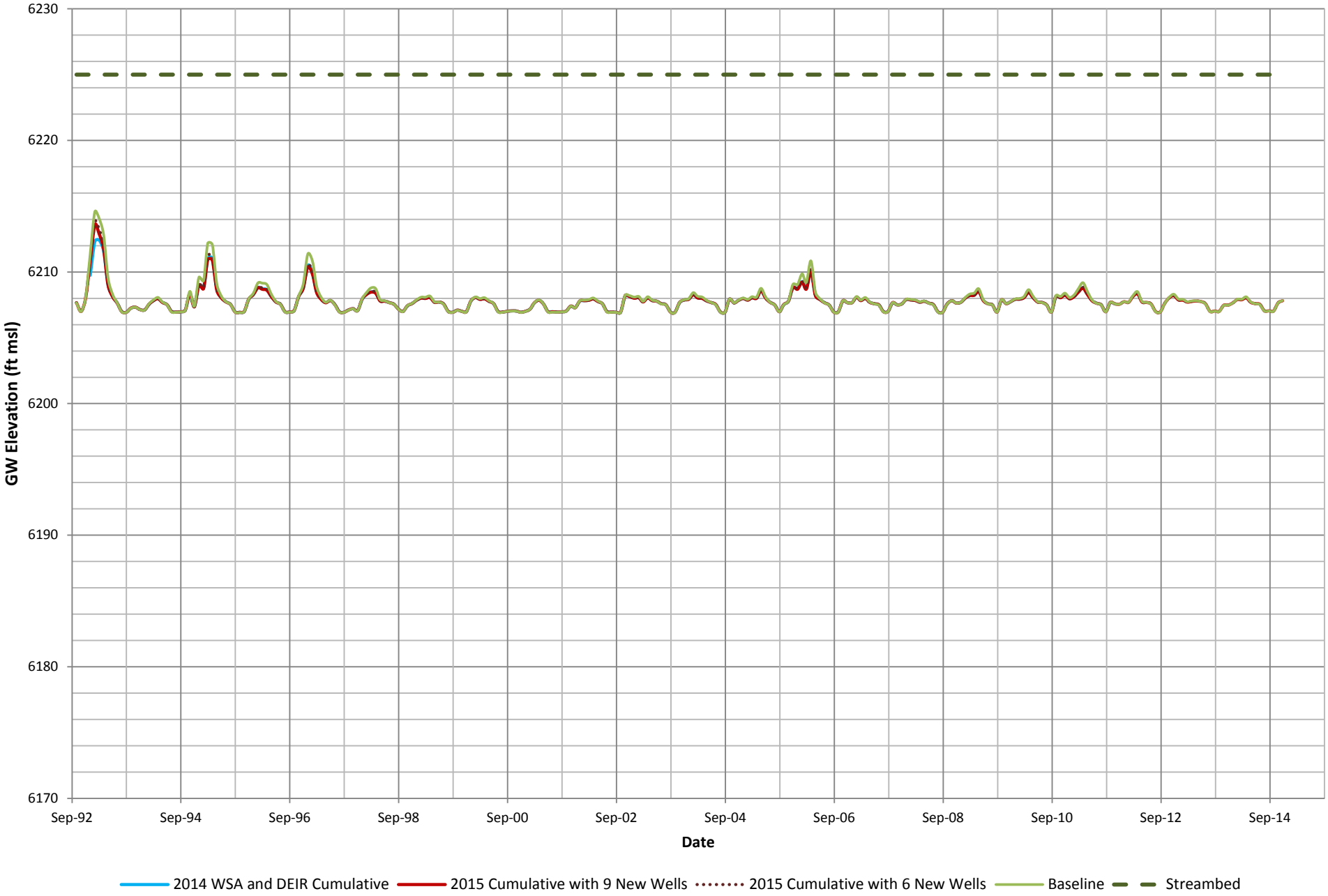
East Cell N Change in Groundwater Elevations, Future vs. Baseline
2015 WSA Update and DEIR Model Simulation Comparison



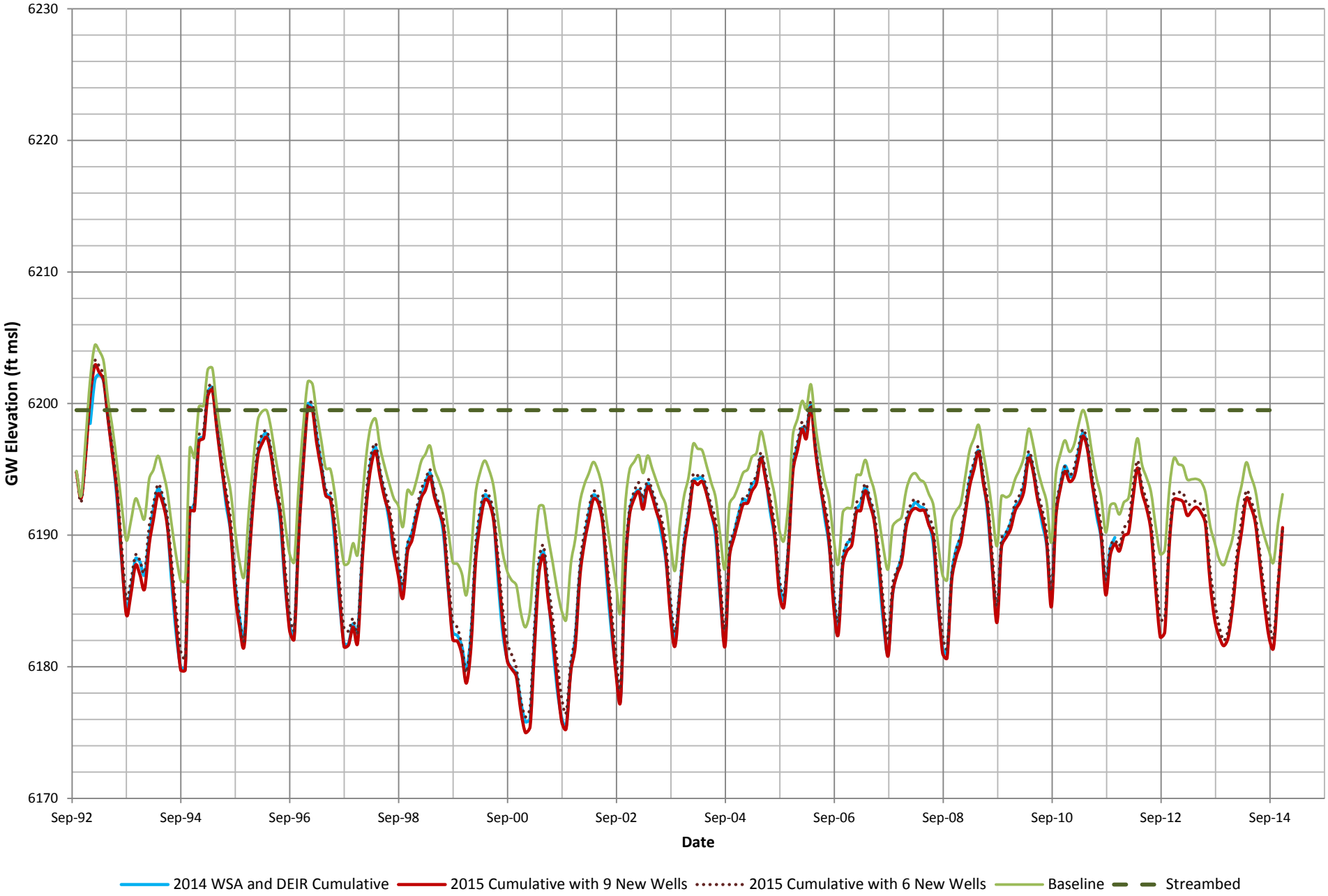
APPENDIX C

Model Simulated Groundwater Elevation Data Beneath Squaw Creek, SVPSD Well 5R Off Late Summer through Fall

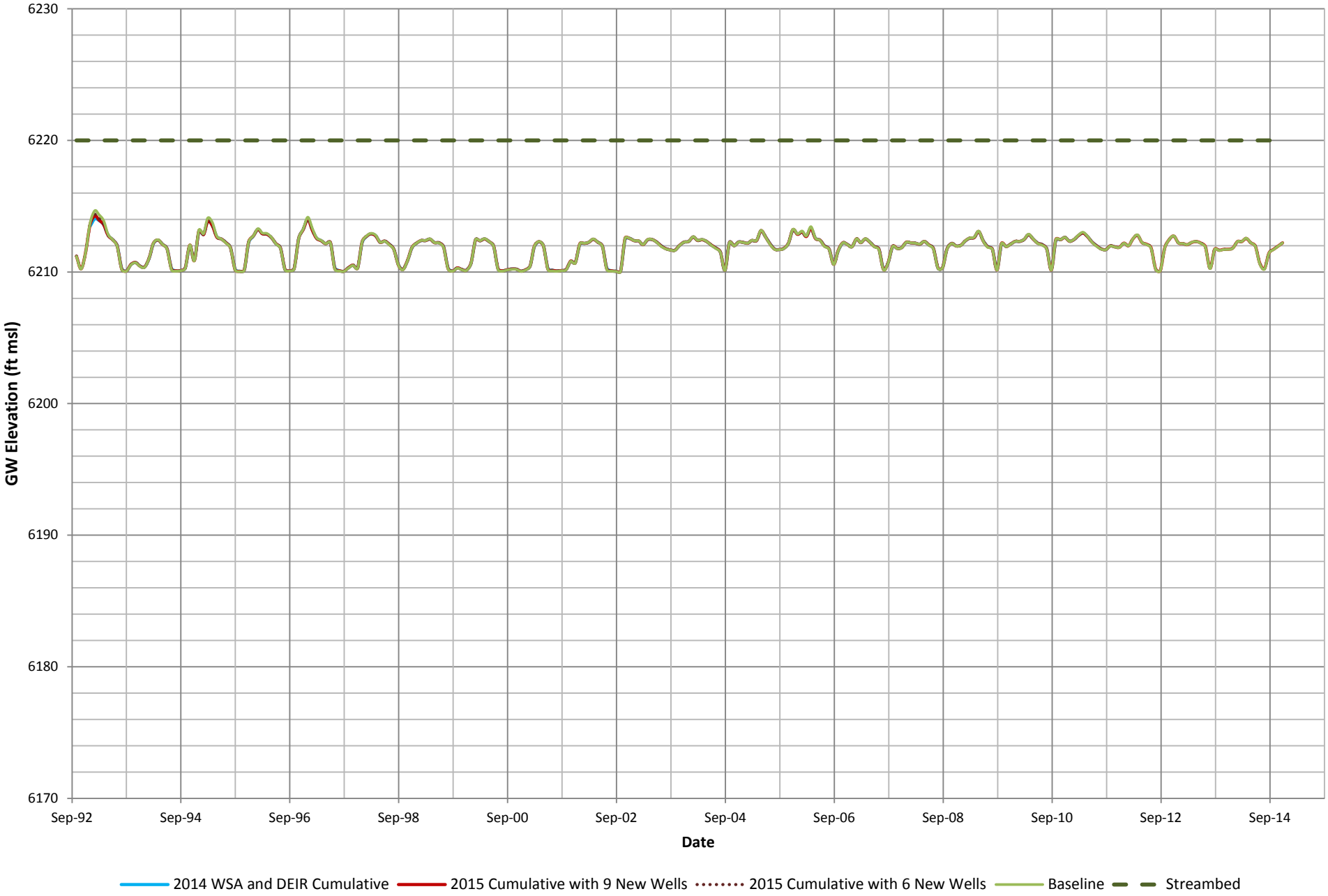
West Cell A Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



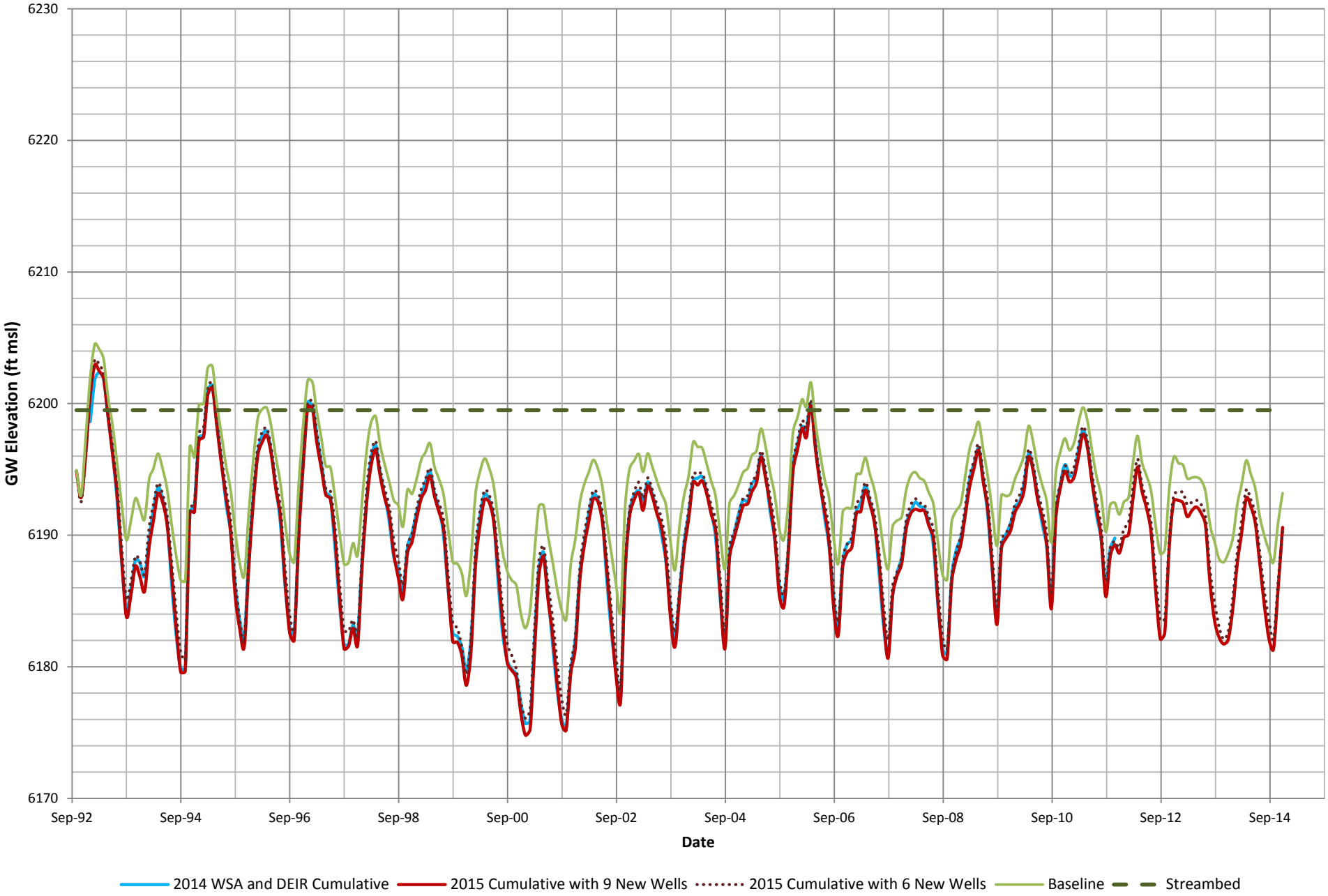
West Cell B Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



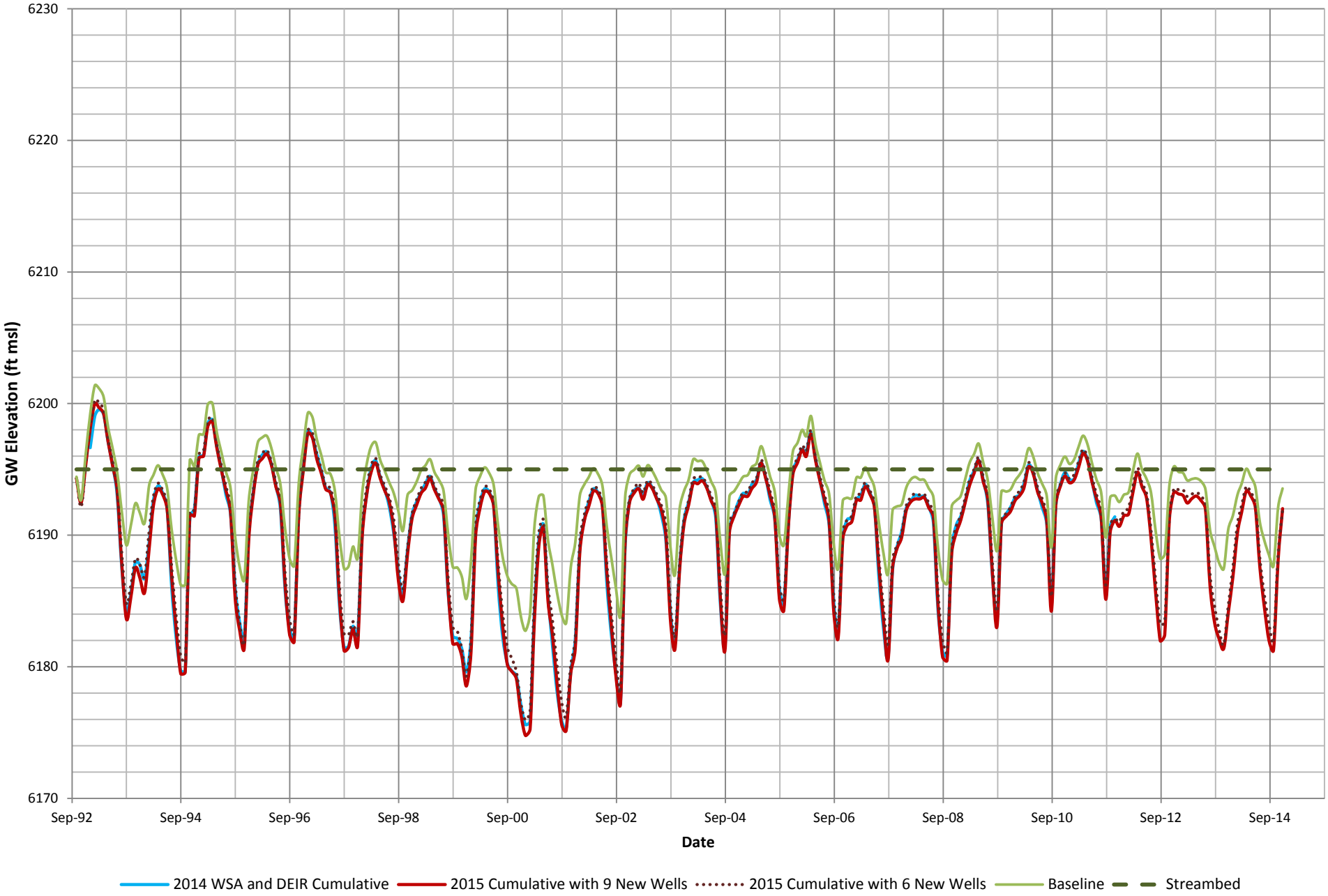
West Cell C Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



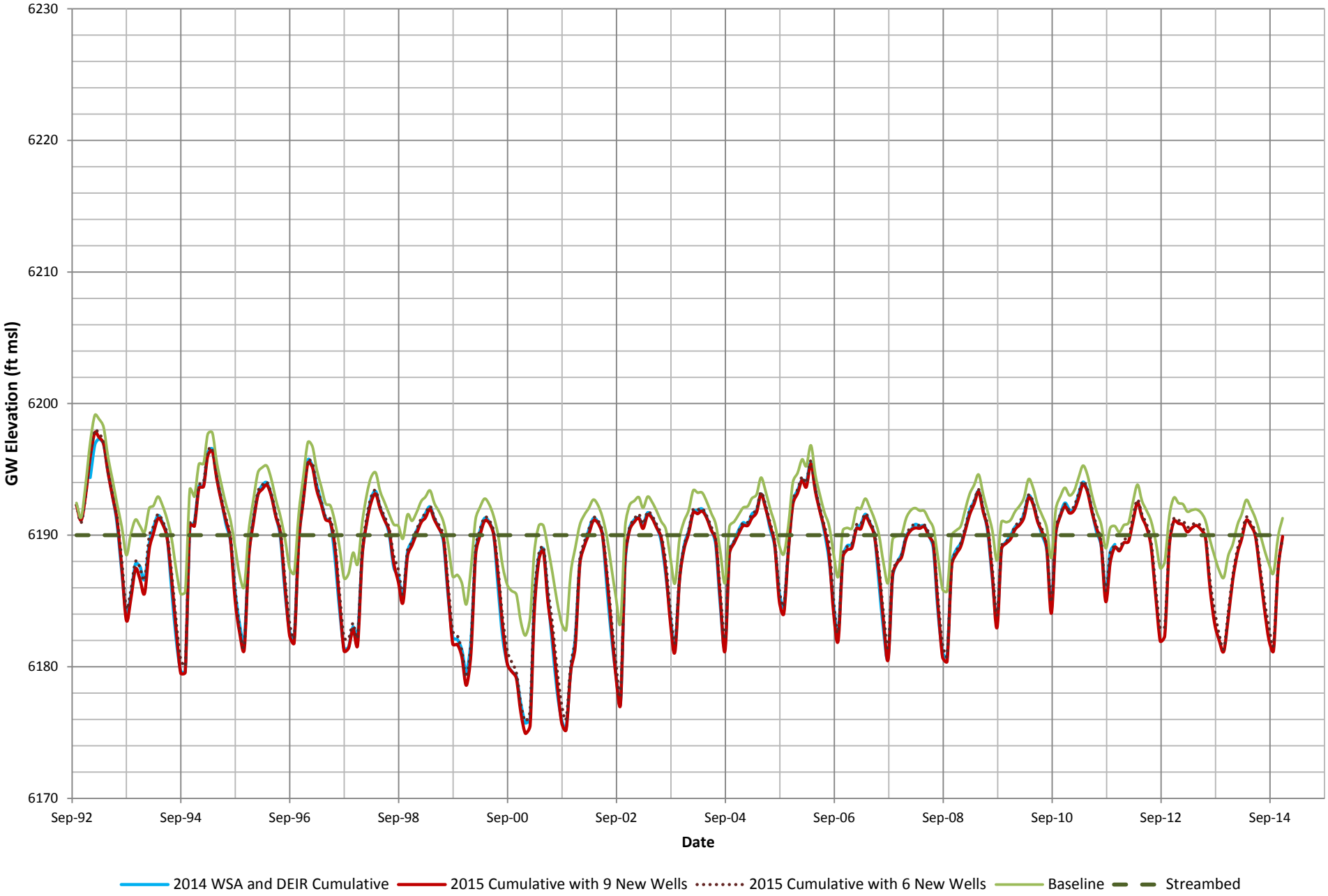
West Cell D Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



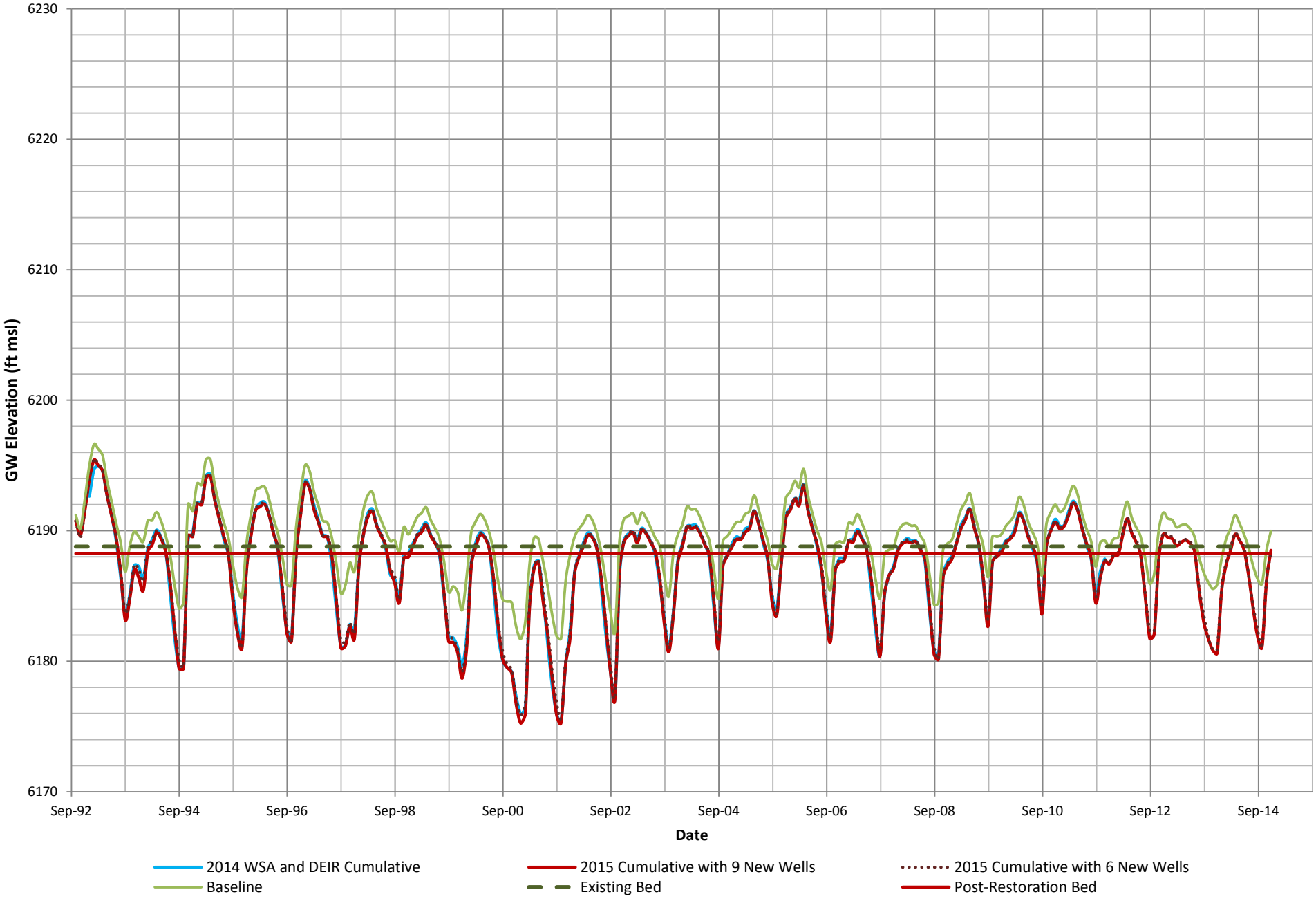
West Cell E Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



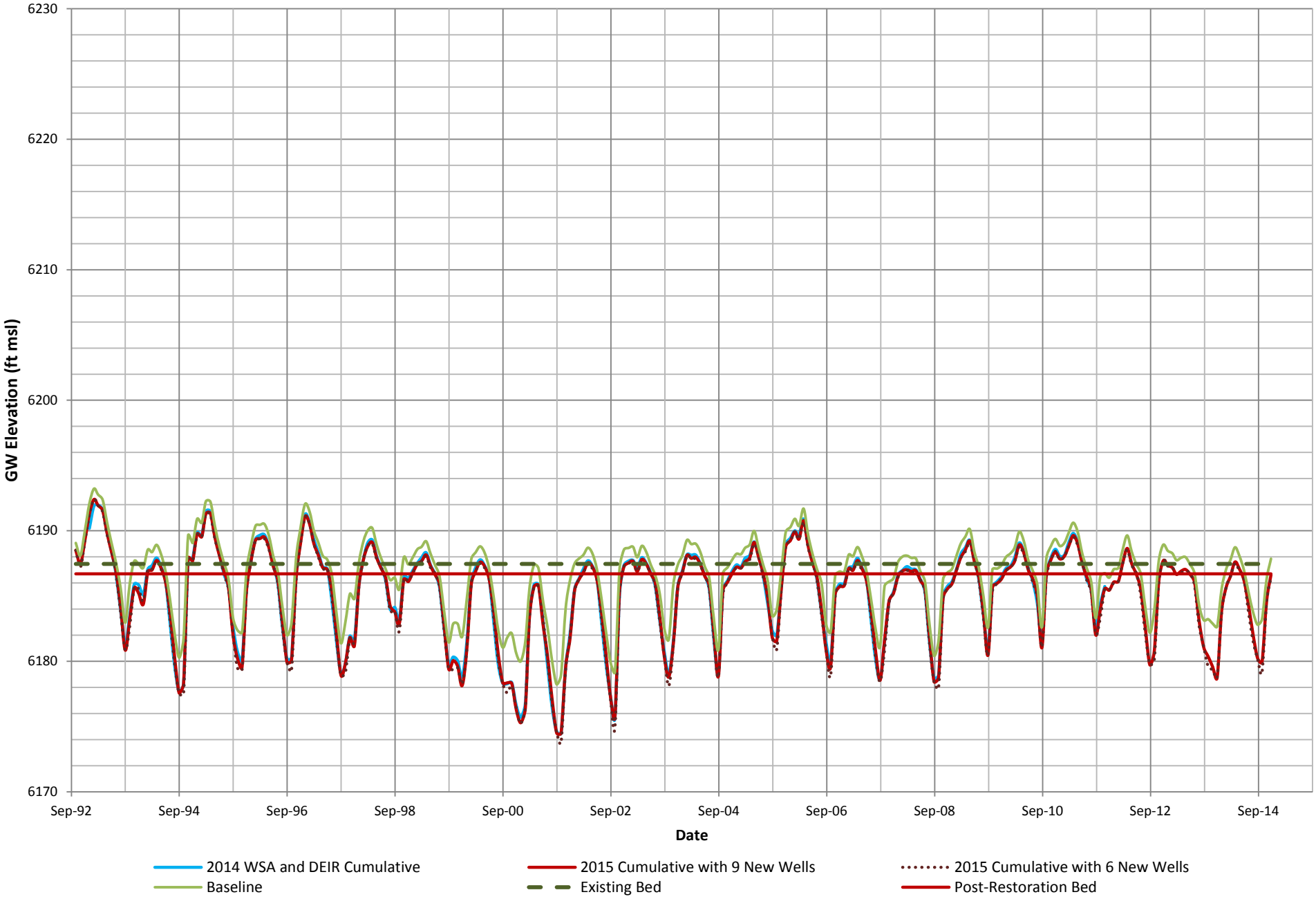
West Cell F Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



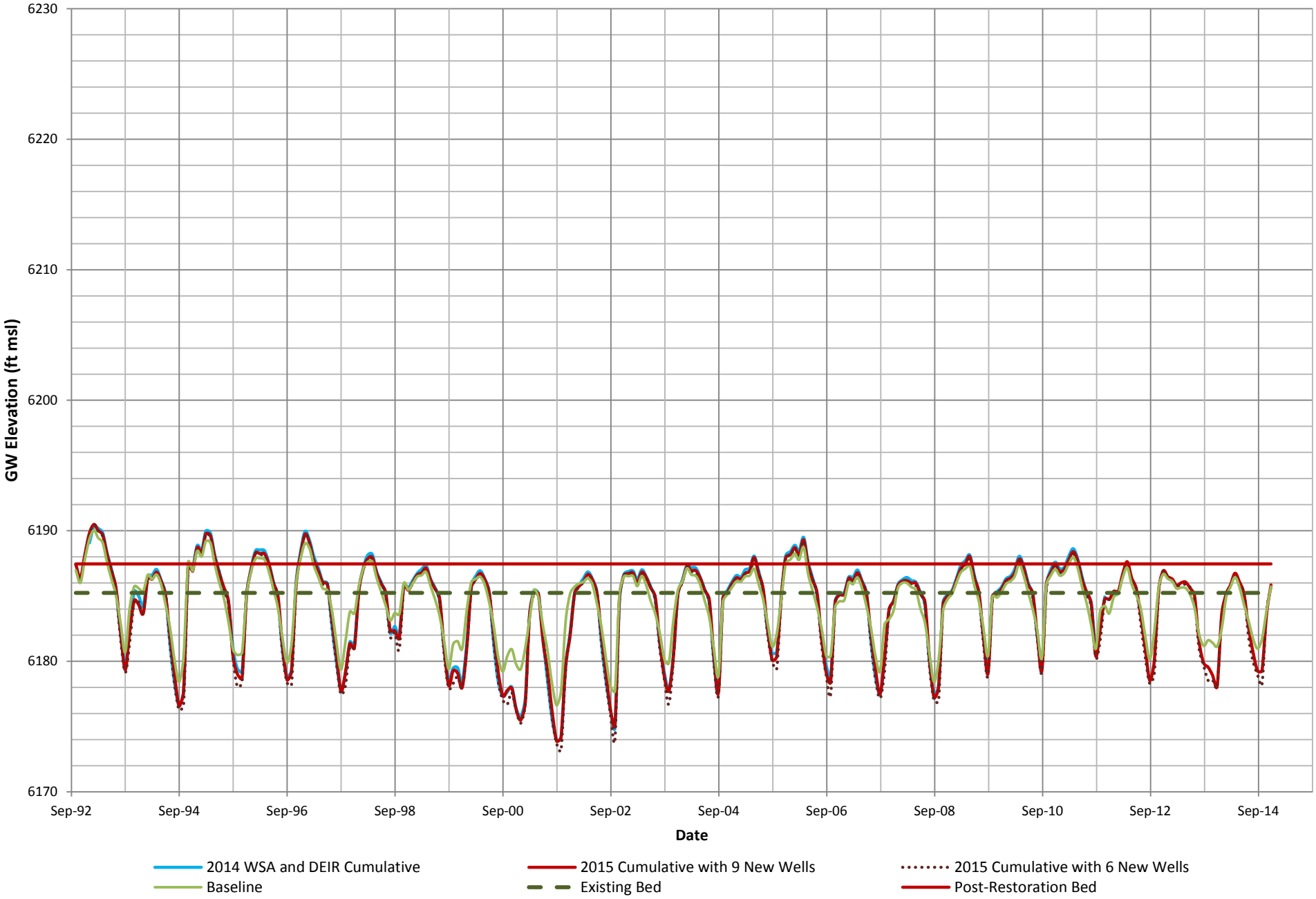
West Cell G Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



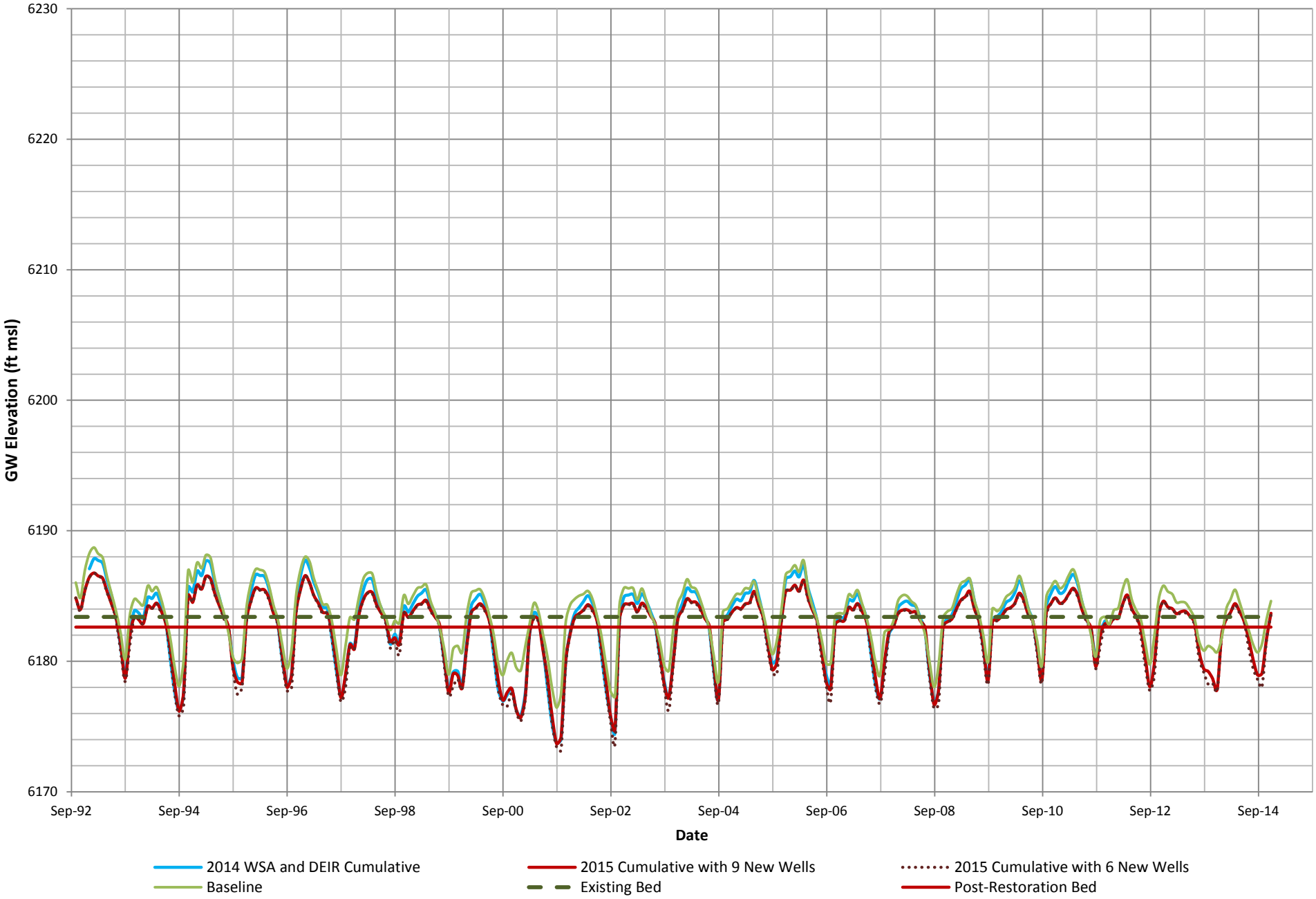
West Cell H Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



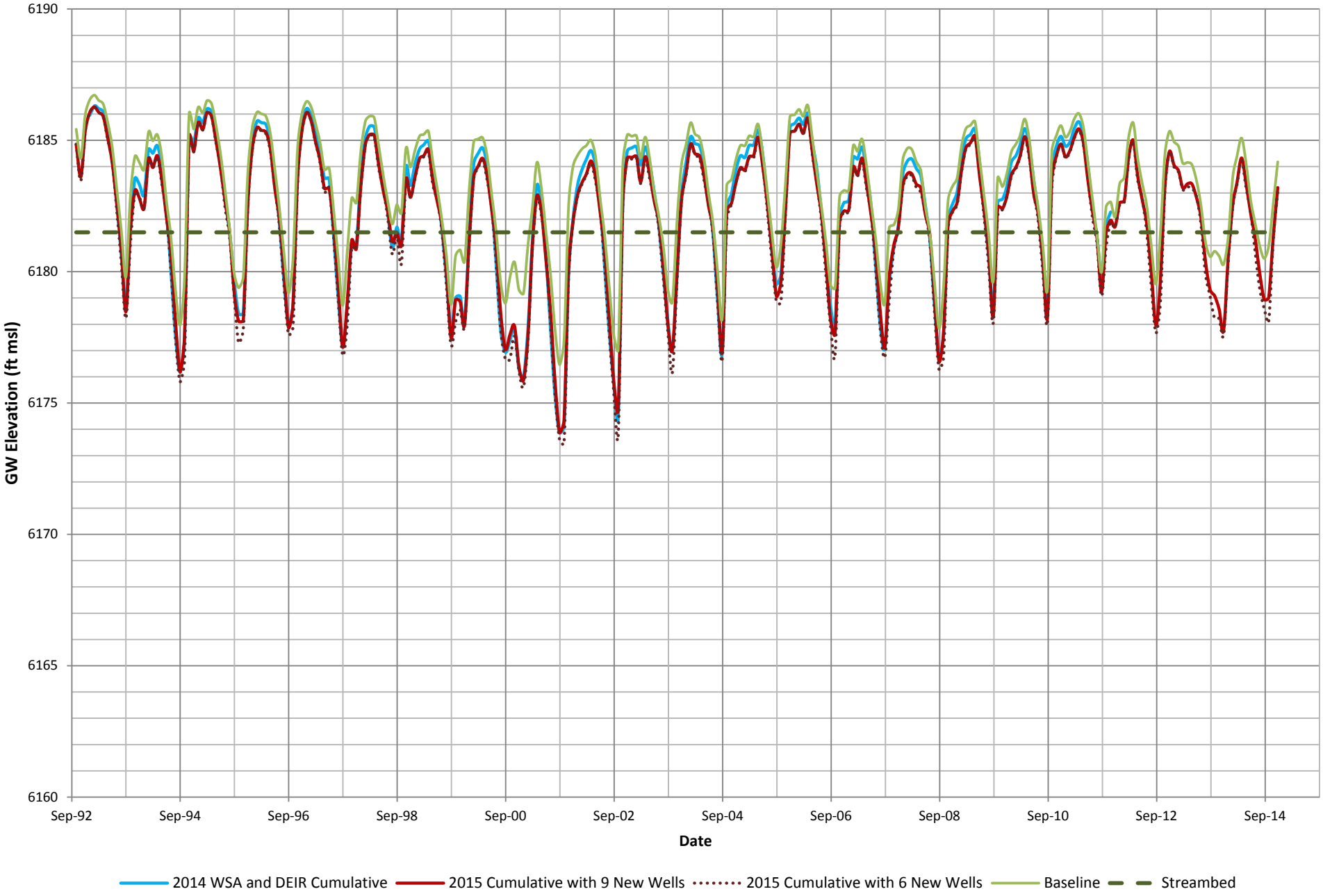
West Cell I Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



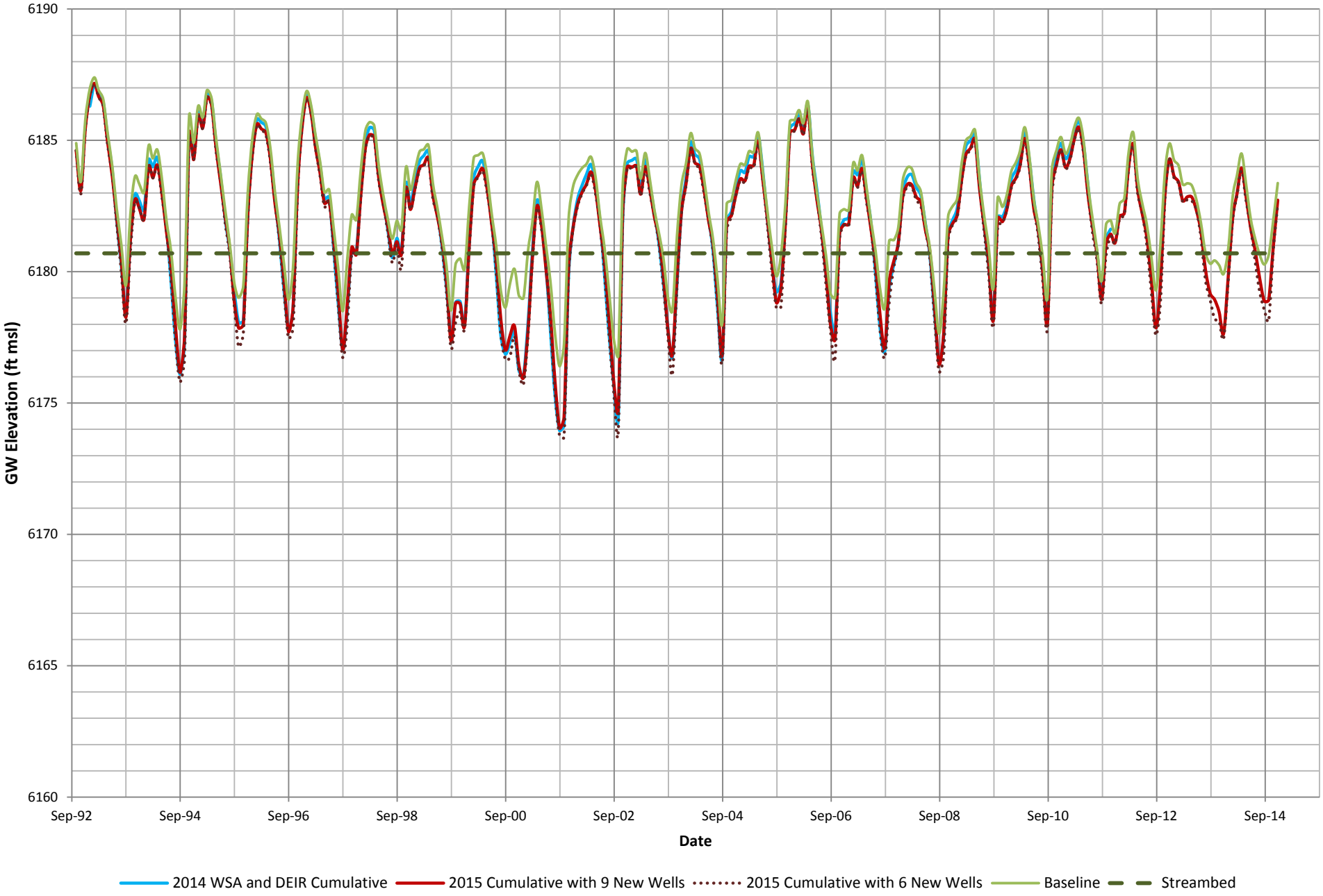
West Cell J Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



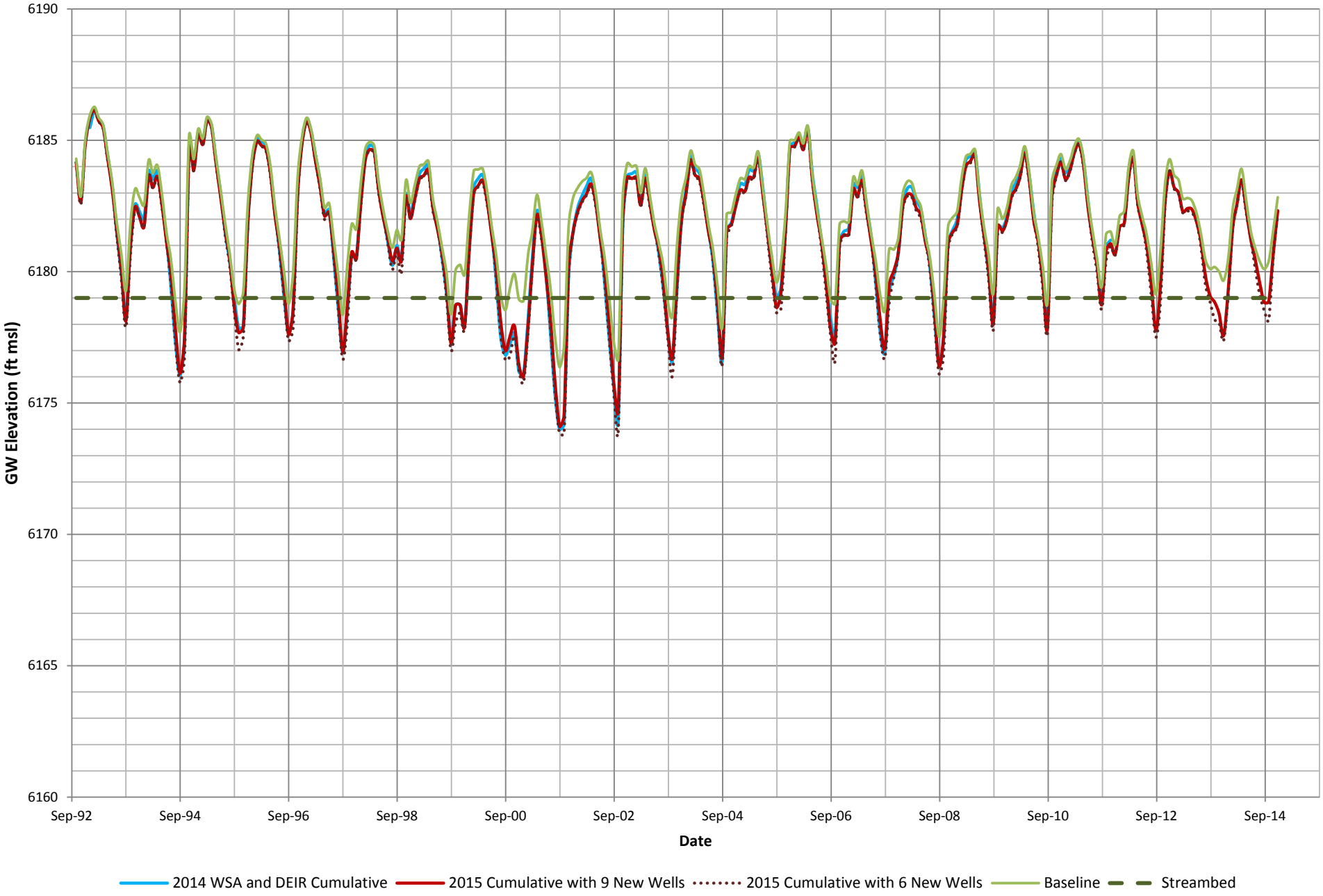
East Cell A Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



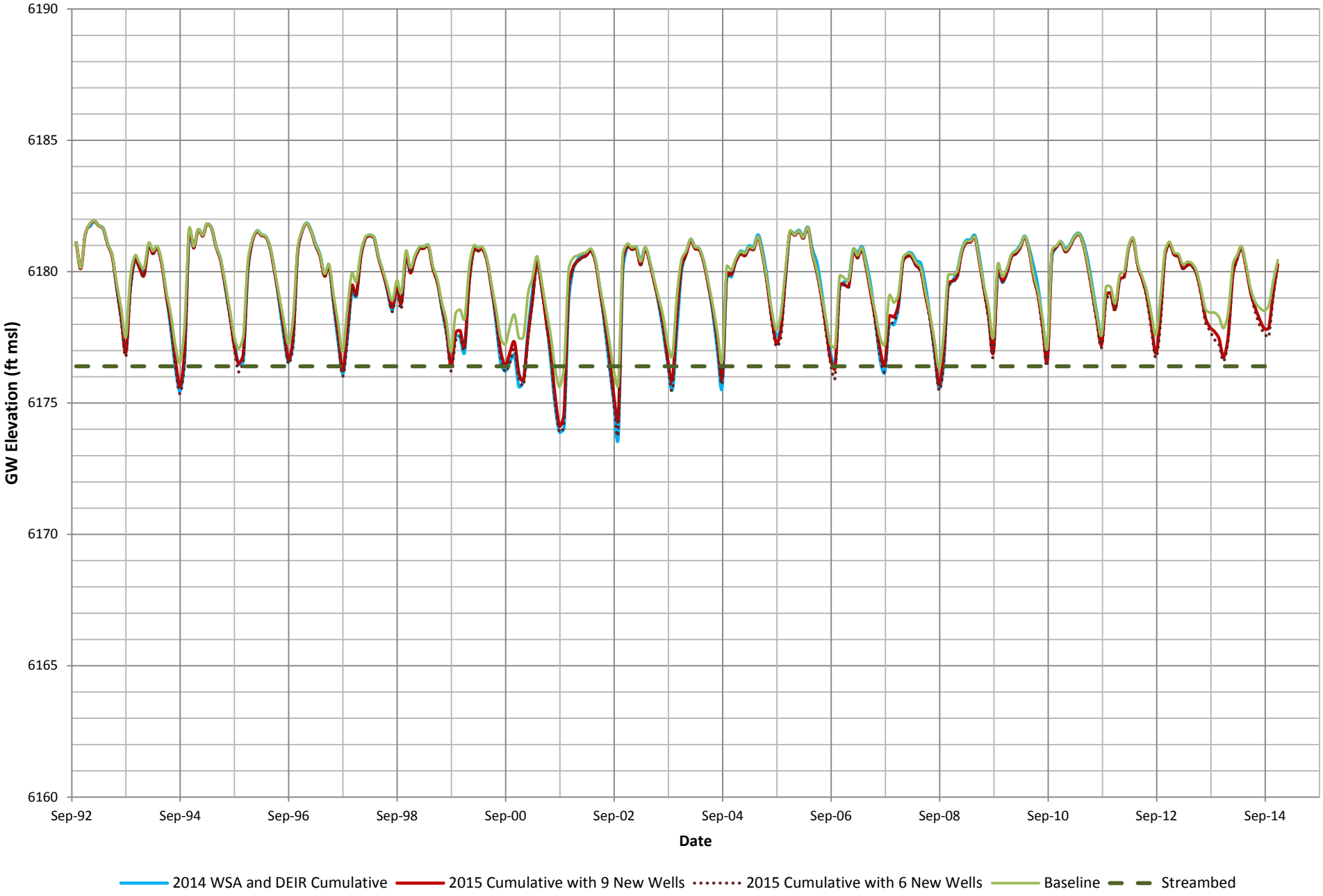
East Cell B Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



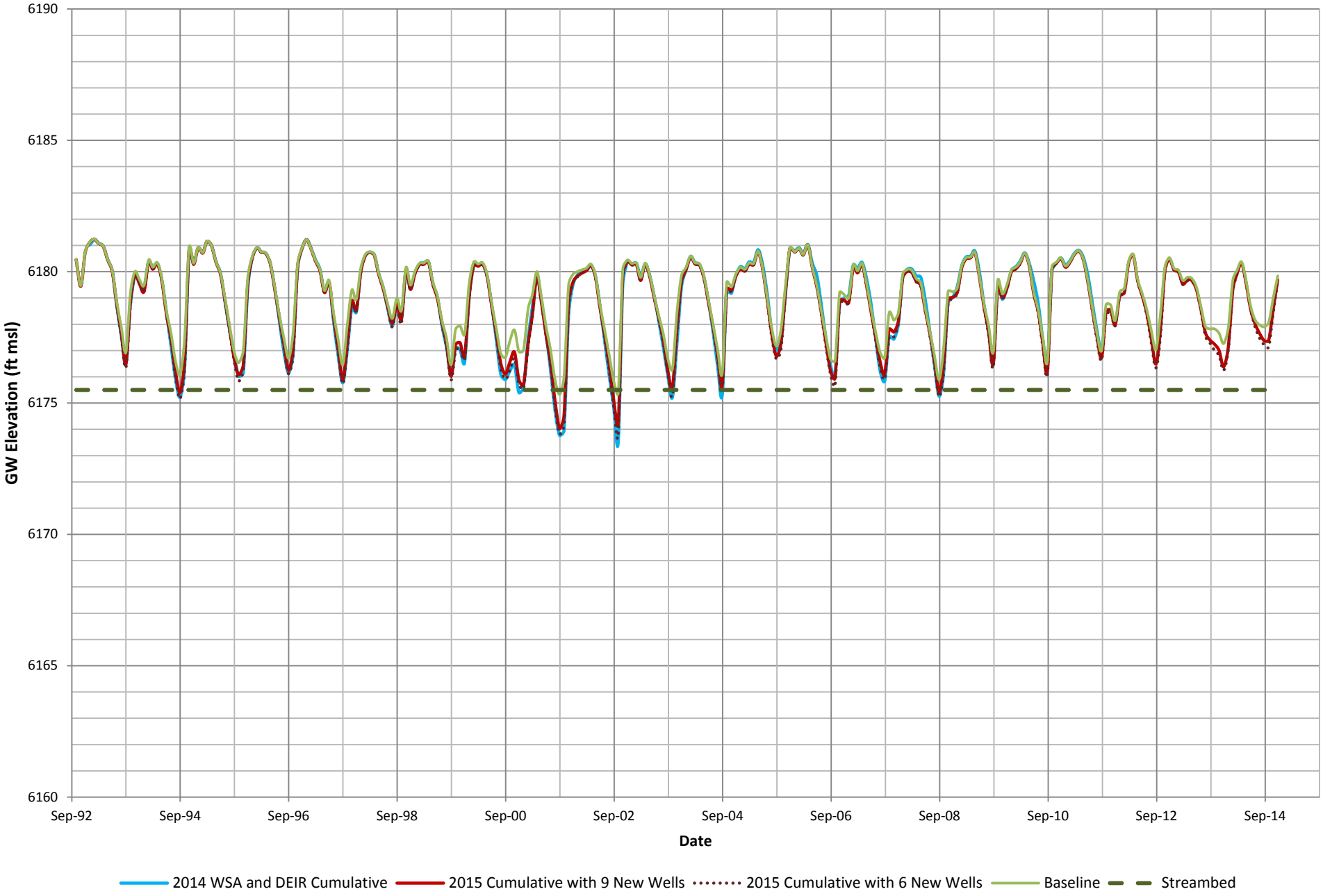
East Cell C Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



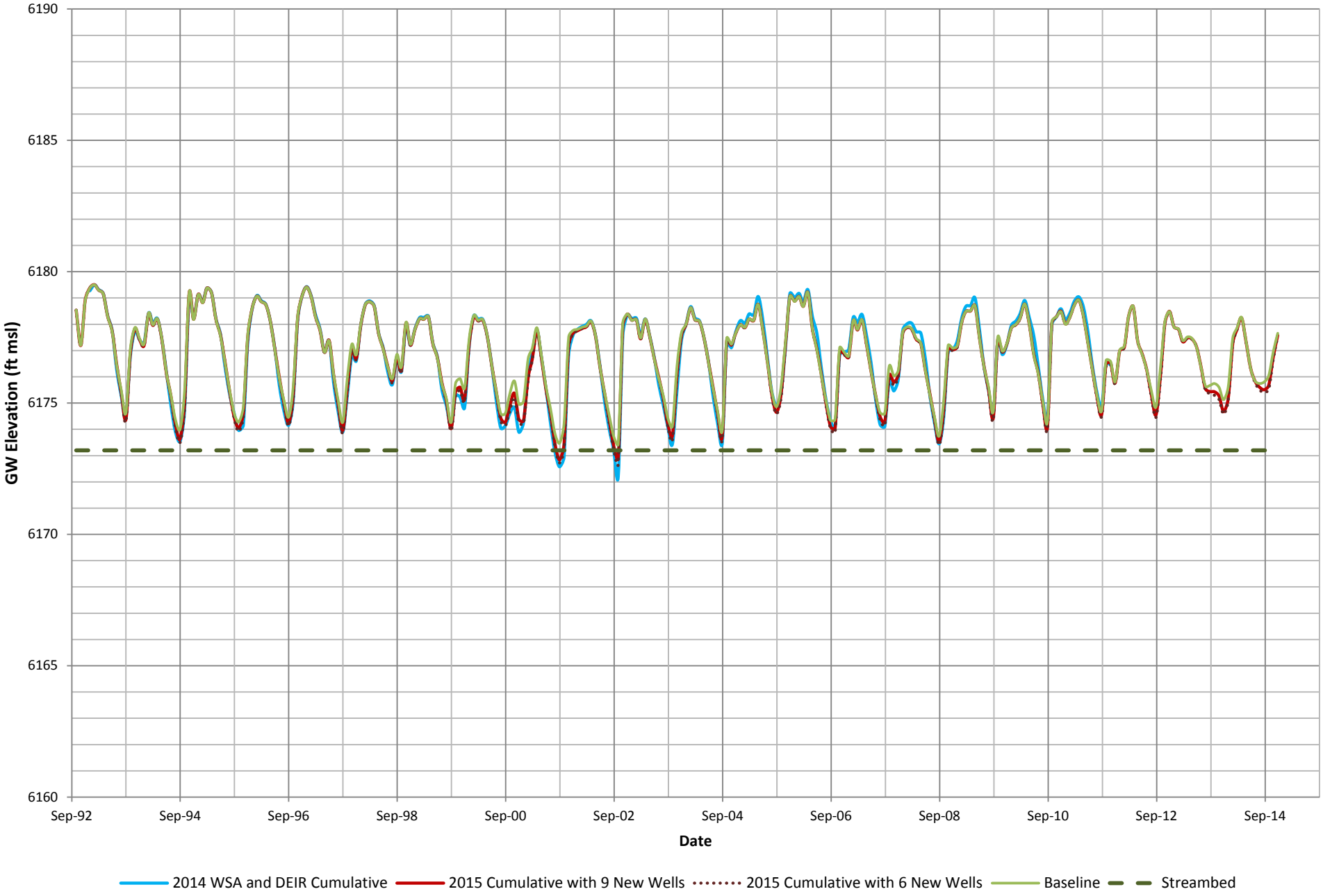
East Cell D Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



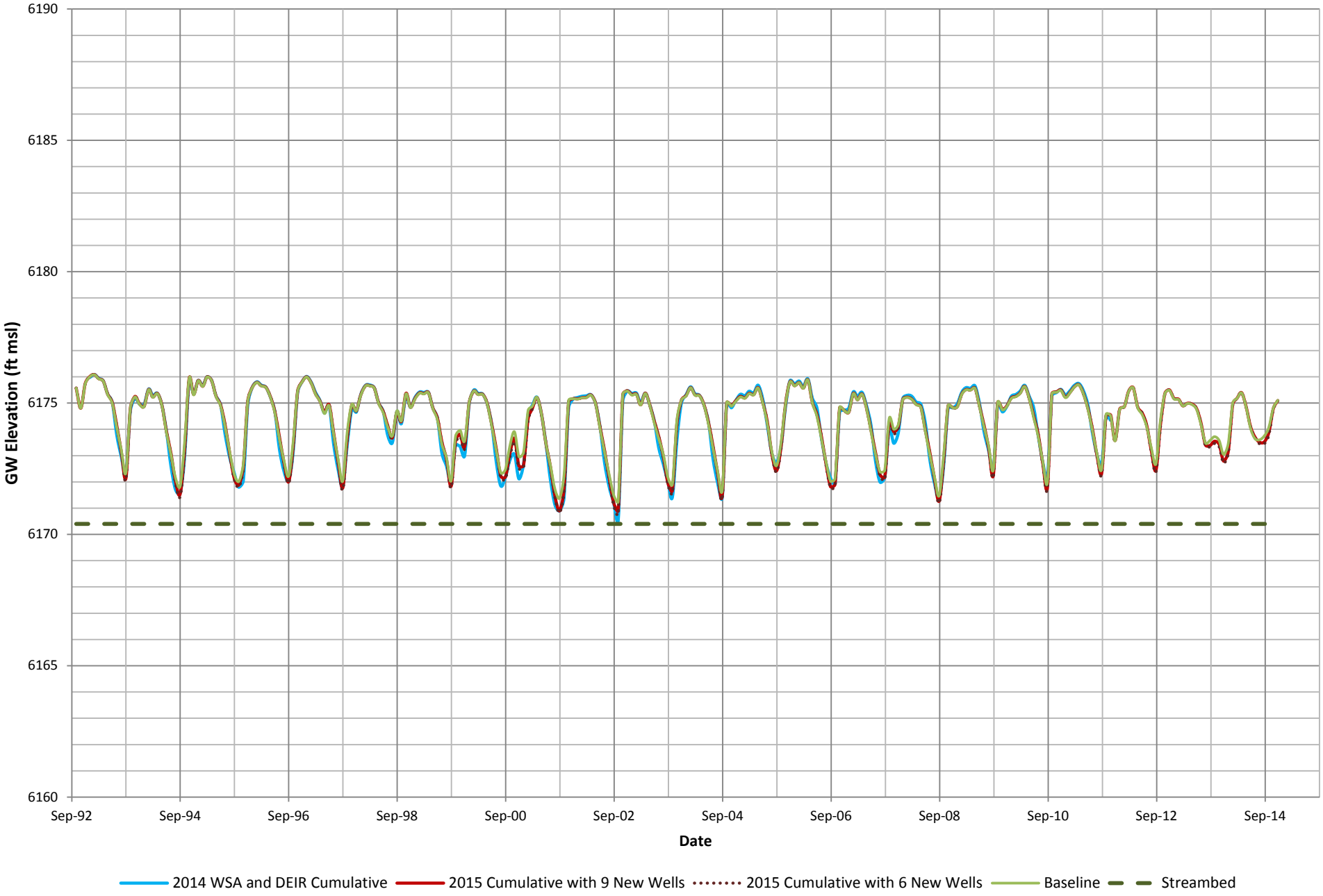
East Cell E Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



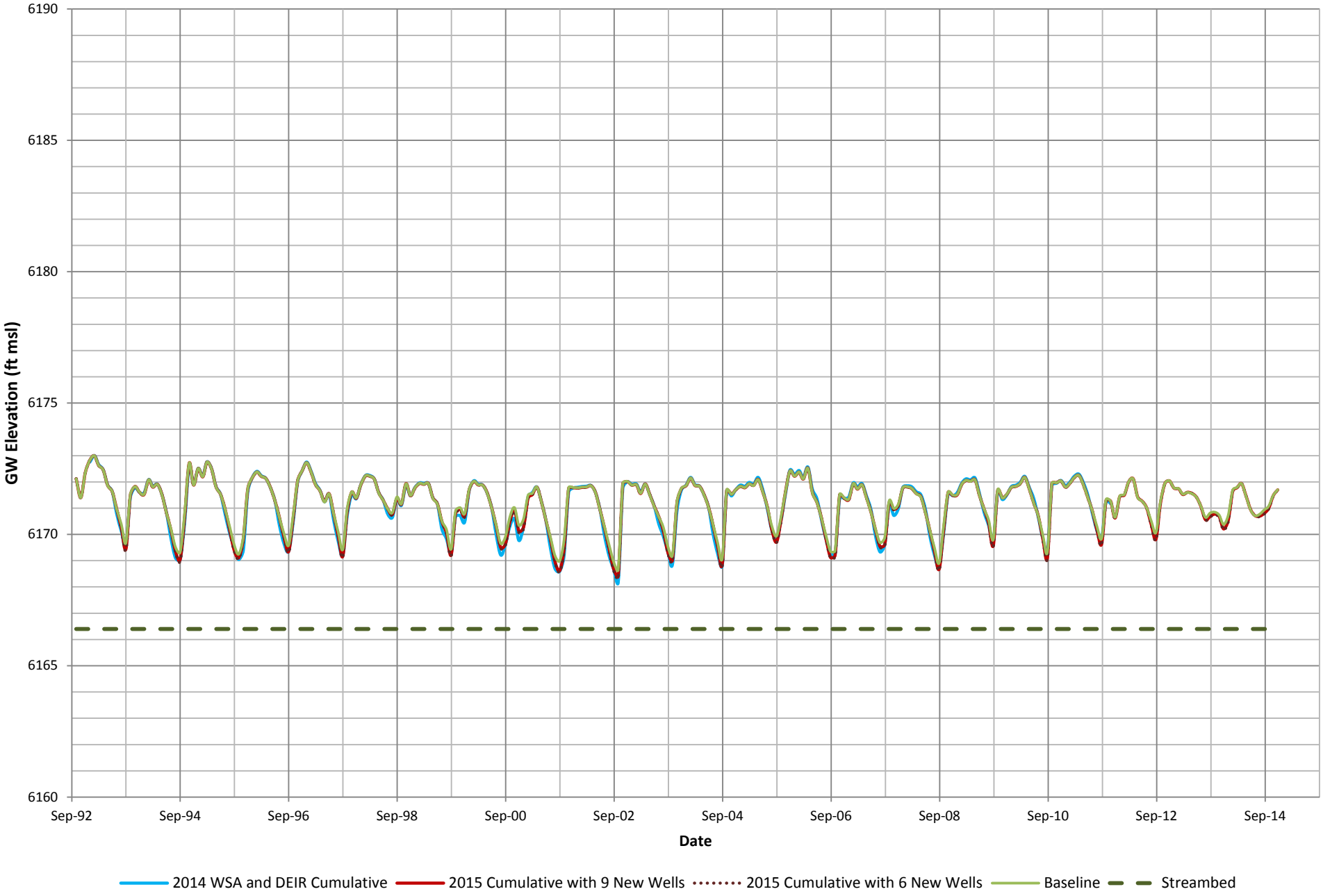
East Cell F Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



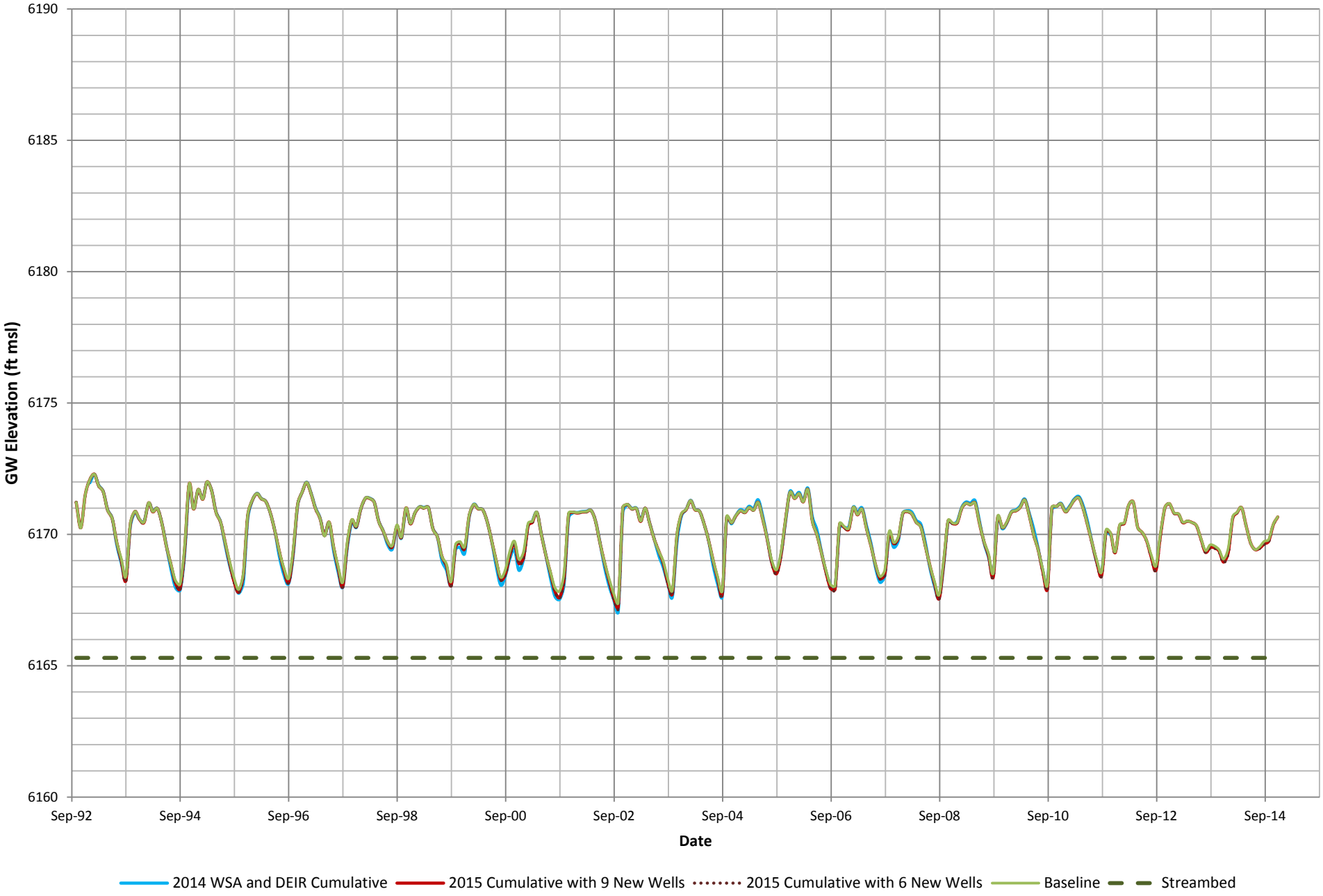
East Cell G Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



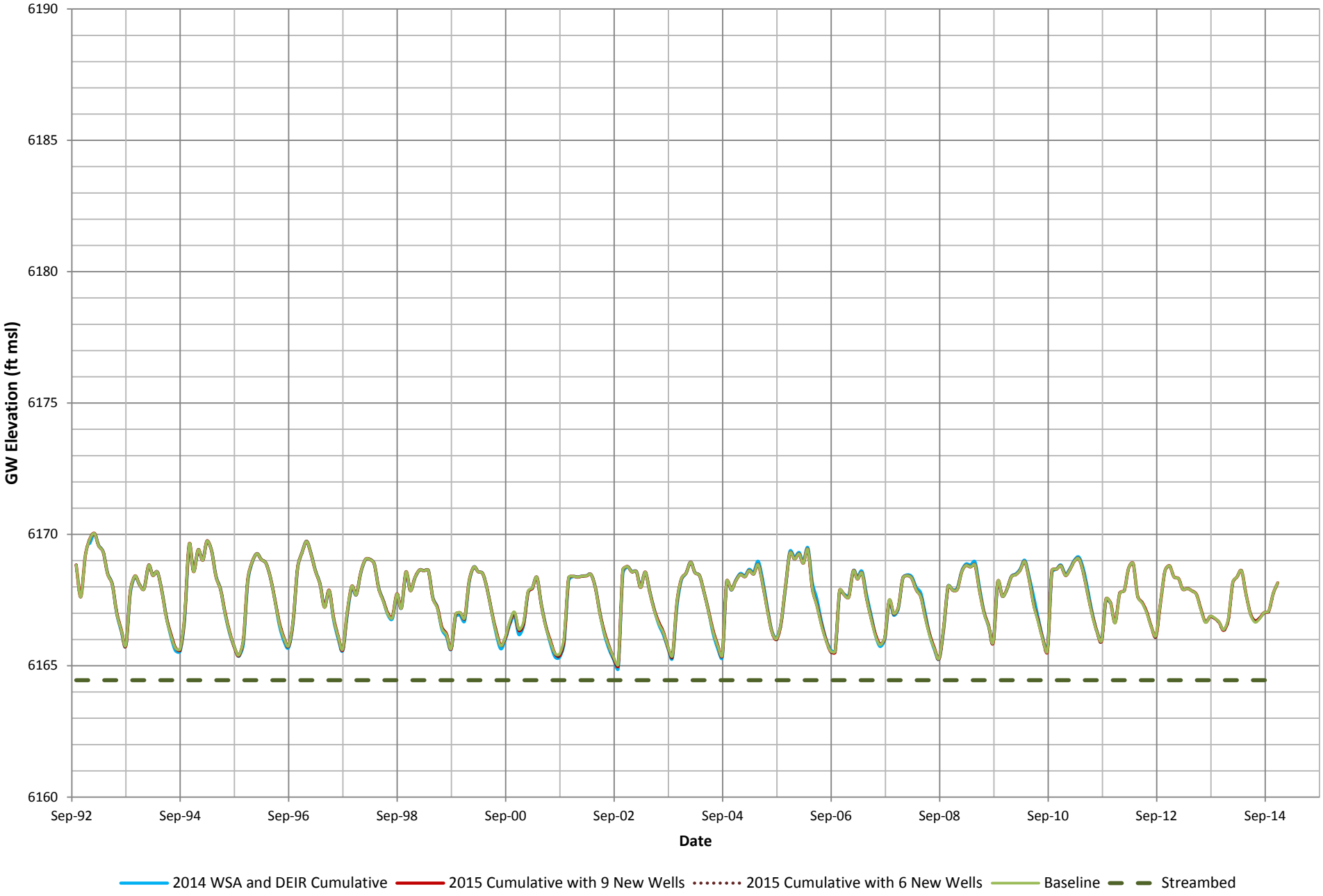
East Cell H Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



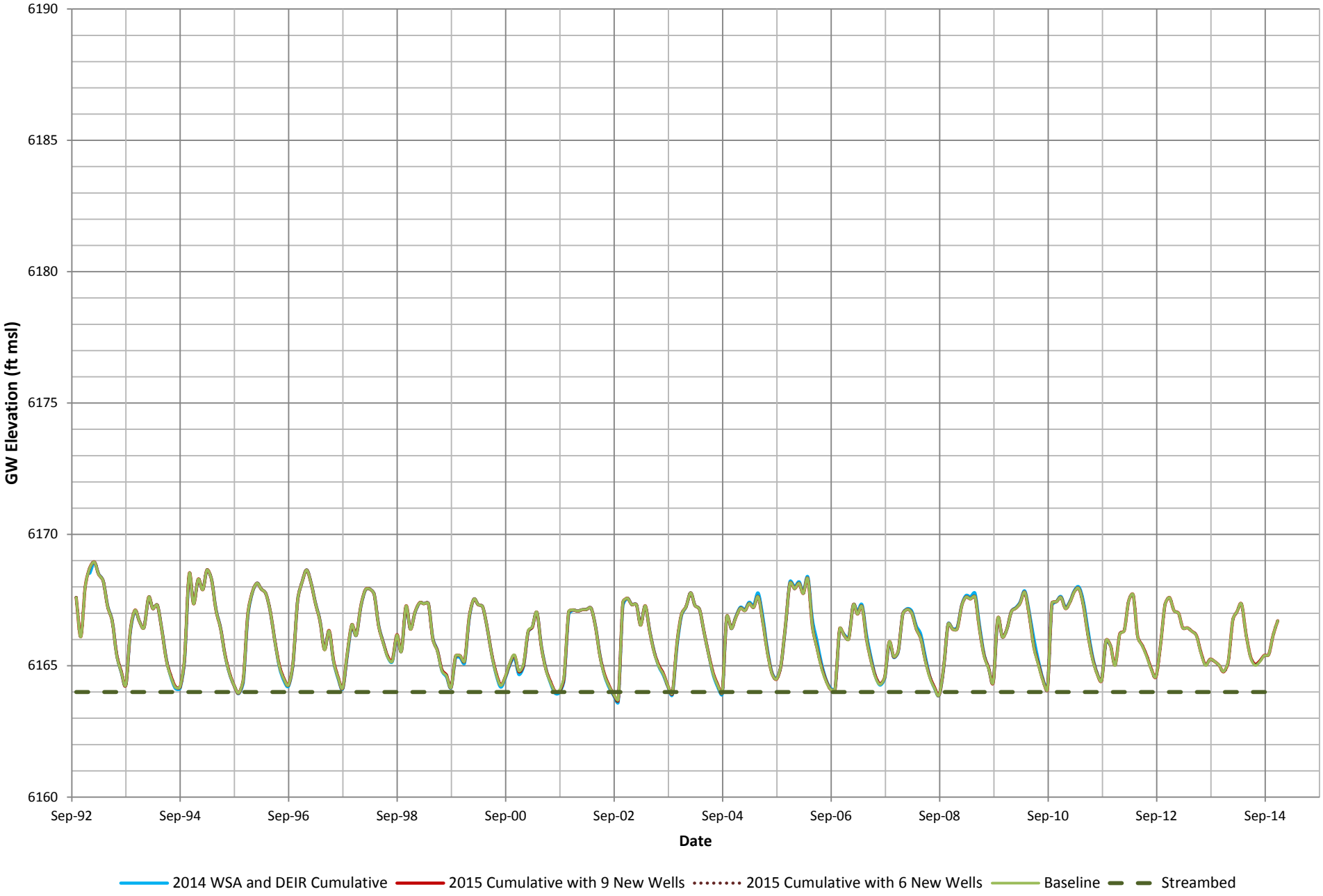
East Cell I Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



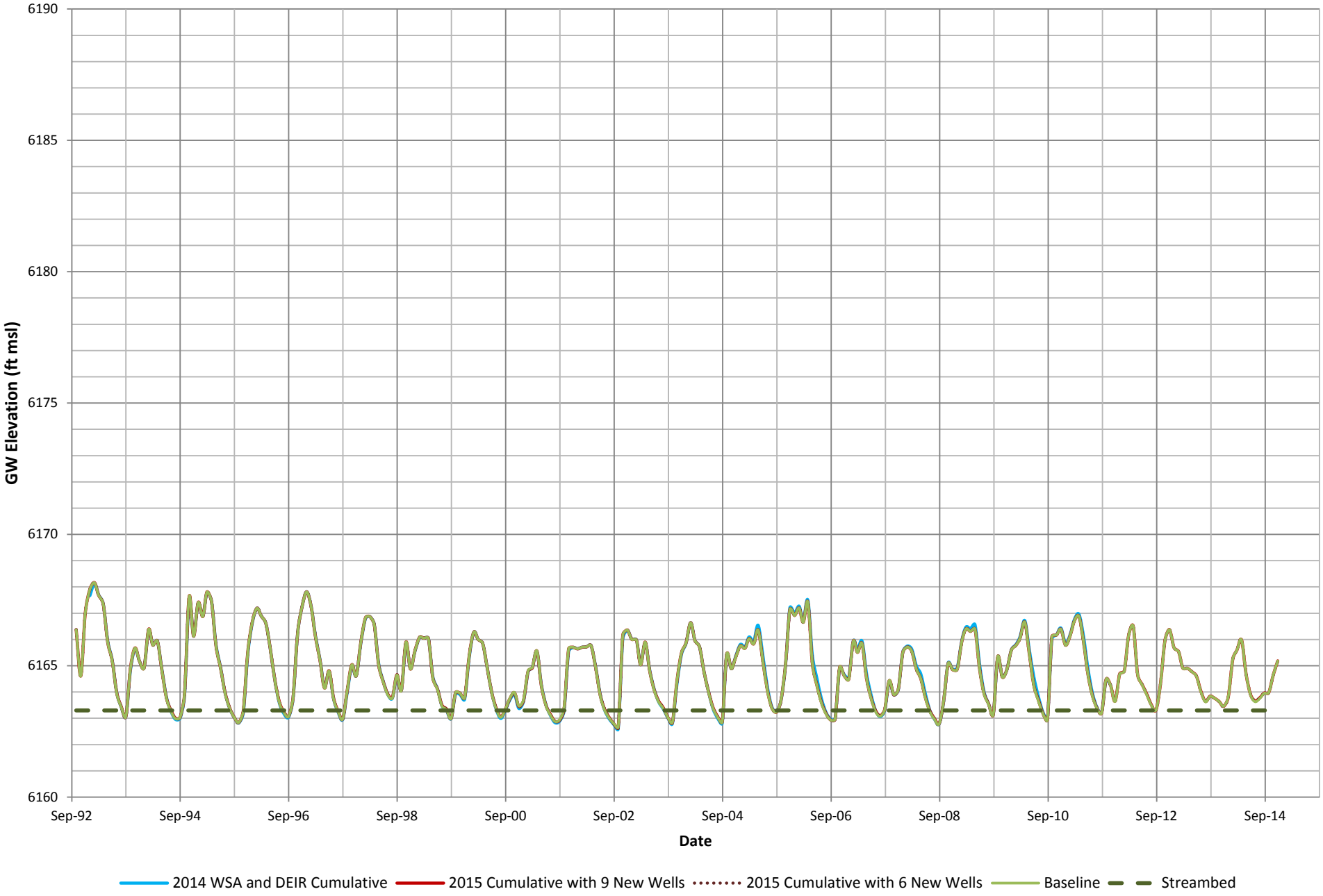
East Cell J Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



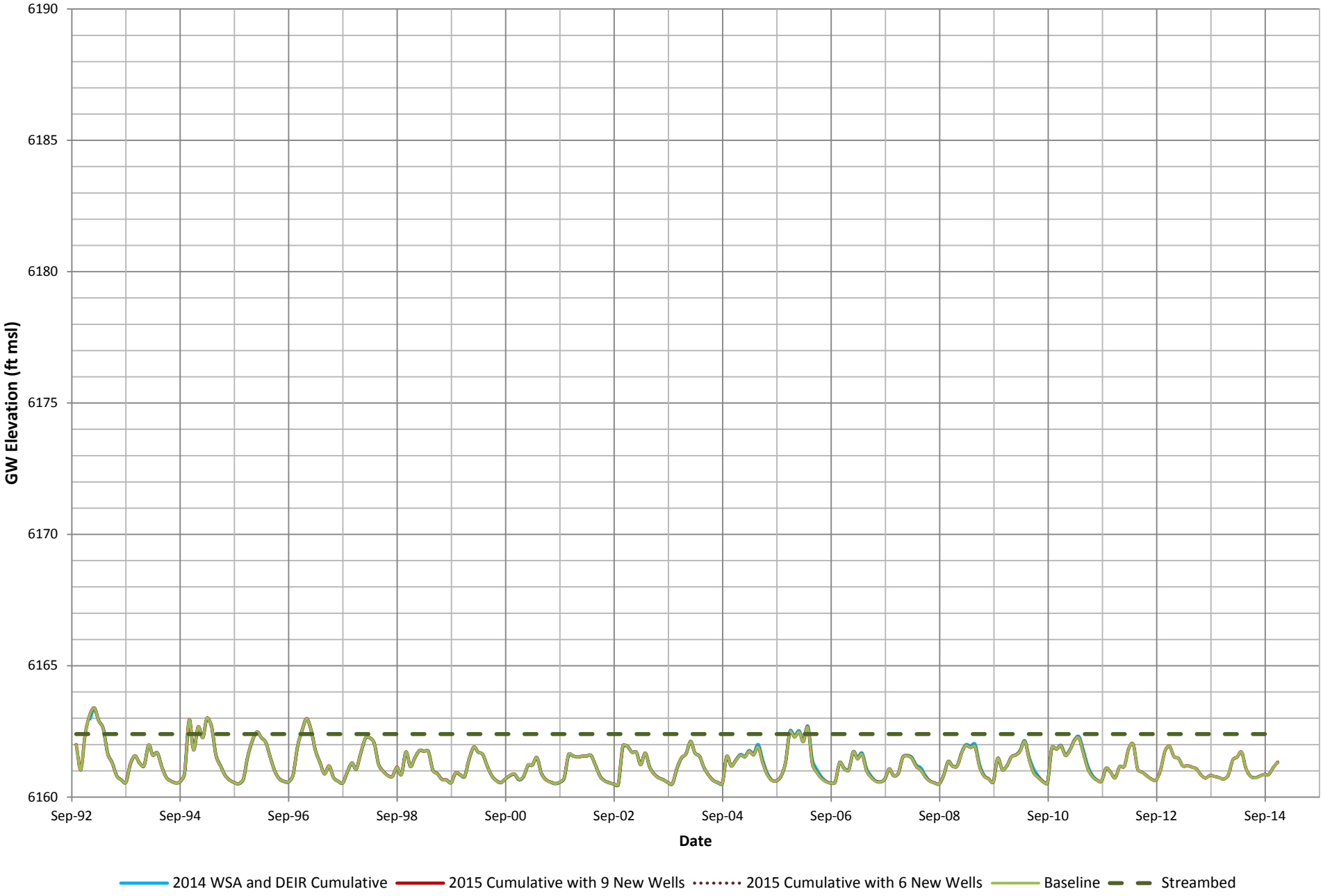
East Cell K Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



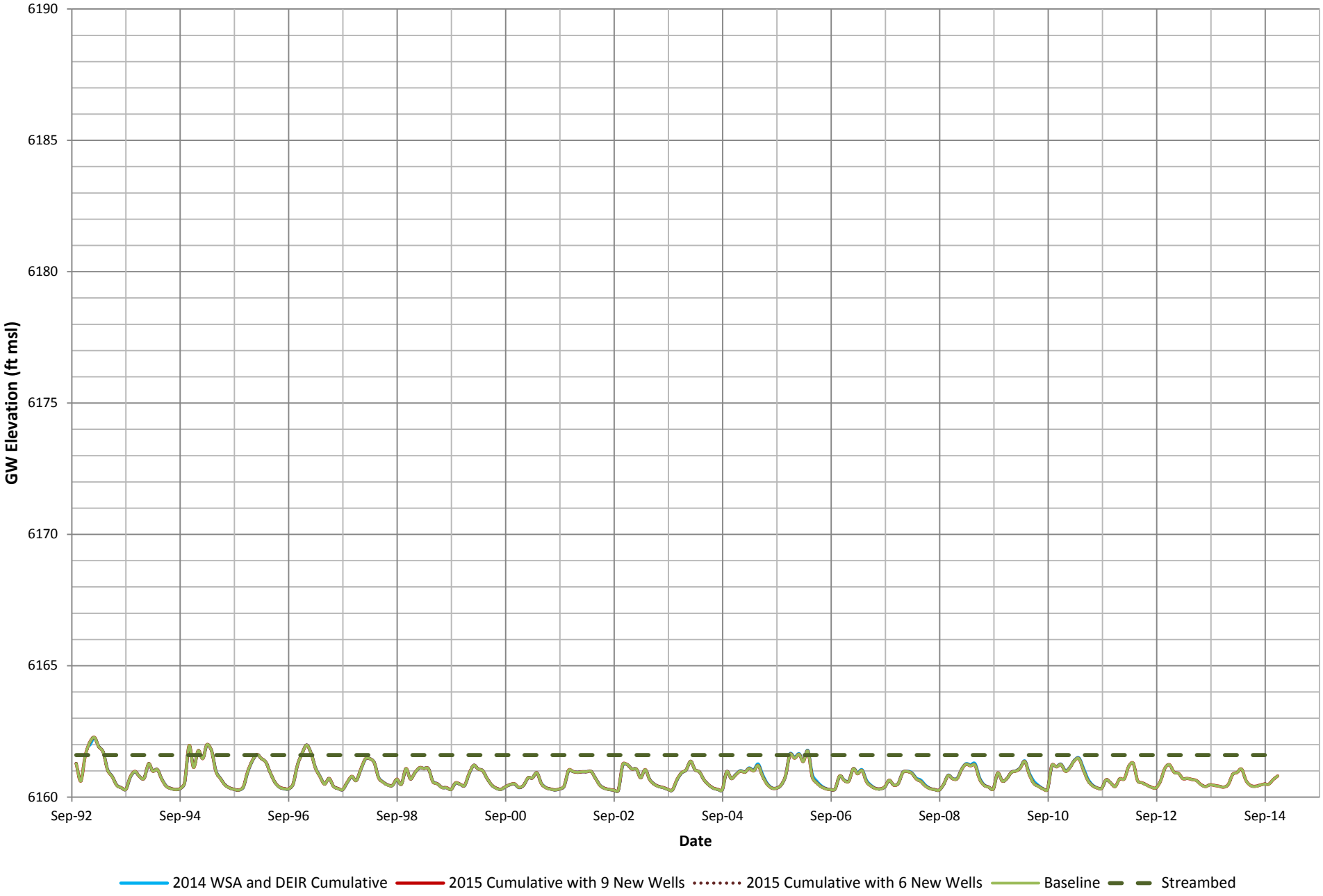
East Cell L Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



East Cell M Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



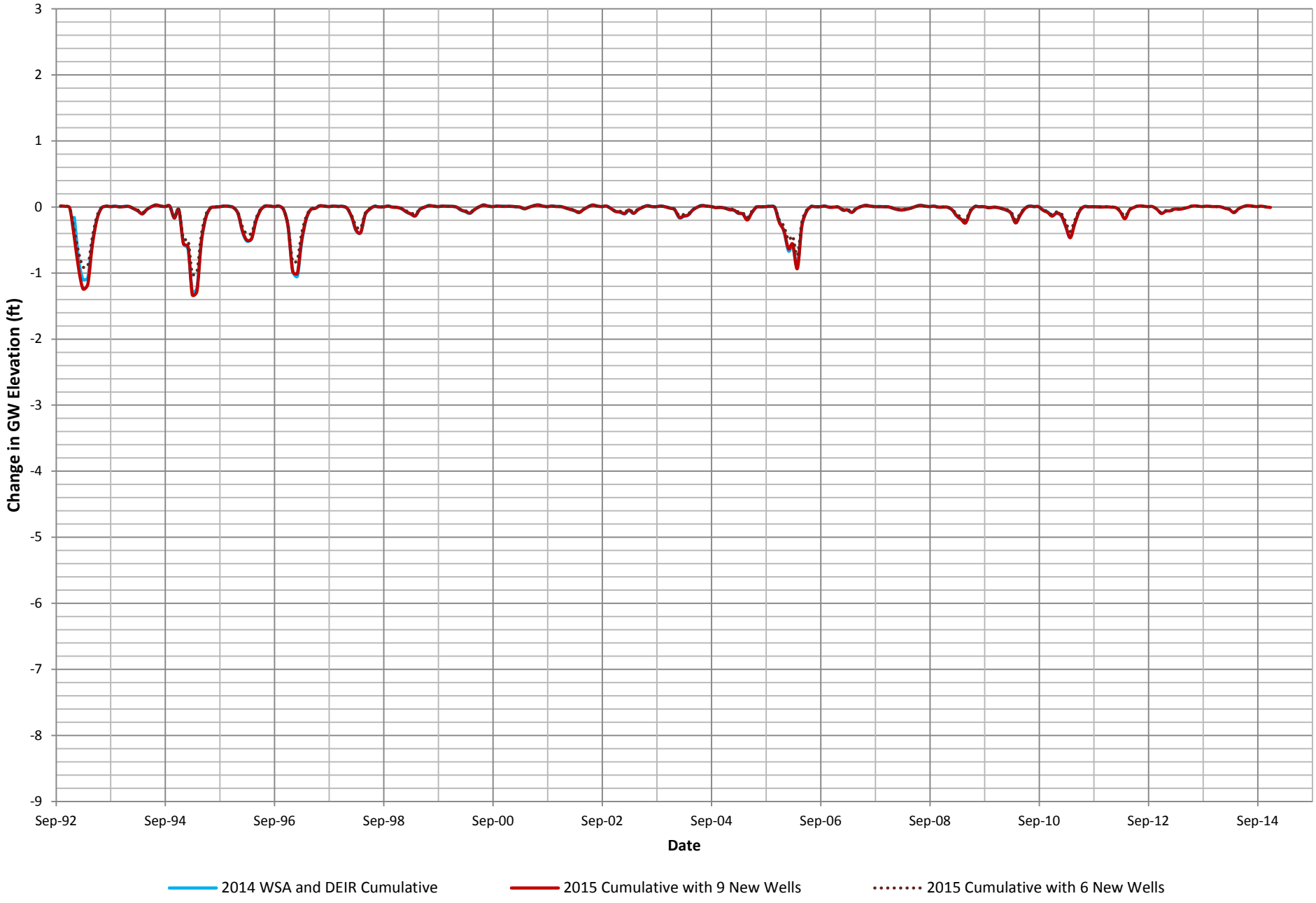
East Cell N Groundwater Elevations
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



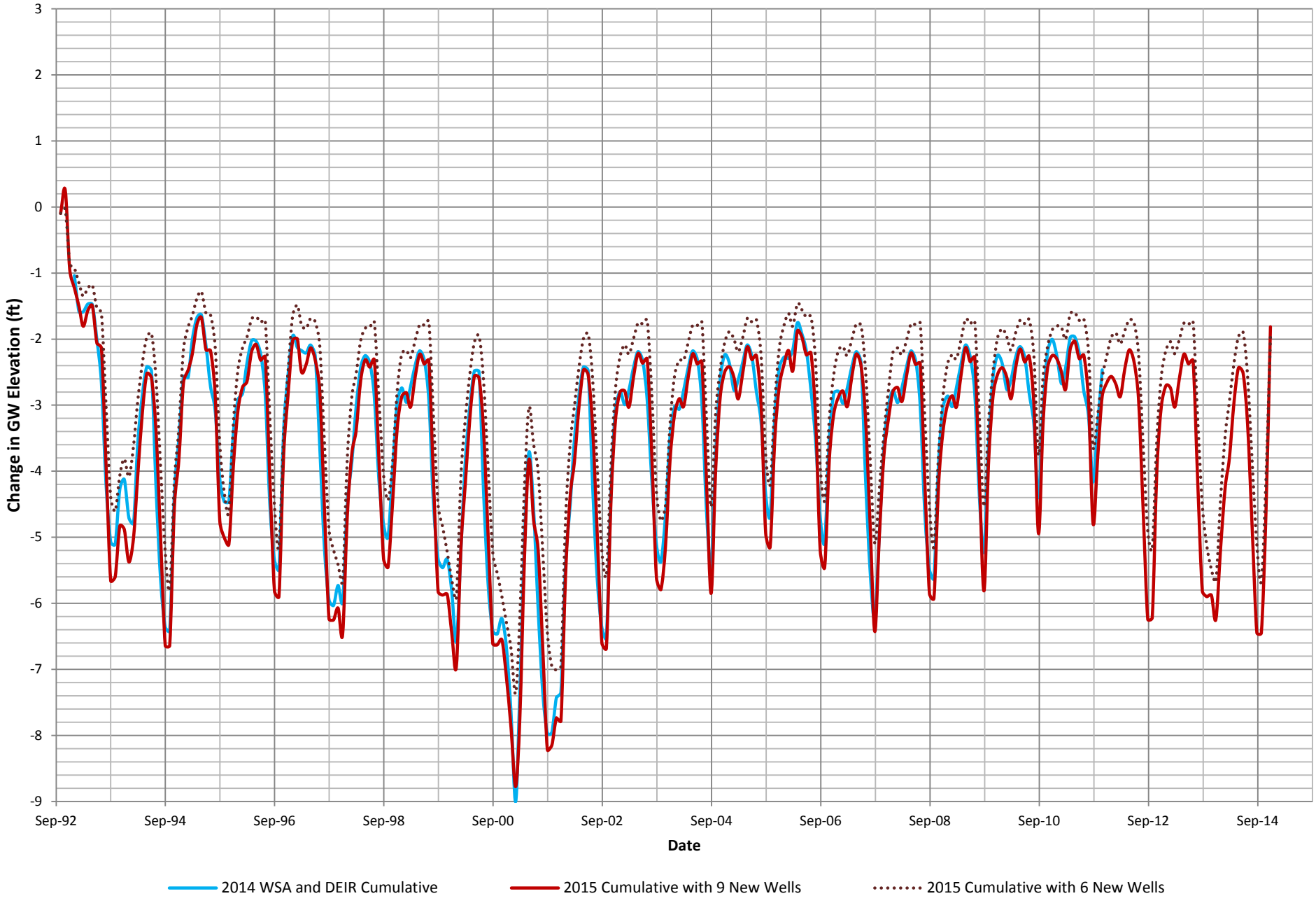
APPENDIX D

Model Simulated Changes in Groundwater Elevations vs. Baseline Beneath Squaw Creek, SVPSD Well 5R Off Late Summer through Fall

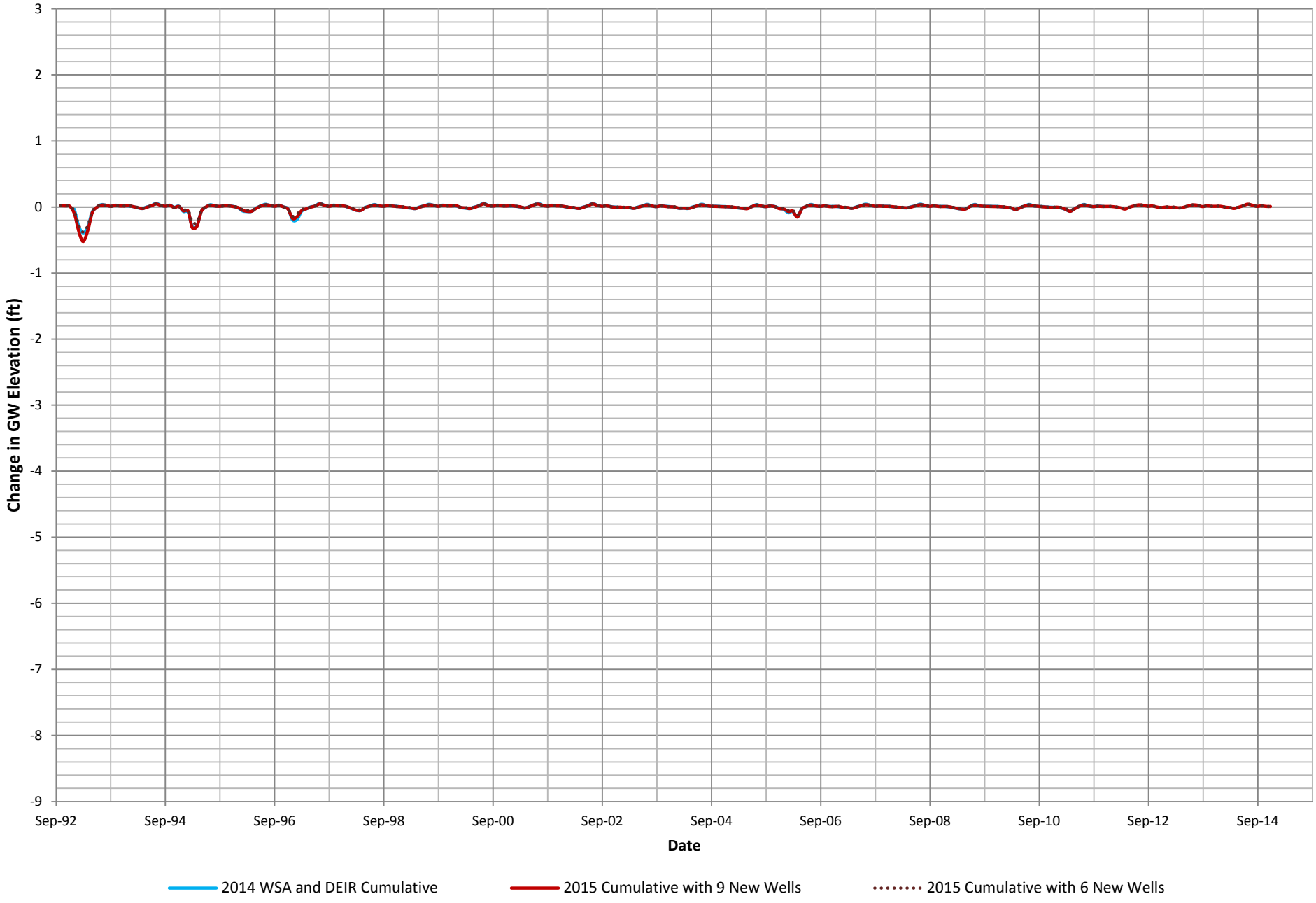
West Cell A Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



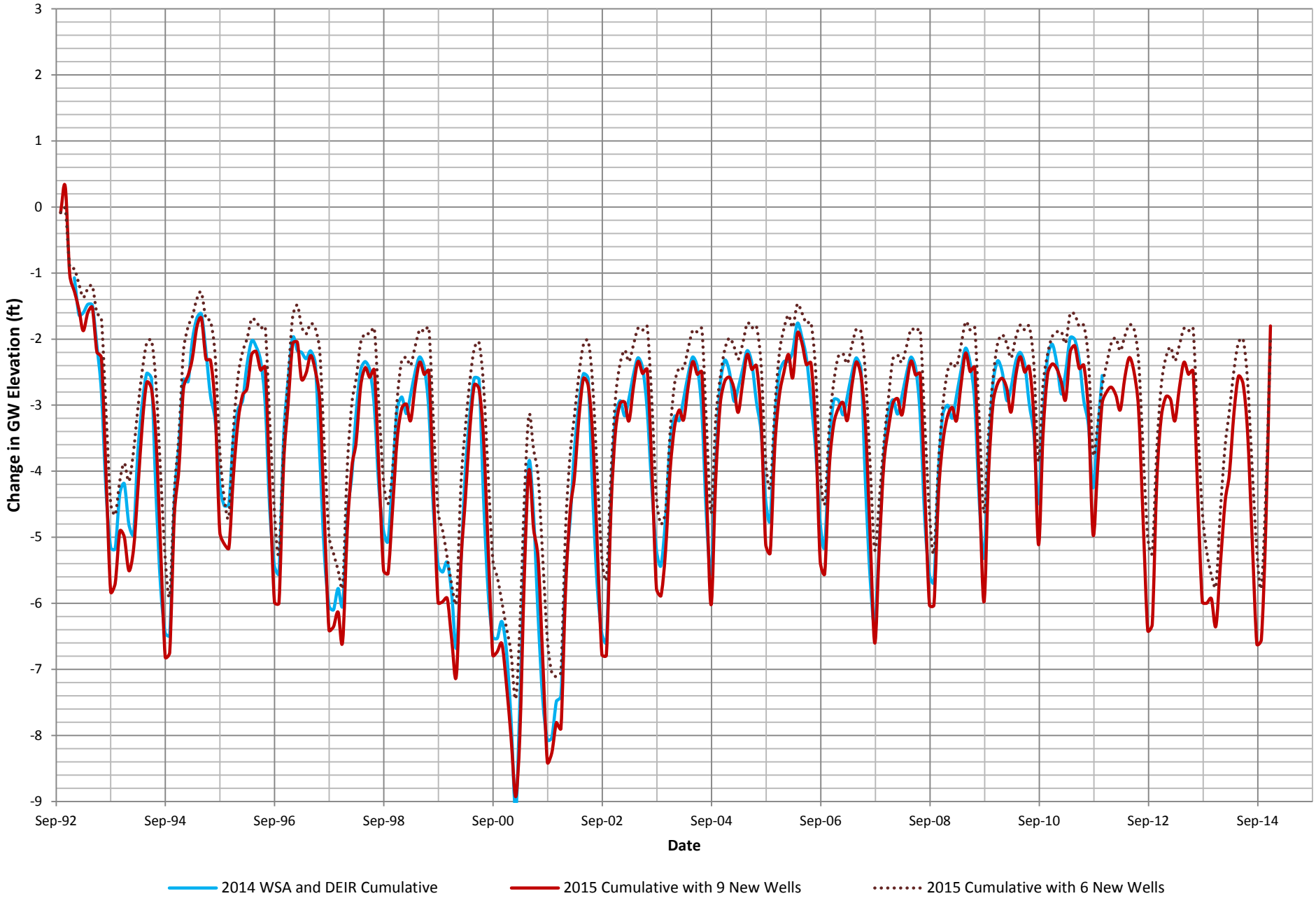
West Cell B Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



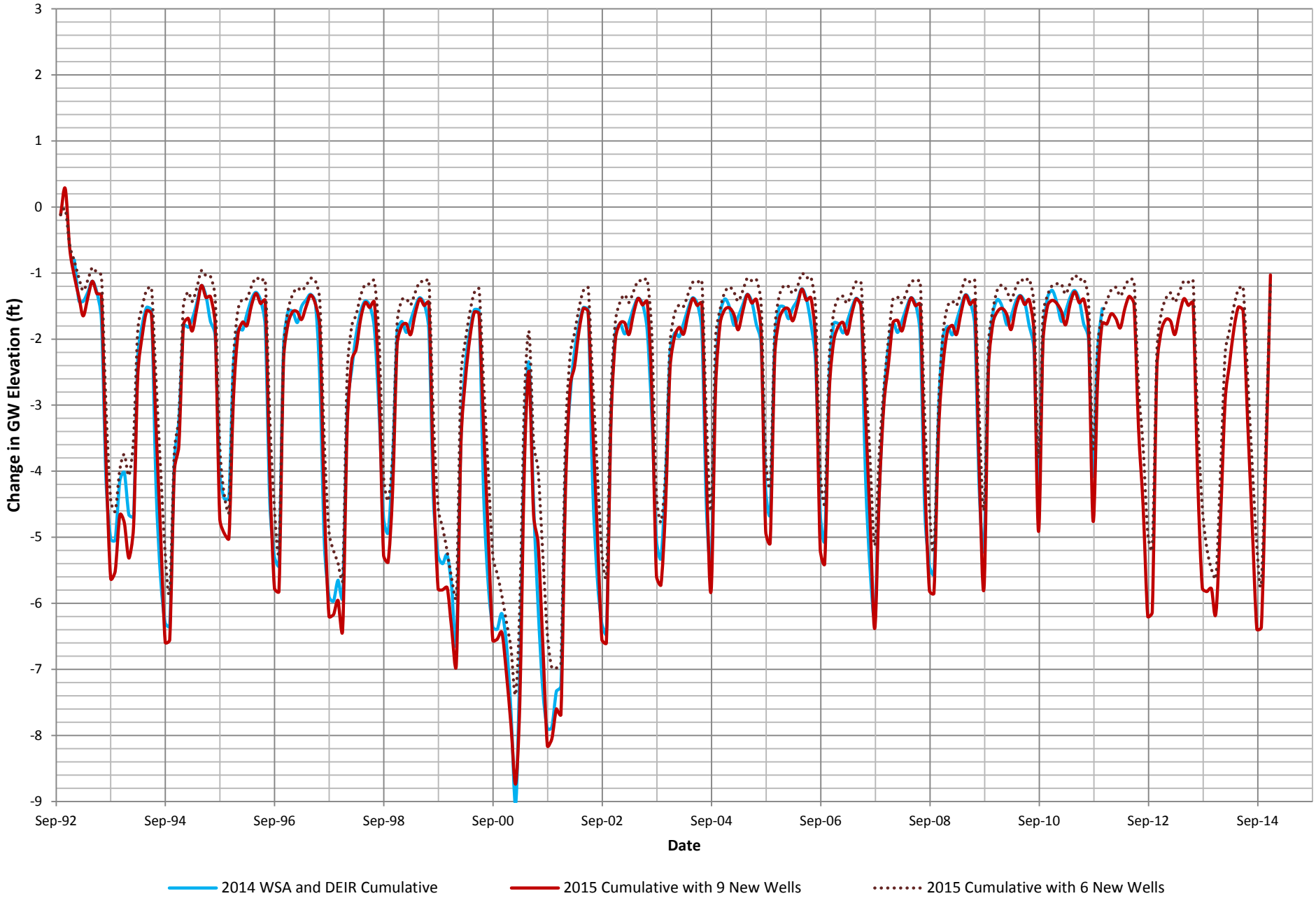
West Cell C Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



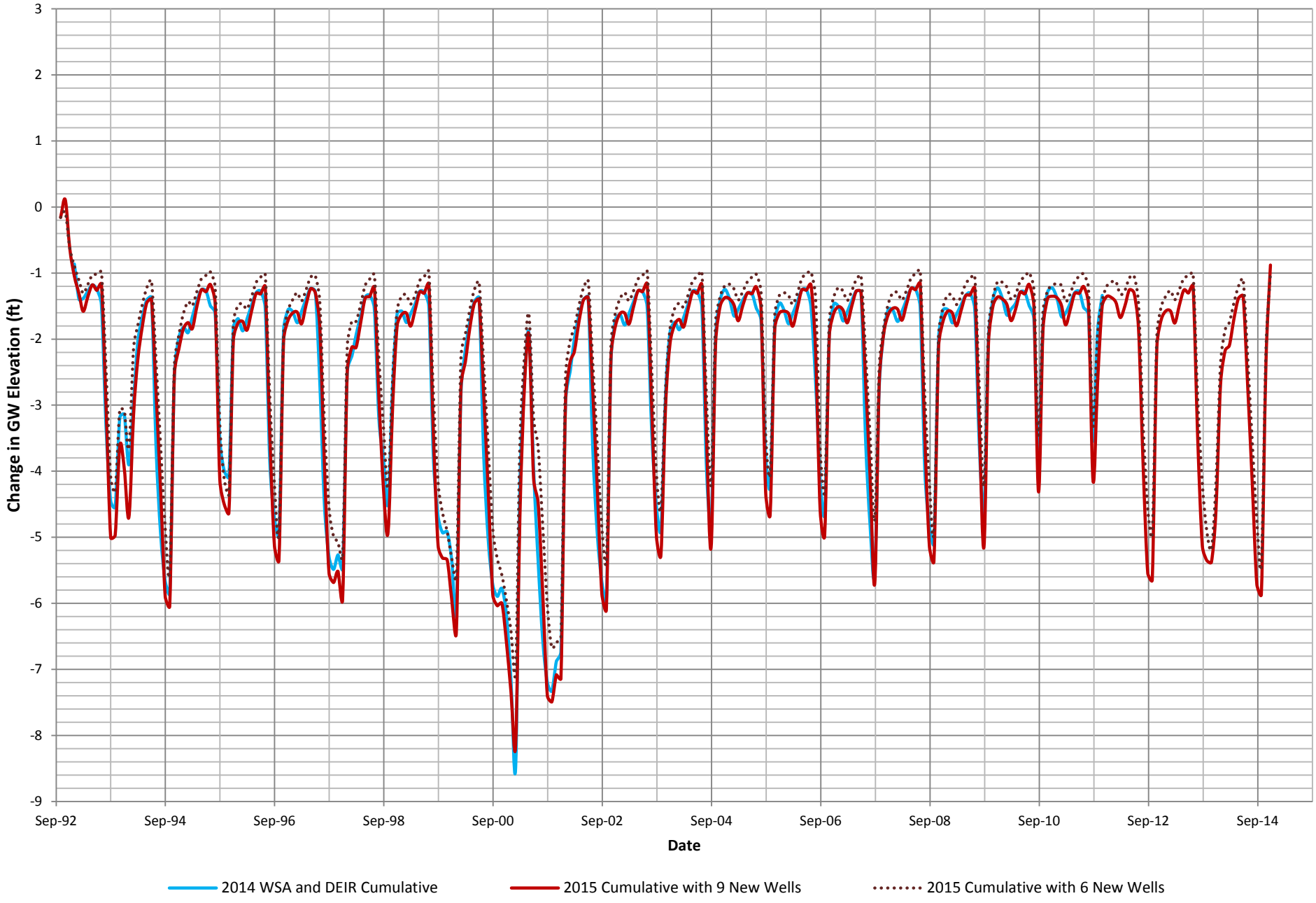
West Cell D Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



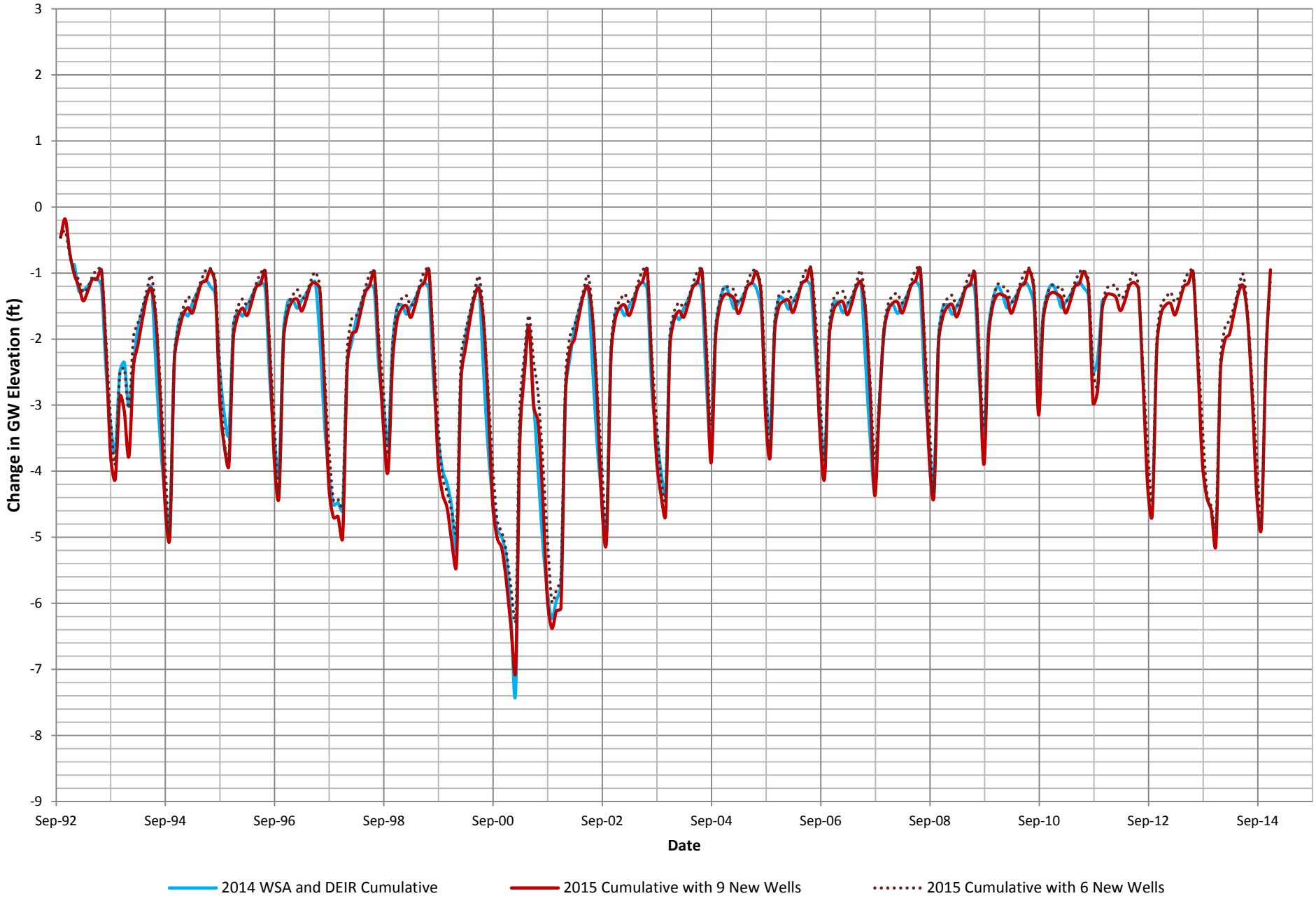
West Cell E Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



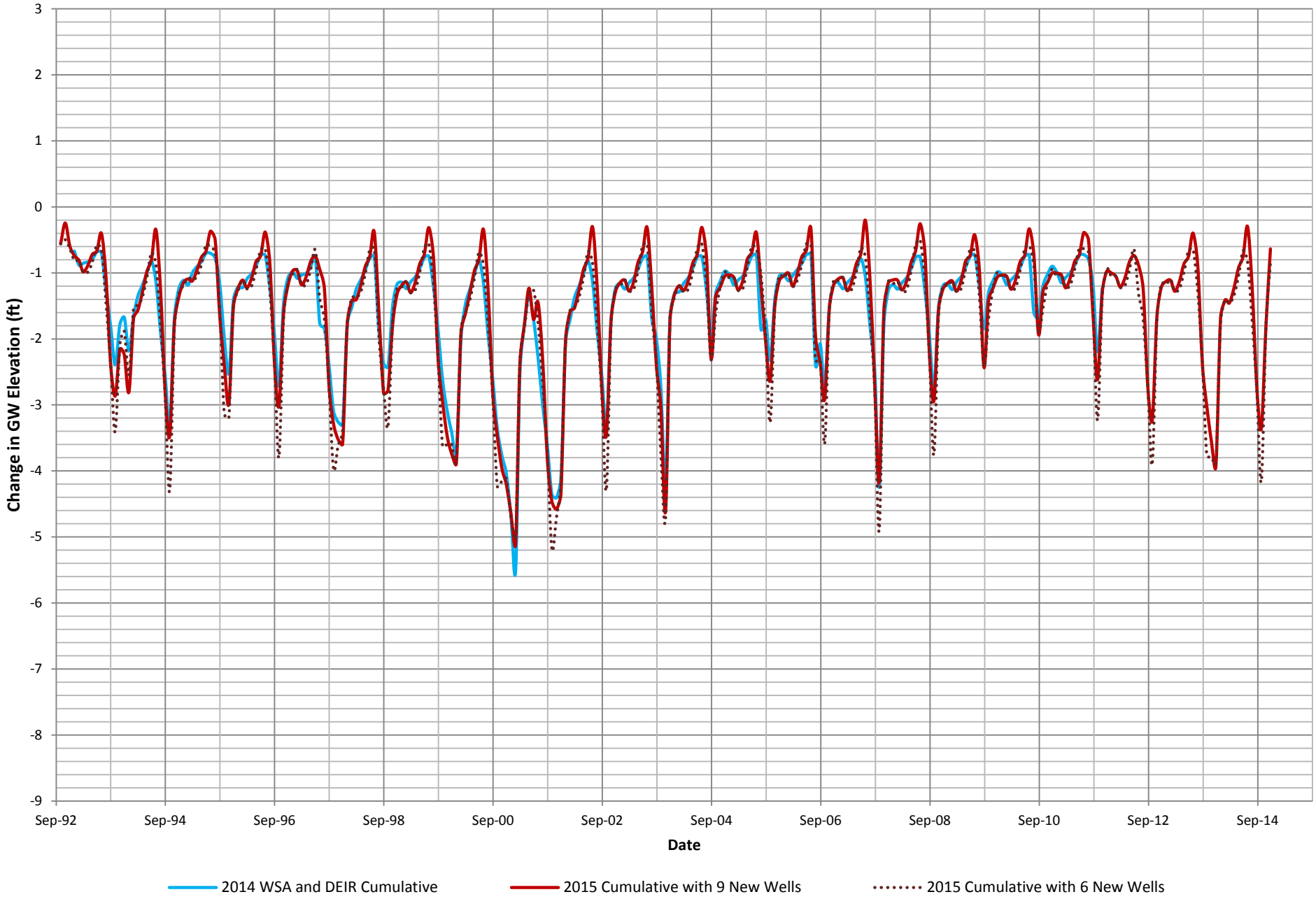
West Cell F Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



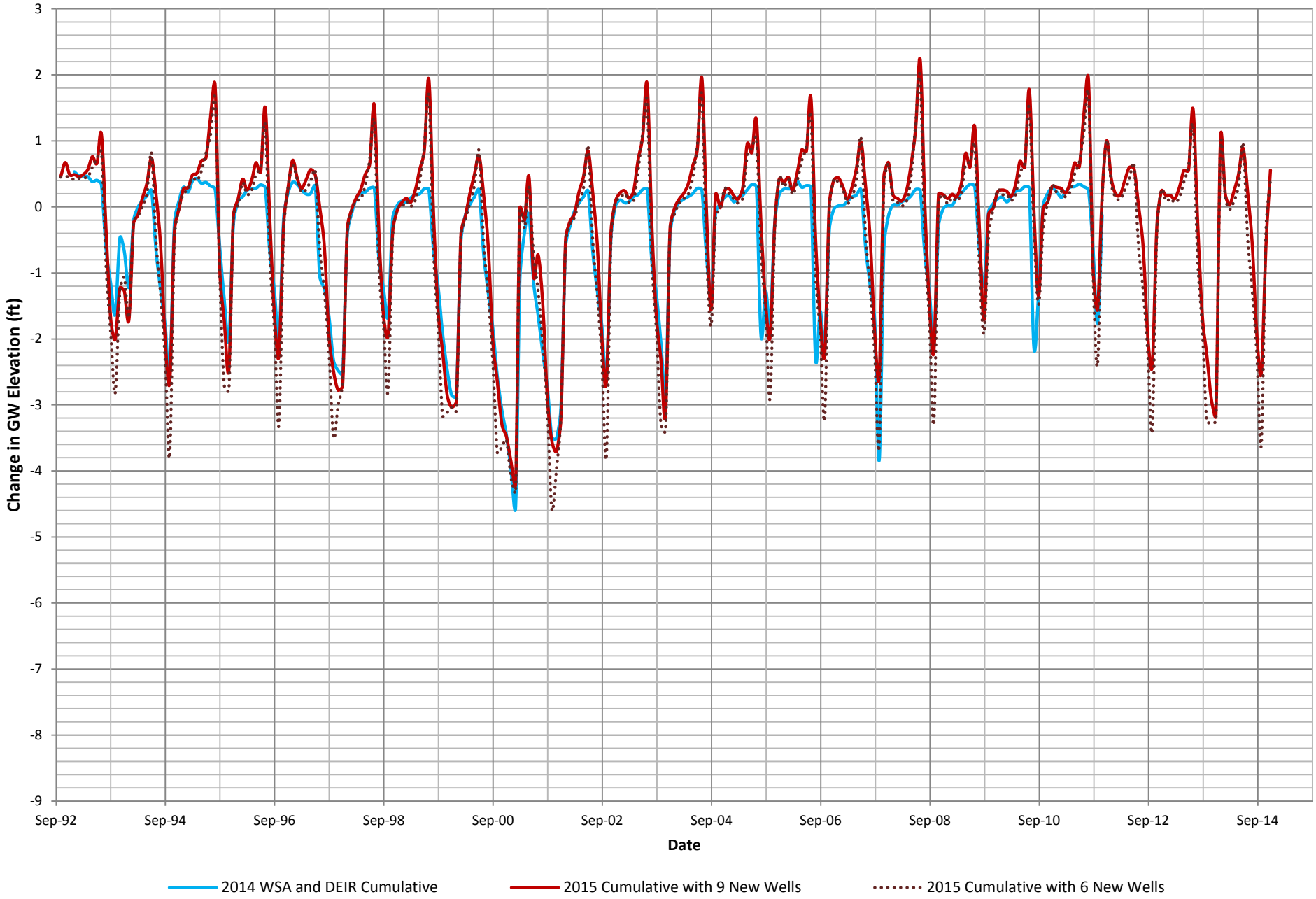
West Cell G Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



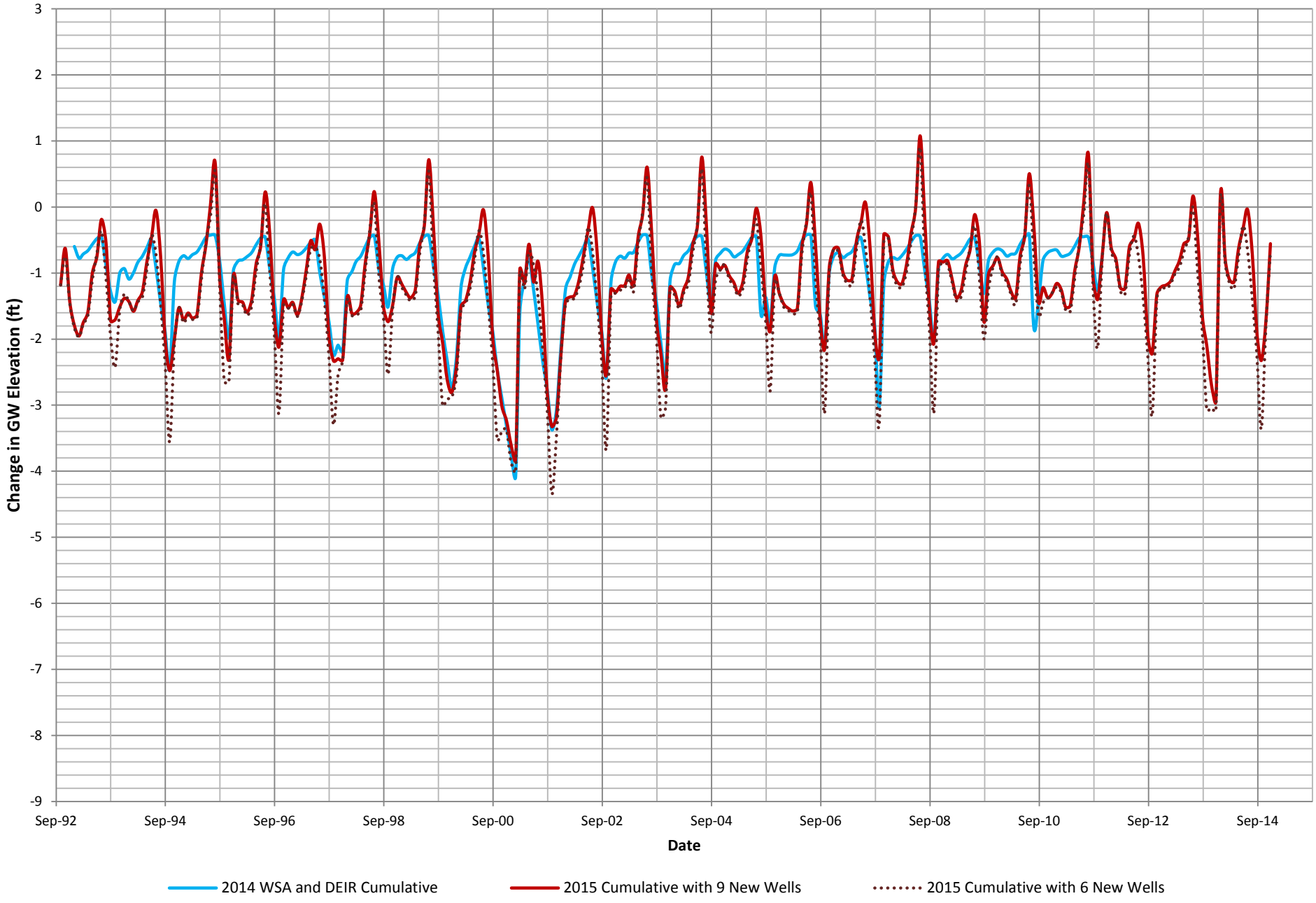
West Cell H Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



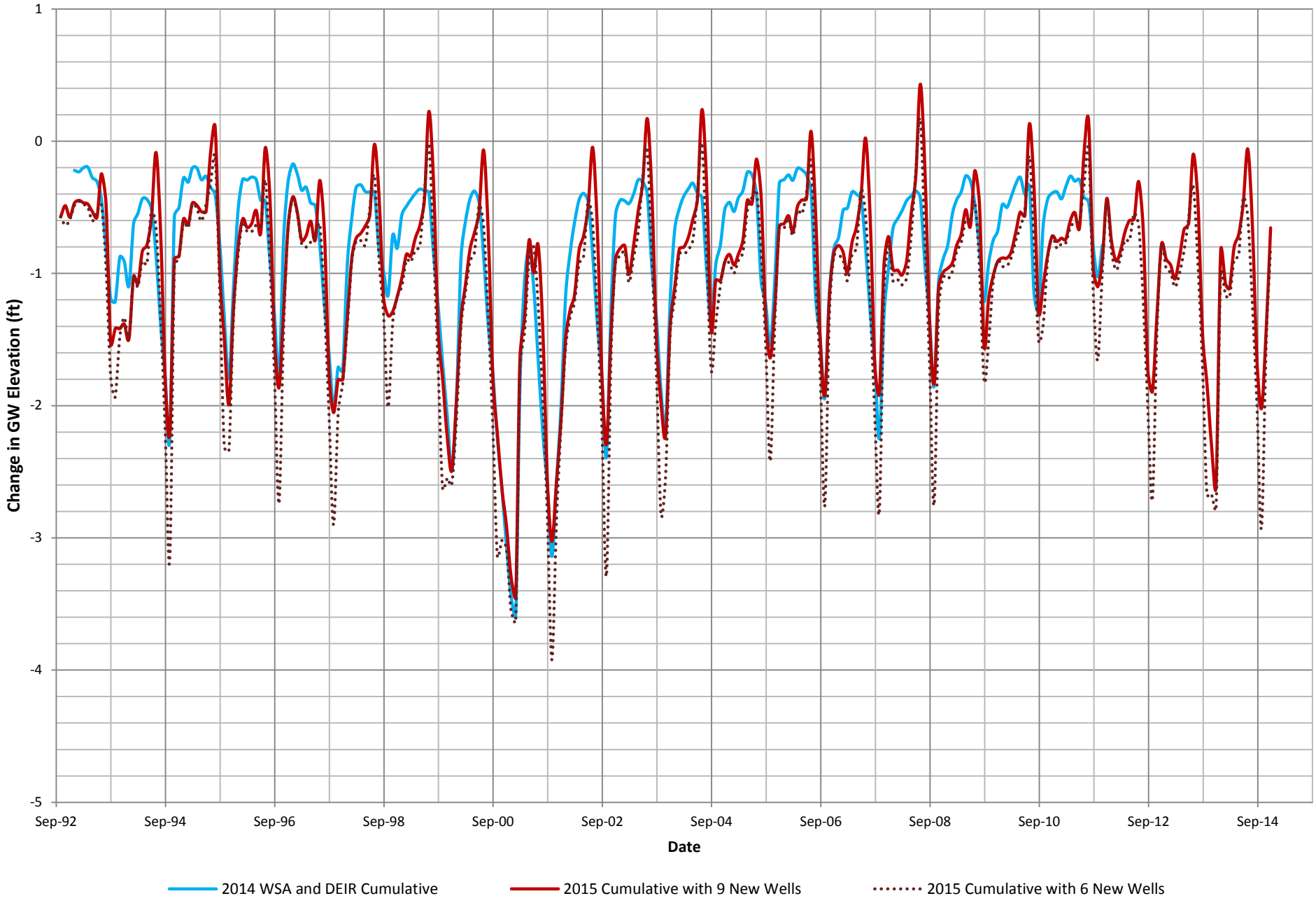
West Cell I Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



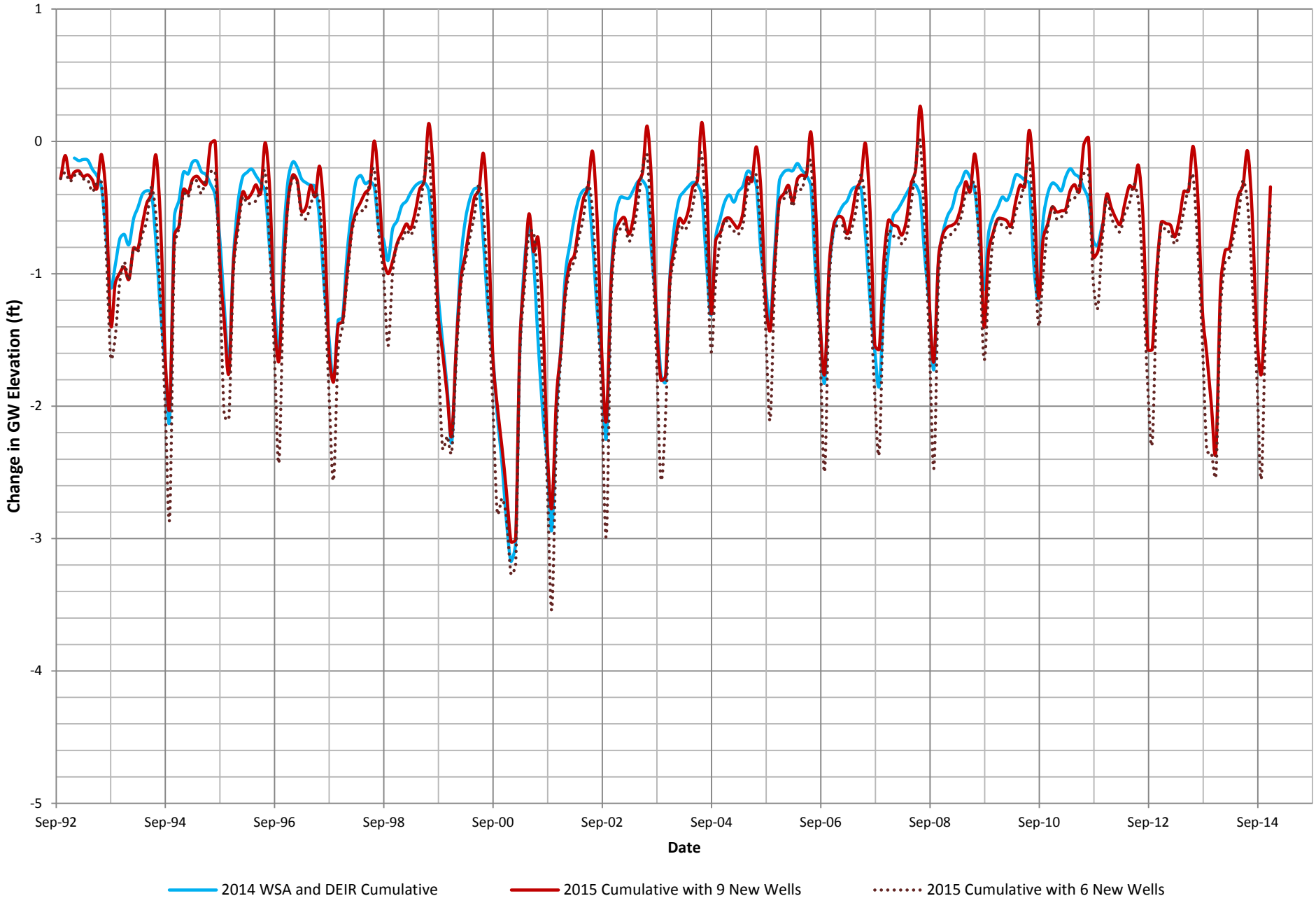
West Cell J Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



East Cell A Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



East Cell B Change in Groundwater Elevations, Future vs. Baseline
Model Simulations with SVPSD Well 5R Off in Late Summer/Fall and DEIR



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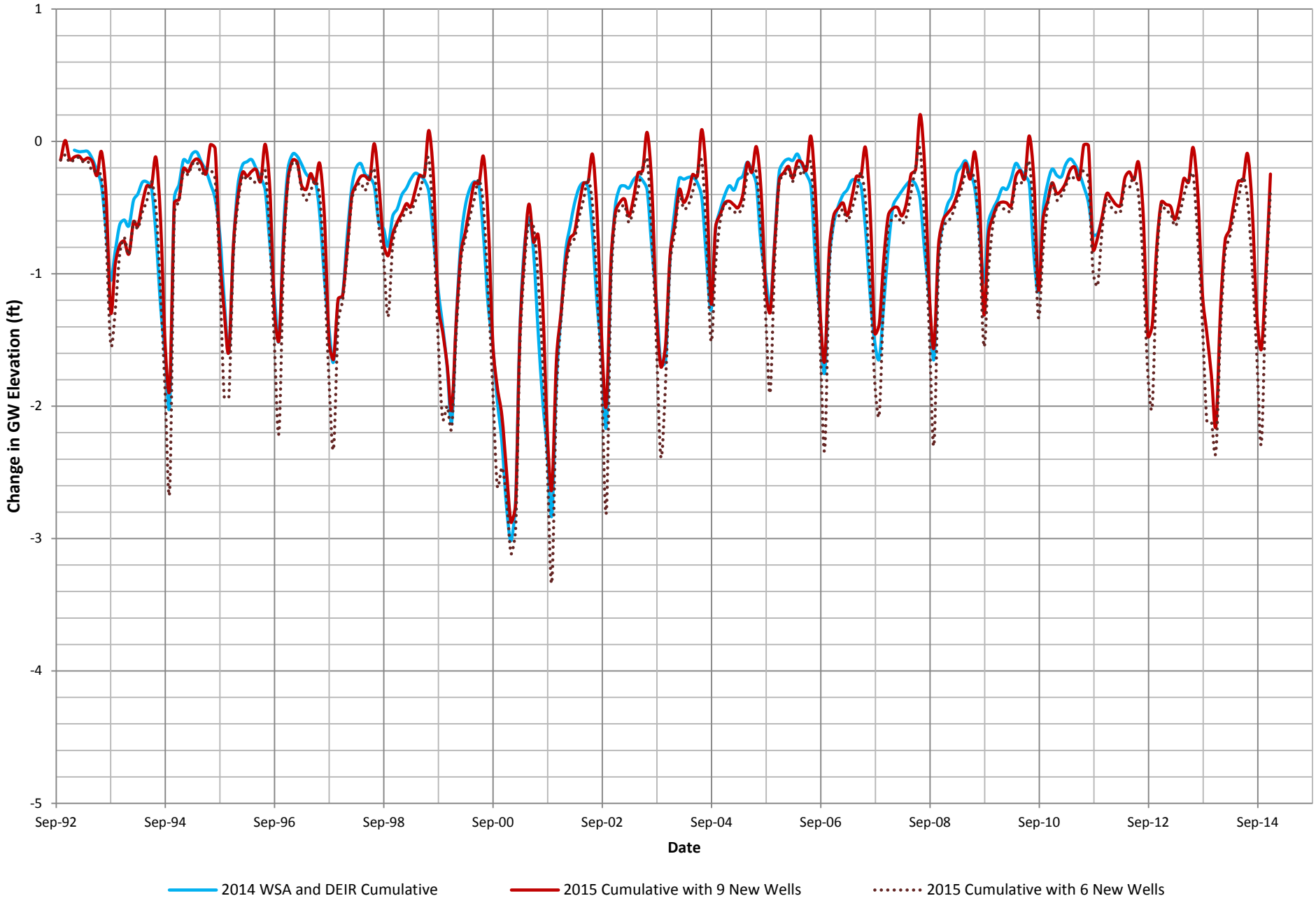

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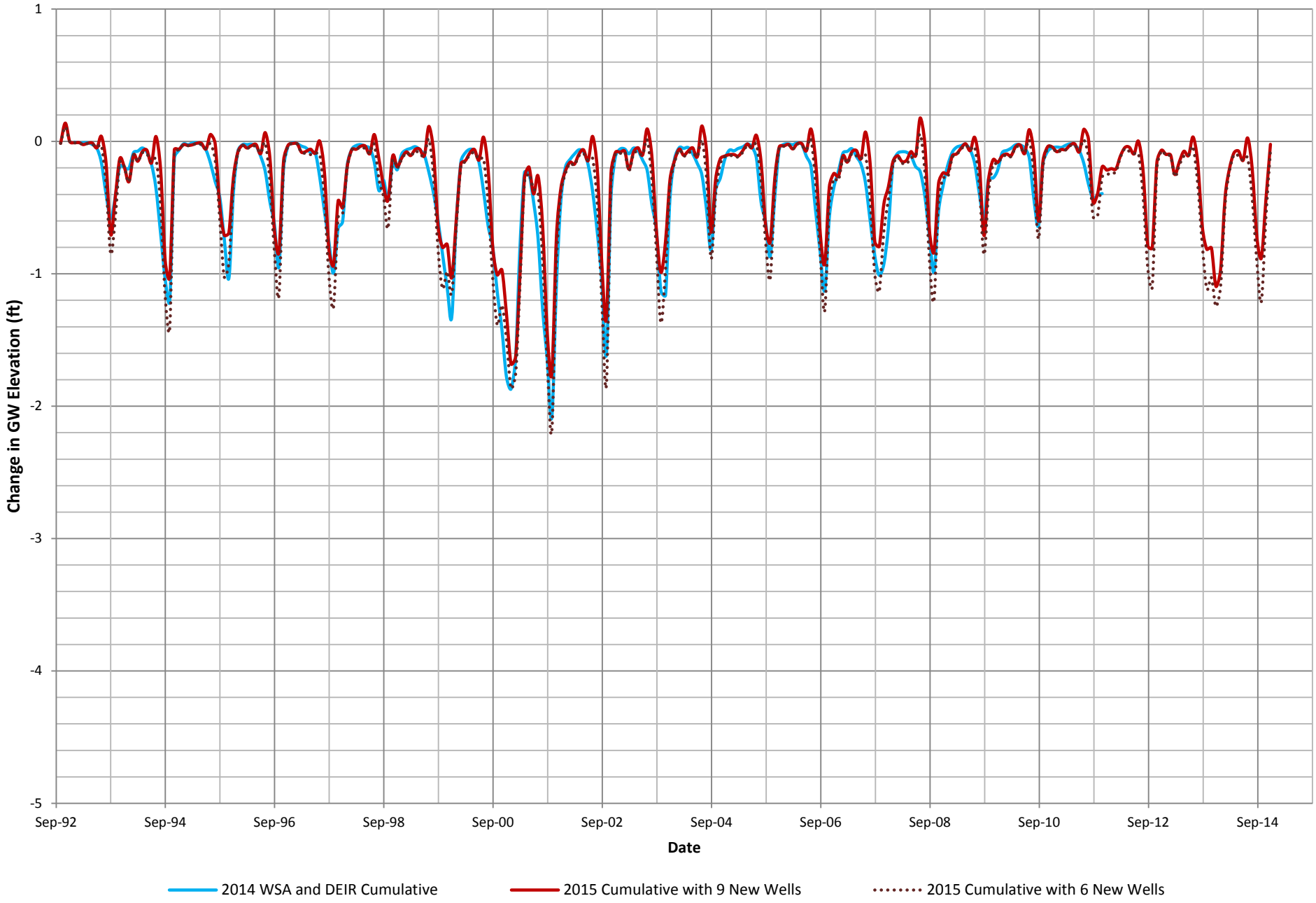

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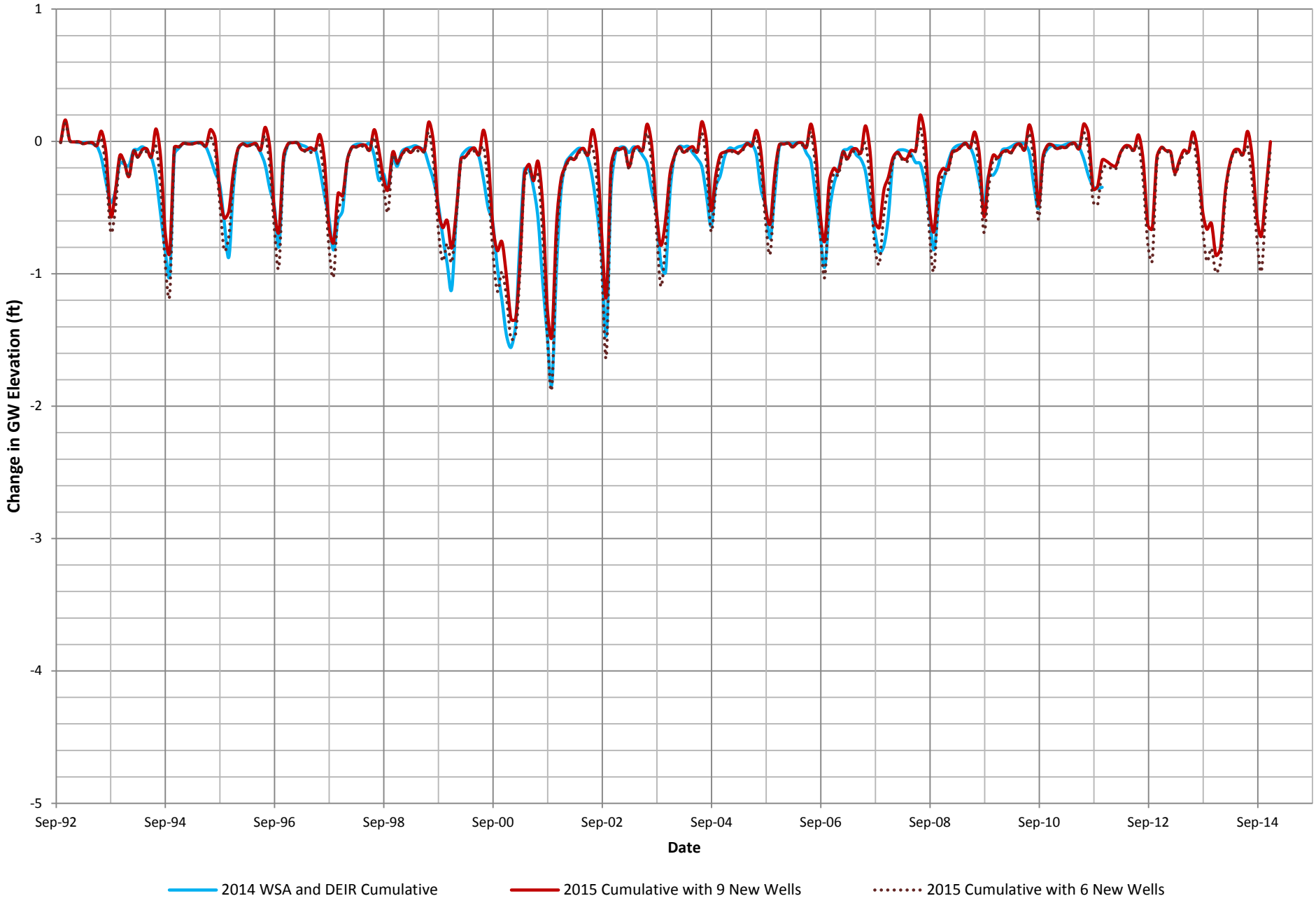

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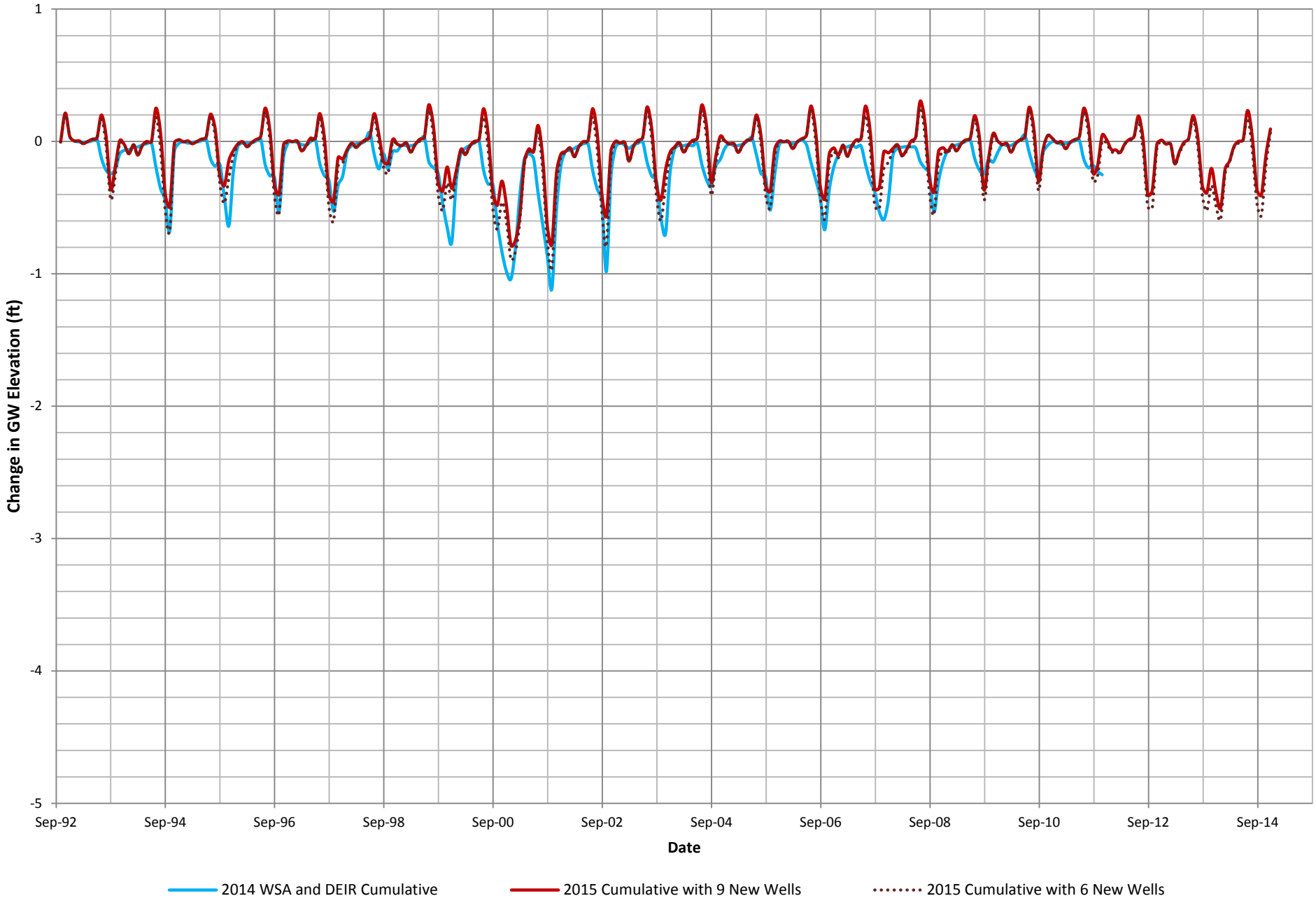

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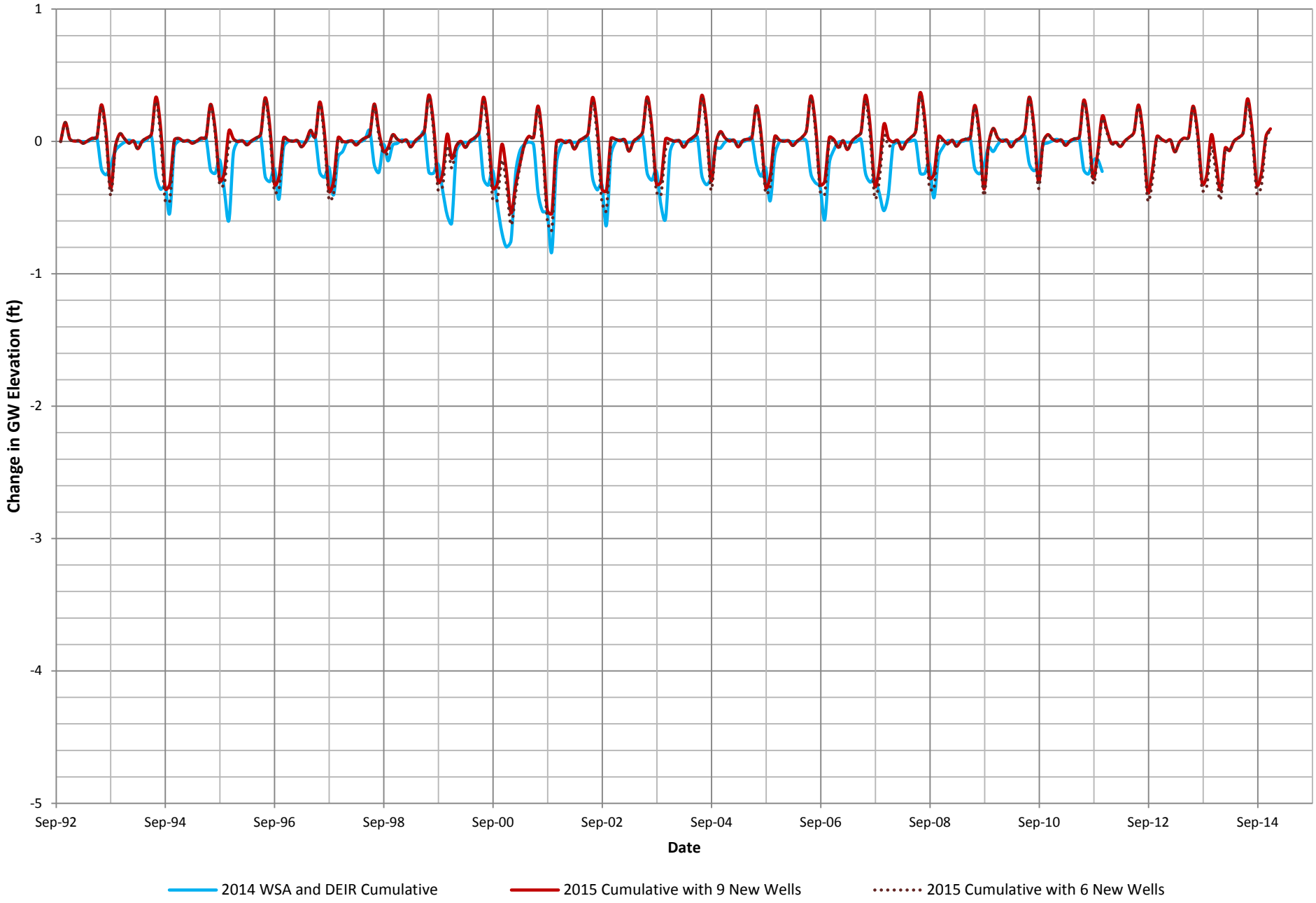

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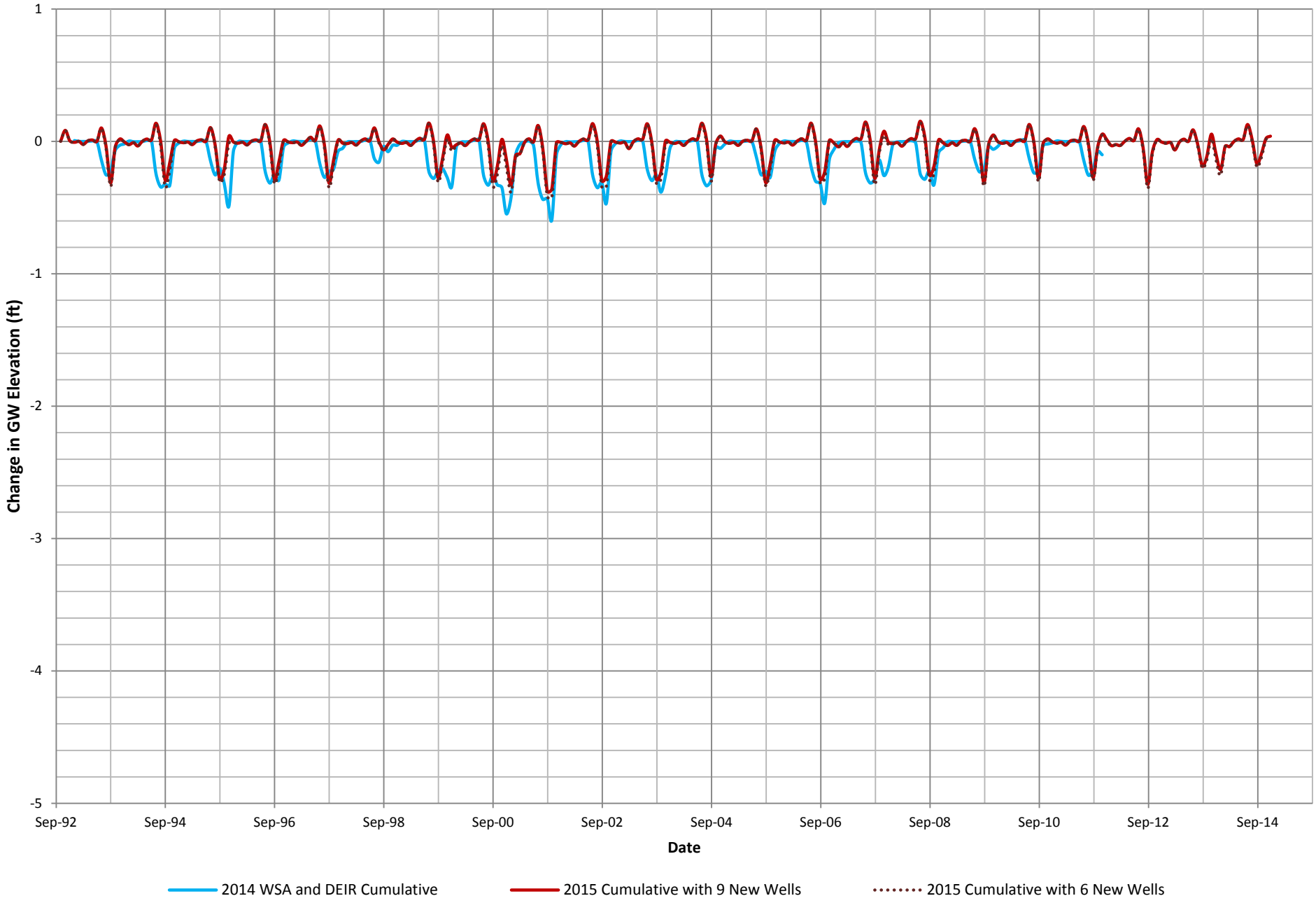

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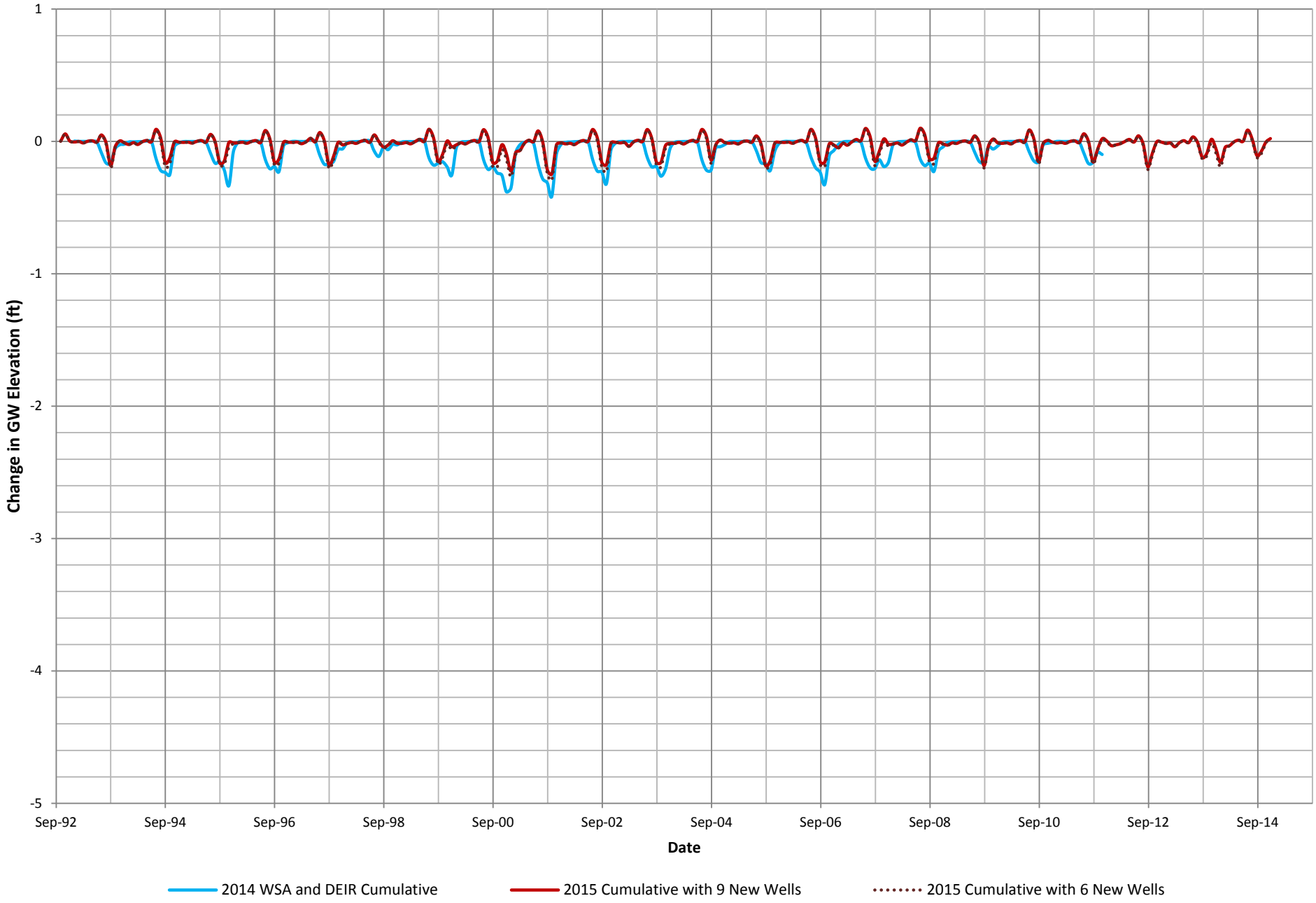

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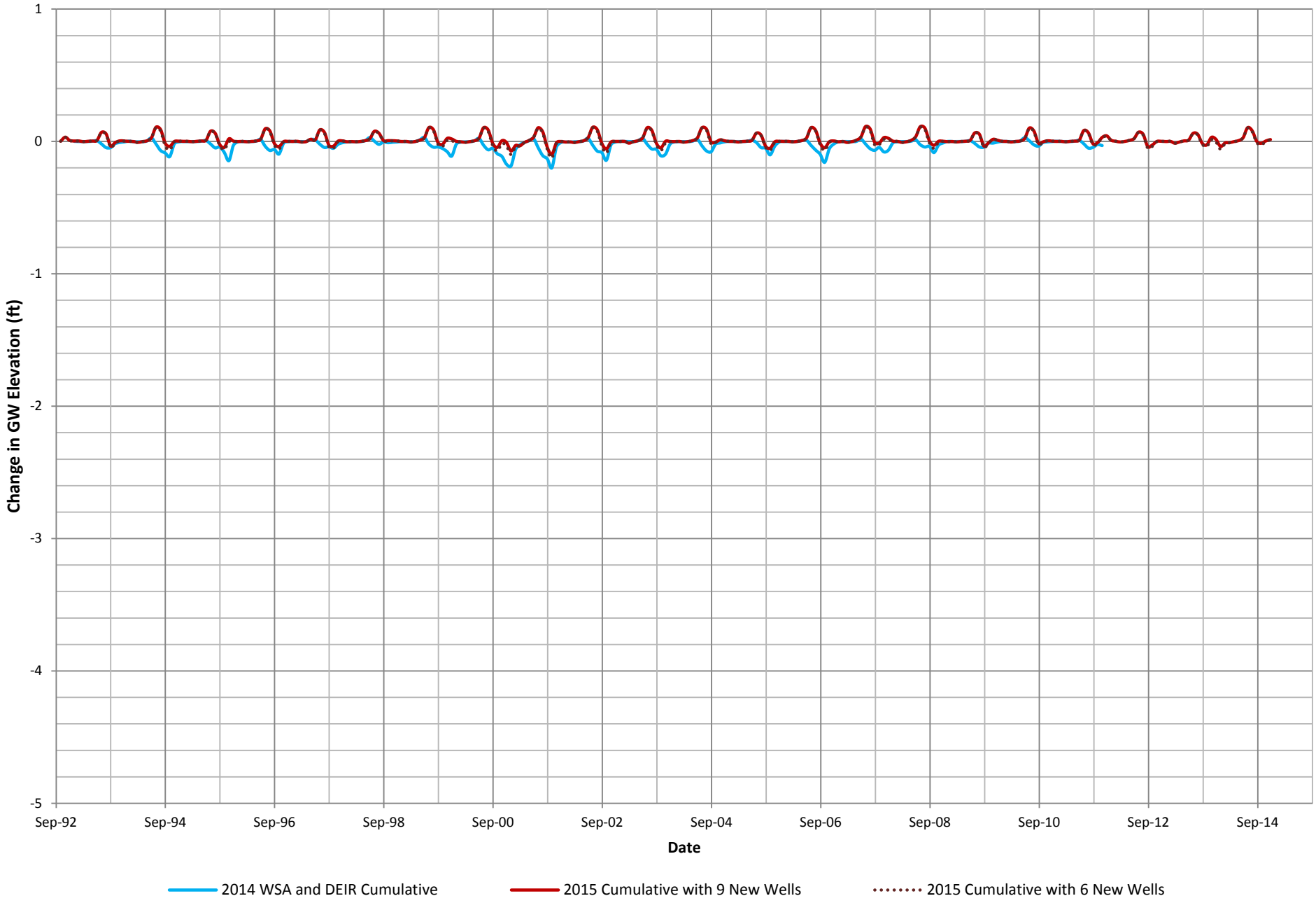

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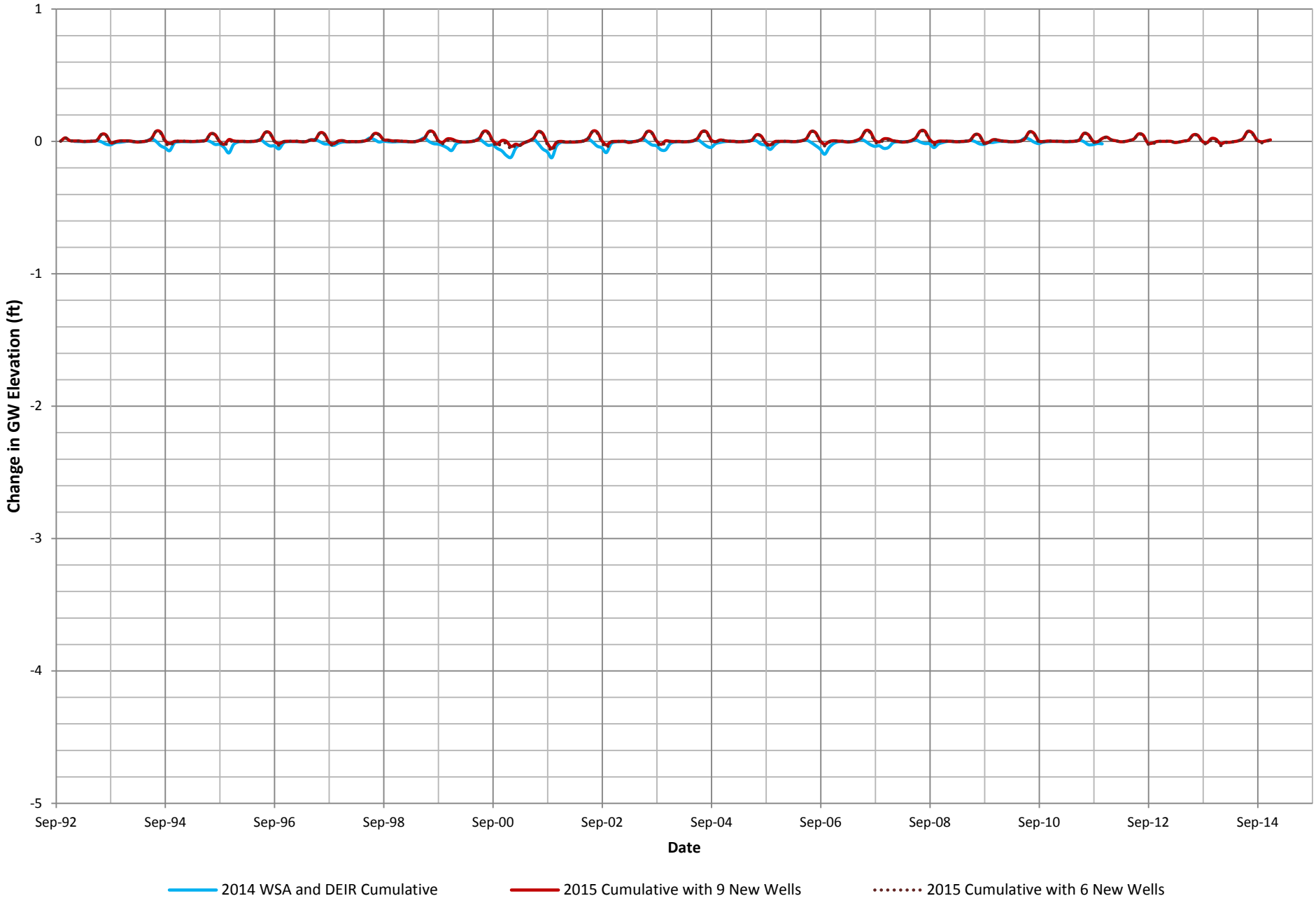

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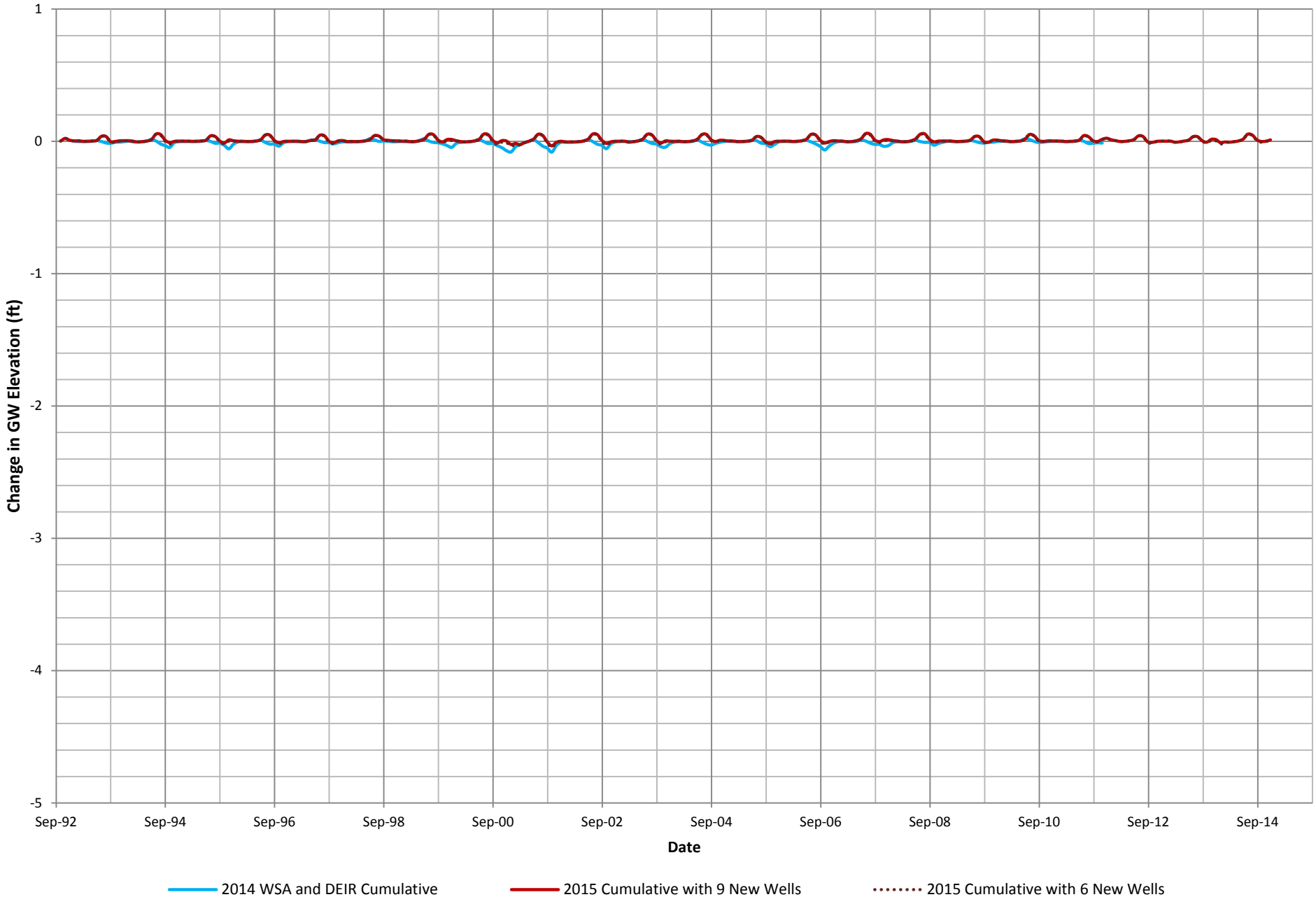

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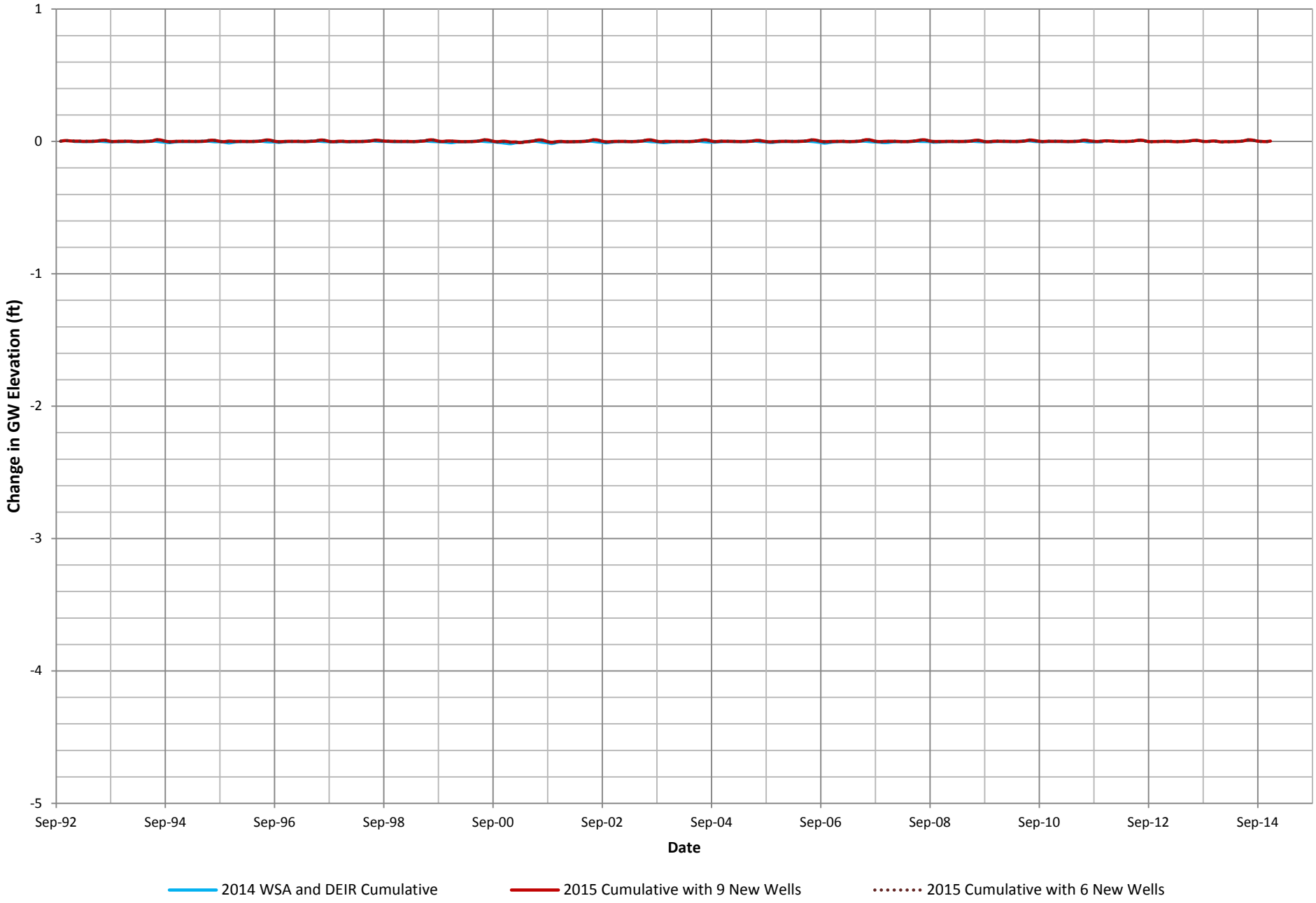

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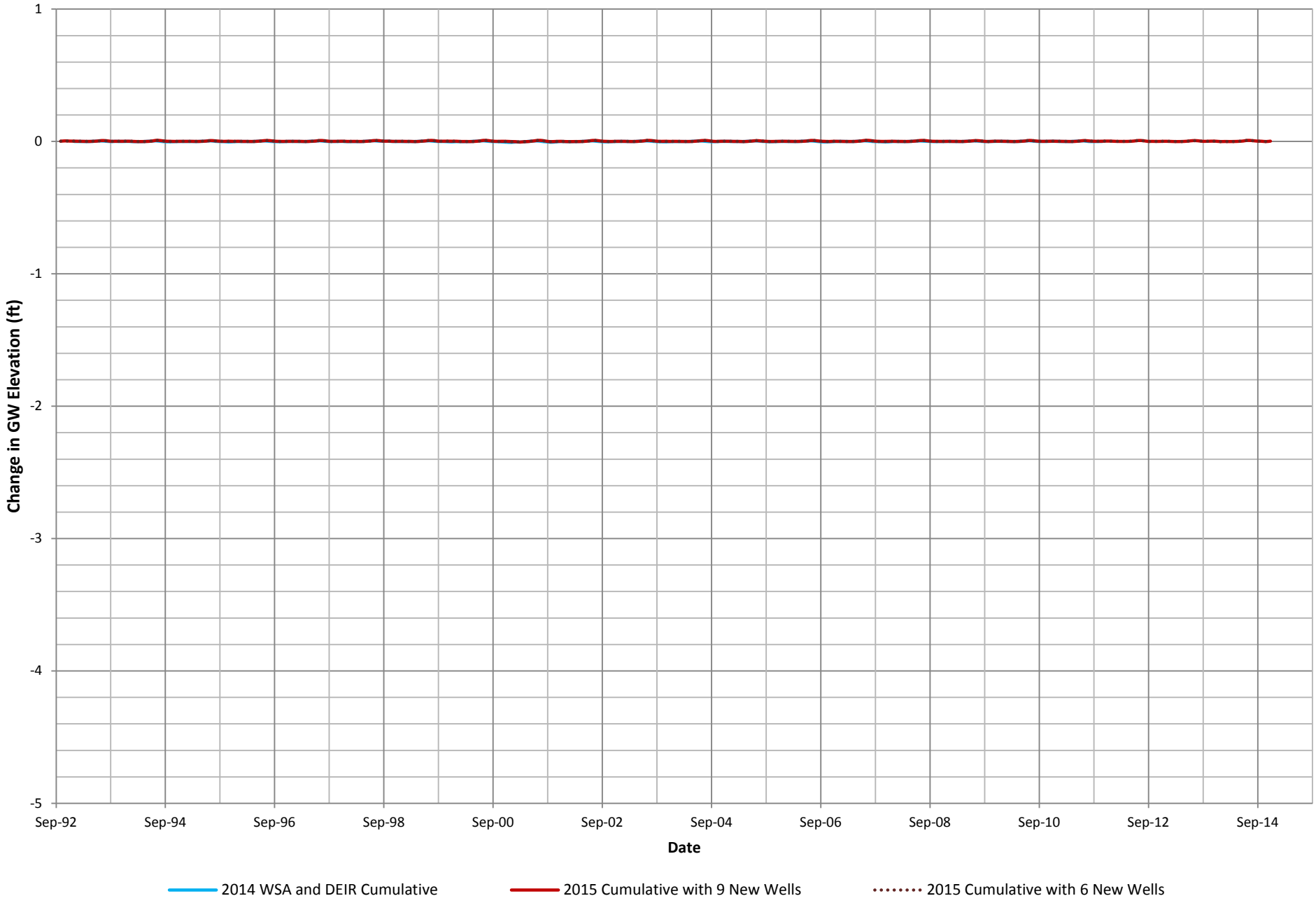

B2

Anticipated Changes to Surface and Groundwater Hydrology Associated with the Squaw Creek Restoration Project, part of the VSVSP, Placer County, California

Memo

To: Chevis Hosea and Andrea Parisi, Squaw Valley Ski Holdings

From: David Shaw

Date: October 15, 2015

Subject: Anticipated changes to surface and groundwater hydrology associated with the Squaw Creek Restoration Project, part of the Village at Squaw Valley Specific Plan, Placer County, California

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You have asked that Balance Hydrologics quantify some of the anticipated changes to surface water and groundwater conditions that are anticipated to occur as a result of the proposed Squaw Creek Restoration Project, part of the Village at Squaw Valley Specific Plan (VSVSP). To do this, we have reviewed stream stage (water level) and groundwater level records from late June 2014 to August 2015, and used the data, along with information in our previously completed Restoration Design Basis Report (Shaw and others, 2014), to address the following questions:

1) To what degree is the proposed channel restoration anticipated to increase the rate and volume of groundwater recharge in the vicinity of the Olympic Channel?
2) How will the deeper refugia pools included in the restoration design extend the period of refugia pool inundation?
3) To what degree will channel corridor grading reduce the distance between riparian vegetation and the groundwater table?
4) To what degree might early season surface inflows support refugia pool hydrology and groundwater levels, or offset anticipated reductions in groundwater elevations associated with increased demand from the proposed project?

This work is being conducted in response to findings outlined in the Draft Environmental Impact Report (DEIR) for the Project, which stated that creek restoration efforts might not provide the anticipated benefits and could result in greater disturbance to hydrologic conditions if not implemented effectively. Mitigation Measures 6-1a and 6-1b reduce this potential impact to a less-than-significant level by requiring the applicant to obtain necessary resource agency permits and develop a comprehensive Mitigation Monitoring Implementation Program prior to or concurrent with an Improvement Plan review by Placer County.

The DEIR also concludes that the project has the potential to contribute to a loss of riparian or meadow vegetation through lowered groundwater levels. We are providing this memo in advance of the development of a comprehensive monitoring program, in order to expand on conclusions which state that the restoration project, when implemented as designed, will result in positive impacts to groundwater conditions and in-channel habitat hydrology, and effectively

mitigate impacts associated with lower groundwater conditions in the vicinity and immediately east of the project.

Existing Conditions

Data Sources

In late June 2014, Balance installed near-continuous water-level recorders in Squaw Creek (Station SCGC) and the Olympic Channel (OCSC), where restoration activities are proposed as part of the VSVSP, as shown on **Figure 1**. The automated water-level record was calibrated to periodic staff-plate readings made in the field and converted to elevations (NGVD) based on survey data provided by Andregg Geomatics. Streamflow was measured at a range of stages on Squaw Creek during Water Year 2015[1], and was used to develop a relationship between stage and flow, or 'stage-discharge rating curve' at this location. This rating curve was developed and applied to the 15-minute stage record to derive a 15-minute streamflow record, according to methods employed by the US Geological Survey as outlined by Carter and Davidian (1968).

Event-based precipitation data was provided by Squaw Valley Public Services District via a data request from Todd Groundwater, and was recorded at the Squaw Valley Fire Department. Daily precipitation data was obtained from the Squaw Valley Gold Coast SNOTEL station, located in the upper Squaw Creek Watershed.

Groundwater data was provided by the Squaw Valley Public Service District via a data request made by Todd Groundwater. The SVPSD has several wells located between the base of the mountain and the lower valley, including a number of paired shallow and deep monitoring wells at the same location. For this analysis, we focused on data from the shallow monitoring wells, which are considered to be the best indicator of shallow groundwater conditions immediately adjacent to the Olympic Channel and lower trapezoidal channel restoration.

Existing Conditions in the Olympic Channel

Figure 2 shows the relationship between Olympic Channel stream stage, shallow groundwater elevation as measured at the Poulson-S well, and precipitation events from July 2014 to August 2015. The Olympic Channel was dry during most of summer 2014, with occasional periods of brief inundation as triggered by precipitation events. During winter 2015, flow was sustained in the Olympic Channel from late November until mid-June, when the stage receded below the water-level recorder as the stream dried down. Summer thunderstorms in 2015 again triggered brief periods of inundation in the channel, as during summer 2014.

At the onset of winter, flow along the Olympic Channel was not sustained until the shallow groundwater elevation rises above the elevation of the streambed, otherwise the duration of flows were short-lived. As streamflow recedes into the summer season, the persistence of inundation in the Olympic Channels was closely related to the timing of shallow groundwater falling below

[1] The period beginning October 1, 2014 and ending September 30, 2015.

the elevation of the streambed; flow and periods of inundation persisted for approximately 3 weeks after groundwater levels dropped below the streambed.

Existing Conditions in Squaw Creek

Figure 3 shows the relationship between Squaw Creek stage at the SCGC station, shallow groundwater elevation as measured at the Poulsen-S well, and precipitation from July 2014 to September 2015. Similar to the Olympic Channel, water levels in the creek were closely related to local shallow groundwater fluctuations. In summer 2014, Squaw Creek became dry as groundwater levels receded below the streambed elevation, and streamflow did not resume until shallow groundwater levels recovered with the onset of winter precipitation.

Summer thunderstorms in 2014 did not cause a measurable response in Squaw Creek stage or streamflow, as they did in the Olympic Channel. In Summer 2015, however, a localized rainstorm dropped approximately 0.6 inches of rain on the upper watershed[2], which resulted in a brief increase in streamflow from approximately 1 cubic foot per second (cfs) to approximately 20 cfs (see **Figure 4**) and an associated increase in stage of approximately 0.5 feet (see **Figure 3**). Although the flow and stage response was relatively short-lived, streamflow stabilized at approximately 1.9 cfs, and at a slightly higher stage than prior to the storm, indicating that surface runoff response to precipitation events serves a role in the maintenance and persistence of streamflow and water levels in Squaw Creek.

Restored Channel Conditions

The proposed channel restoration concept is described in detail in the Squaw Creek Restoration Design Basis Report (Shaw and others, 2014). **Figure 1** includes a conceptual grading plan for the proposed creek restoration alongside a topographic map of the existing channel, and shows the locations of existing and proposed channel alignments, wetland basins, and refugia pools. The Olympic Channel is proposed to be converted from a straight ditch to a series of broad depressions and multiple swales. Two of these depressions, Pools A and B, will increase the wetted area of the channel by approximately 14,700 square feet.

Data Analysis and Discussion

To what degree is the proposed channel restoration anticipated to increase the rate and volume of groundwater recharge in the vicinity of the Olympic Channel?

The Olympic Channel is an incised channel fed by groundwater (a "gaining stream") and runoff during the wet season. Gaging data indicate that streamflow stops and the creek dries after the shallow groundwater elevation drops below the elevation of the streambed. It is during this period that conditions allow for the stream to recharge the aquifer (a "losing stream"). We

[2] As measured at the Gold Coast SNOTEL station (Station 784; http://www.wcc.nrcs.usda.gov/snow/snotel-precip-data.html)

estimated the rate of recharge, or water loss from the stream to the ground, during this recharge period under existing and proposed conditions, using standard principles of groundwater flow.

Darcy's law is the basic formula describing the flow of groundwater, and can be expressed as:

$$Q = KiA$$

Where Q is the flow through the aquifer, K is the hydraulic conductivity, i is the hydraulic gradient, and A is the aquifer area. During the period when the groundwater level is below the elevation of the Olympic Channel, we assume that the vertical hydraulic gradient (i) is equal to 1, and the aquifer area (A) is represented by the wetted area of the wetted channel. Accordingly, the groundwater recharge from the Olympic Channel can be estimated by multiplying the wetted area of the channel by the hydraulic conductivity, for purposes of comparing pre-project to post-project conditions.

Hydraulic conductivity is estimated according to published values, but varies by soil type, and can be highly variable within a particular soil type. Goetechnical investigations carried out by Holdrege and Kull (Raynack and Hudson, 2014) in the vicinity of the Restoration Project documented stratified loamy sands, silts, and some gravel, as consistent with soils mapping completed by the Tahoe National Forest (Hanes, 2002), which shows the Tallac very gravelly sandy loam in this area. Published K values for the Tallac Soil Series range from 10^{-5} cm/s to 10^{-3} cm/s, and Driscoll (1986) reports a similar range in values for silt and coarse sand. For the purposes of this analysis, we used an estimated K value of 10^{-4} cm/s, equal to 0.28 ft/day, recognizing that the absolute results of our calculations are representative of highly variable conditions.

Evaporation is anticipated to increase as a result of wetland expansion. Huntington and McEvoy (2011) reported evaporation from water bodies in the Truckee River Watershed during June to be on the order of 0.41 feet. This was multiplied by the wetted area for the existing channel and of the proposed restoration basins and subtracted from the calculated recharge rate in both cases.

Table 1 provides a summary of these calculations, which indicate that under the existing channel configuration, groundwater recharge from the Olympic Channel during summer 2015 was on the order of 0.23 acre-feet (AF) over the 22 days of losing stream conditions. If the restoration project were in place, with its larger wetted area and under the same hydrologic conditions, recharge is anticipated to increase approximately tenfold, since the wetted area increases by this ratio.

Potential net increase in recharge associated with the restored Olympic Channel would be the order of 2 AF over the same 22-day time period; however, it is important to recall that this calculation is based on "order-of-magnitude" estimates of hydraulic conductivity for comparison of pre- and post-restoration conditions. Actual volumes recharged may be considerably less or more than this estimate, but the post-restoration configuration will always show an approximately tenfold increase in recharge, as long as the wetted area increases by this amount and pre- and post-restoration soils and hydraulic conductivity are similar.

Table 1. Estimated recharge rates and volumes under existing and proposed conditions, Olympic Channel Restoration area.

		Existing Stream	Restored Stream
Stream type		Straight Channel	Pool and Swale
Wetted area	(ft^2) (ac)	1670 0.04	20,716 0.48
Duration of losing stream conditions	(days)	22	22
Hydraulic conductivity (K)	(cm/s) (ft/day)	10^{-4} 0.28	10^{-4} 0.28
Calculated recharge rate under 2015 hydrologic conditions	(ft^3/day)	473	5,872
Evaporation rate	(ft/day) (ft^3/day)	-0.014 -23	-0.014 -283
Total recharge over the duration of losing stream conditions	**(ft^3)** **(ac-ft)**	**9,912** **0.23**	**122,961** **2.82**

How will the deeper pools included in the restoration design extend the period of inundation in pools?

The pools located along Squaw Creek will be deeper and include structural elements to maintain scour in those pools, so they are anticipated to intersect the groundwater table for a longer period as its elevation recedes during the summer months. To illustrate this, we compare observed groundwater levels in summer 2014 to pool bottom elevations and pool depths under existing and proposed conditions in **Table 2**. In order to project when a pool becomes dry under existing and proposed conditions, we compared pool bottom elevations to receding groundwater elevations in one of 3 nearby wells, the Plumpjack shallow well (PJ-S), the MW-5 shallow well (MW-5S), and or the Poulsen shallow well (P-S). This analysis shows that because most of the existing pools will be replaced with deeper pools with pool bottoms at a lower elevation, the water table will drop below the bottom of the pools at a later date, assuming that all other factors remain constant. These results lead us to conclude that where pools become deeper, pool inundation will be extended by construction of the restoration project by between 20 to 40 days, simply through the creation of deeper pools in the channel system, where shown in **Figure 1**.

Another way of considering these increases is to simply examine the rate of water level (stage) decline in the existing stream. Squaw Creek stage records presented in **Figure 3** show a steady decline of 0.004 ft/day in late spring, quickly dropping to 0.03ft/day when the groundwater elevation drops below the streambed elevation. At 0.03 ft/day, every foot of pool depth increase corresponds to 33 days of pool drawdown after streamflow ceases.

Table 2. Existing and proposed pools and estimated duration of ponding after streamflow ceases

Existing Pools				Co-located Proposed Pools					
ID	Min Elev (ft, NGVD)	Max pool depth (ft)	Drying Date in 2014 (date)	ID	Min Elevation (ft, NGVD)	Max pool depth (ft)	Drying Date in 2014 (date)	Indicator well	Change in duration of inundation (days)
39	6189.0	0.4	2-Aug	N	6185.7	3.5	2-Sep	PJ_S	31
40	6188.8	n/m	3-Aug	M	6185.3	3.3	5-Sep	PJ_S	33
41	6187.7	n/m	15-Aug	K1	6185.1	3	8-Sep	PJ_S	24
42	6186.7	n/m	22-Aug	I	6184.9	2.1	11-Sep	PJ_S	20
44	6186.0	3.5	14-Jun	G2	6183.5	1	26-Jul	MW_5S	42
45	6185.5	n/m	7-Jul	G	6182.9	2.3	30-Jul	MW_5S	23
46	6185.2	n/m	15-Jul	F	6185.5	2.3	1-Jul	MW_5S	-14
48	6183.8	0.7	27-Jun	E	6182.0	2.5	3-Aug	P_S	37
49	6182.5	0.2	16-Aug	D	6180.0	3	4-Sep	P_S	19
53	6180.0	1.5	10-Sep	C	6178.5	3.1	Wetted throughout	P_S	30
								Average increase in duration:	**24 days**

It is important to note that the riffle crests, or high points between the pools, will be the same or very close to (within 1 foot of) the elevation of the existing channel, aside from the location of the sewer crossing, which will be improved for water quality protection and maintenance of sediment transport continuity (Shaw and others, 2014, Appendix B). Since these high points in the channel control the water-surface elevations when the stream is flowing, they also control the hydraulic floor of the aquifer when groundwater is discharging to the creek. These streambed elevations will not change substantially as part of the restoration project, so the restoration project is not anticipated to result in more effective, quicker, or deeper draining of the aquifer.

To what degree will channel corridor grading reduce the distance between riparian plants and the groundwater table?

The DEIR concludes that the potential loss of riparian or meadow habitat along the higher elevations of the Squaw Creek Channel through lowered groundwater elevations could result in reductions in riparian vegetation. The proposed restoration grading plan is, however, anticipated to offset this impact by creating additional areas of a lower terrace and upper bank upon which a riparian re-vegetation plan will be implemented. The lower and newly planted surface will be closer to the water table than the existing surface. As shown in **Figure 5** and **Table 3**, approximately 4.3 acres of channel, floodplain, and upper banks will be lowered by more than 2 feet, and 3.0 acres will be lowered by more than 4 feet, while only 0.2 acres are designed to be filled by more than 2 feet. As described above, the high points within the channel bed will not be substantially lowered, so the hydraulic floor will be maintained during periods when groundwater flows toward the creek.

Table 3. Areas of elevation change associated with the Squaw Creek Restoration Project

Elevation Change (cut)	Area		Cumulative Area	Elevation Change (Fill)			Cumulative Area
(ft)	*(sq ft)*	*(acres)*	*(acres)*	*(ft)*	*(sq ft)*	*(acres)*	*(acres)*
-14 to -12	1915	0.0	0.0	0 to 2	351300	8.1	8.1
-12 to -10	13687	0.3	0.4	2 to 4	9838	0.2	8.3
-10 to -8	22434	0.5	0.9	4 to 6	42	0.0	
-8 to -6	39298	0.9	1.8				
-6 to -4	52314	1.2	3.0				
-4 to -2	59127	1.4	4.3				
-2 to 0	183819	4.2	8.6				

Stream Response to Summer and Fall Precipitation Events

We seek to evaluate the degree to which streams, refugia pools, and associated riparian vegetation gain support from surface water inflows, in addition to groundwater inflow. By utilizing the event-based and daily records as opposed to monthly totals, we are able to identify the degree to which Squaw Creek and the Olympic Channel, and by extension, refugia pools, respond to surface runoff.

Stage and streamflow data indicate that summer thunderstorms and early season precipitation can generate runoff and support aquatic habitat in Squaw Creek (see **Figure 4**). Where channel conditions, groundwater conditions, and geology allow, runoff can also infiltrate and recharge the aquifer at these times. Since surface flows are not anticipated to be reduced as a result of the proposed project, we conclude that watershed surface hydrology has the capacity to offset the effects of groundwater declines.

Proposed off-site improvements that are anticipated to offset potential impacts to riparian vegetation in the meadow

Conceptual restoration plans have been developed for Squaw Creek and the Meadow to the east of the project site (Sound Watershed Consulting, 2014), where increased groundwater extraction is anticipated to potentially impact groundwater levels and riparian conditions. The meadow restoration plan calls for the abandonment and filling (either partial or entirely) of deeply incised channels in the eastern meadow, and re-wetting of relict channels in the western meadow, near the VSVSP site. Raising the bed of the channel in that area is anticipated to reduce the rate at which the stream drains the eastern portion of the aquifer, and could effectively maintain higher groundwater conditions in the meadow.

When completed, the meadow restoration project has the potential to offset or reverse past, present, and future groundwater declines. It would be possible to model and monitor these potential benefits once the meadow restoration project has been designed and implemented, but this has not yet been completed. Studies of similar meadow restoration projects in the region

have indicated restoration of eroded meadows has the potential to increase groundwater storage on the order of 0.6 AF/acre of restored meadow (Shaw, 2010).

Friends of Squaw Creek and Trout Unlimited are actively seeking funds to implement the lower meadow restoration design within the next 5 years (David Lass, personal communication). Squaw Valley Ski Holdings staff maintain a position on the Friends of Squaw Creek Board of Directors, along with other landowners, and are able to participate in and promote the planning of the meadow restoration work.

Conclusions

In summary, the data and analysis presented above leads us to the following conclusions:

1. The Squaw Creek restoration project is anticipated to result in an approximately tenfold increase in groundwater recharge along the Olympic Channel, due to a larger wetted area when the stream is losing water to the ground. Basic calculations indicate that the volume recharged in during summer 2014 would increase from approximately 0.2 to 2.0 acre-feet.

2. The channel restoration design calls for the creation of deeper pools along Squaw Creek, which will allow the channel to intersect the groundwater table for a longer period of time, thereby extending the duration of inundation in these pools. Where the change is greatest, basic calculations indicate that the deeper pools will result in inundation for up to 40 days longer than current conditions.

3. The channel restoration design includes a net lowering of the ground surface in the riparian and inset-floodplain corridor, such that 3 acres of the project will become over 4 feet lower than existing conditions. This is anticipated to help offset potential impacts associated with potentially lower future groundwater conditions.

4. Stage and streamflow data indicate that groundwater levels in the aquifer are not the only influences on water levels in Squaw Creek. Summer and early fall precipitation also influence the creek, and therefore are anticipated to help offset potential impacts associated with potentially lower future groundwater conditions.

5. Friends of Squaw Creek have developed restoration plans for the Squaw Creek meadow, east of the project site. As designed, the Squaw Creek meadow restoration is expected to raise the streambed and water surface elevations and increase groundwater storage in the upper aquifer. This would help offset potential impacts associated with future groundwater withdrawals. Meadow restoration implementation is anticipated to take place within the next 5 years.

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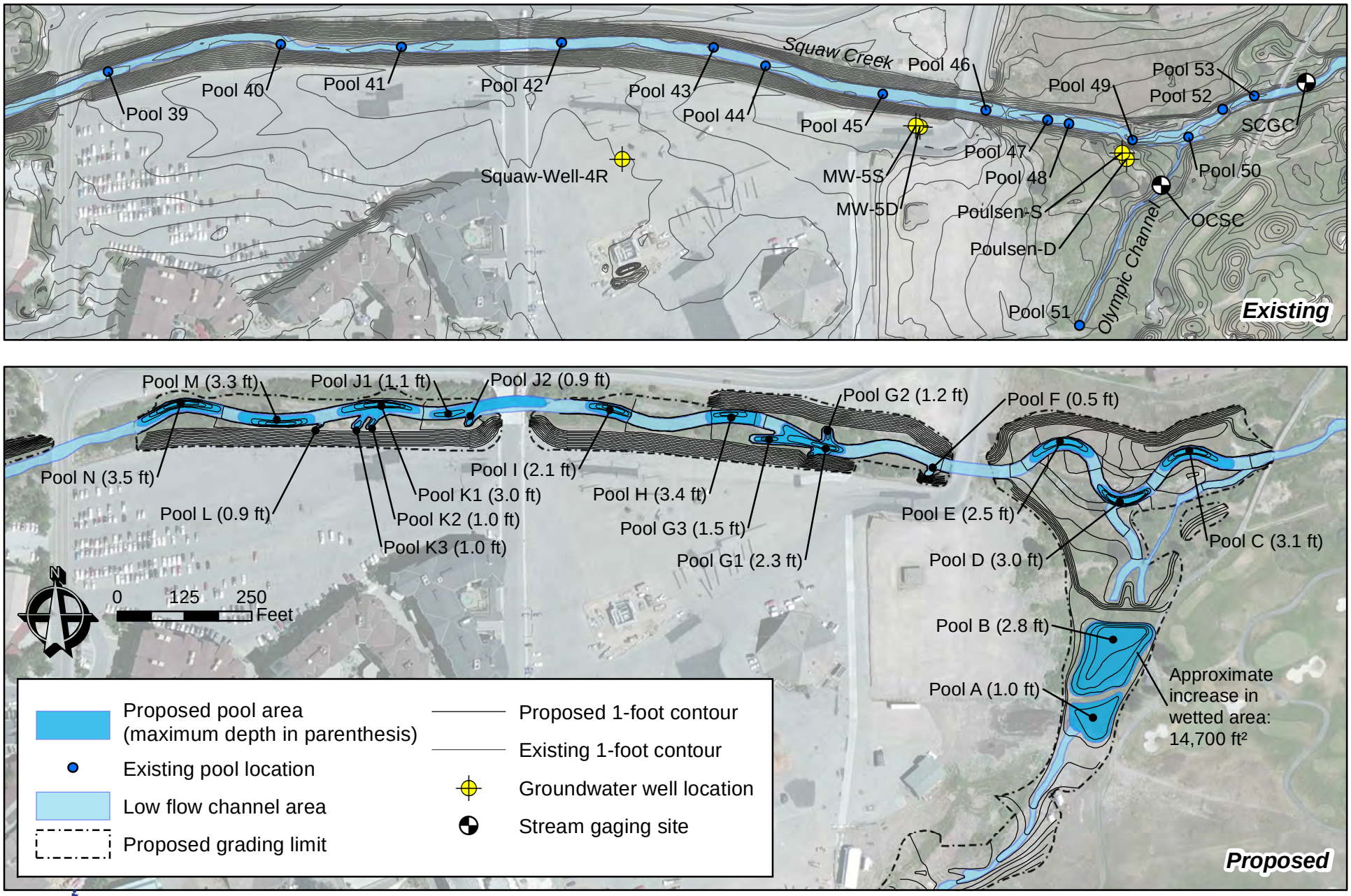
Sound Watershed Consulting, 2013, DRAFT Preliminary design report for lower Squaw Creek Restoration Project, Olympic Valley, California: consulting report prepared for the Placer County Planning Department, 103 p. + Appendix



Balance Hydrologics, Inc.

Figure 1. Data collection points and existing and proposed pool locations, Village at Squaw Valley Specific Plan, Placer County, California

Sources: ESRI ArcGIS Online and data partners, Andregg Geomatics

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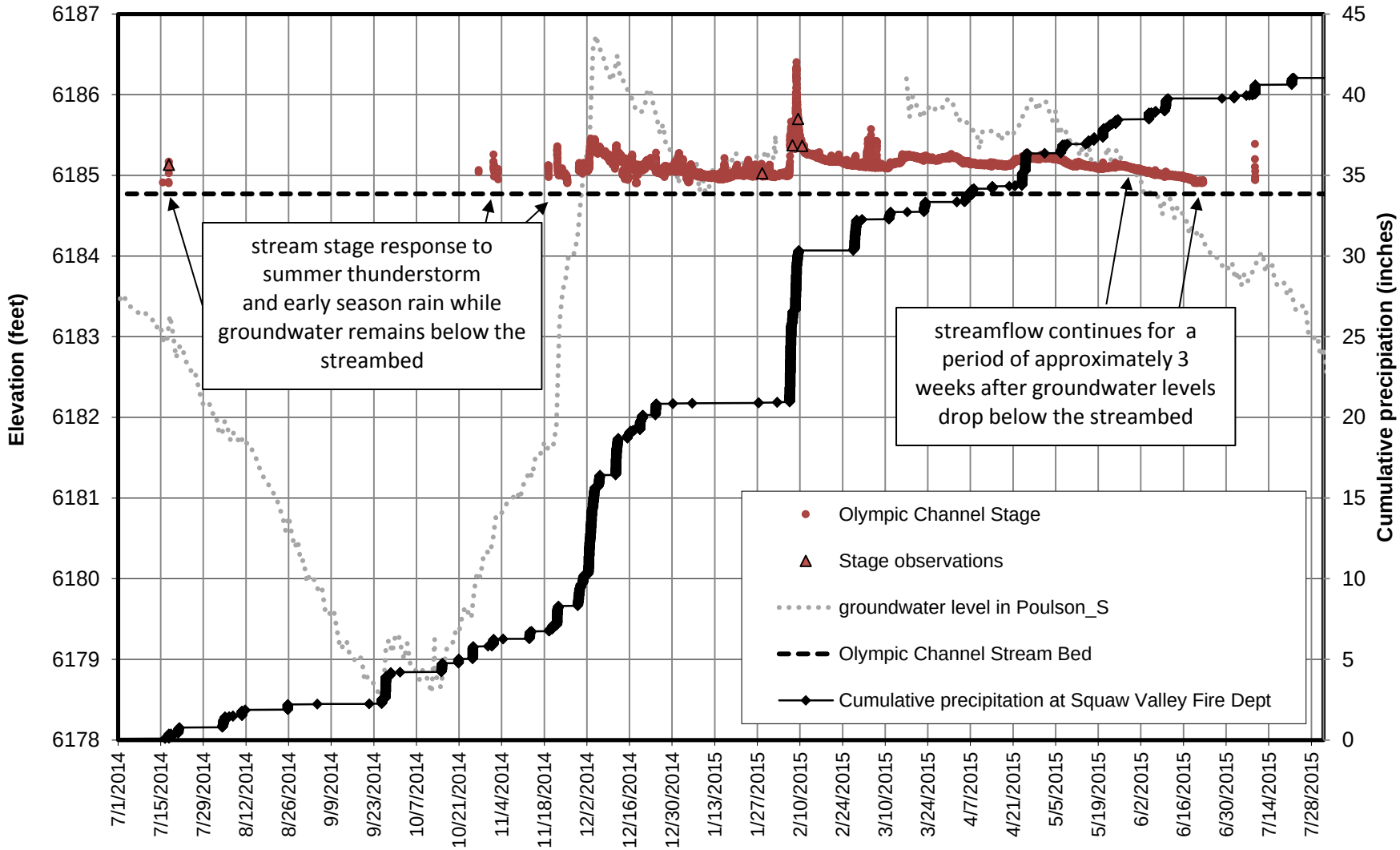

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Figure 2. Stream stage and groundwater levels, Olympic Channel at Squaw Creek (OCSC), Village at Squaw Valley Specific Plan, Placer County, California

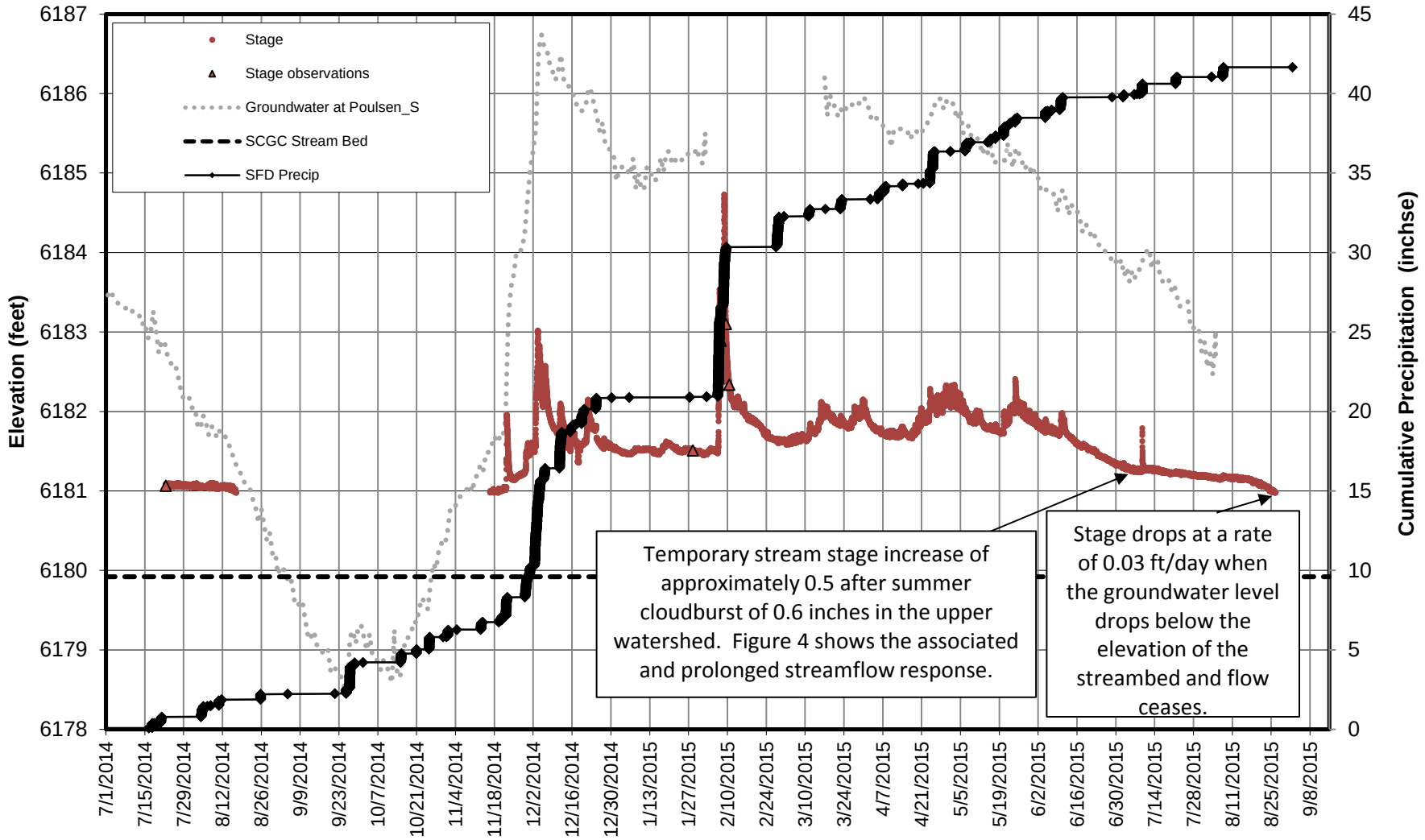

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Figure 3. Stream stage and groundwater levels, Squaw Creek at upper Golf Course Bridge (SCGC), Village at Squaw Valley Specific Plan, Placer County, California

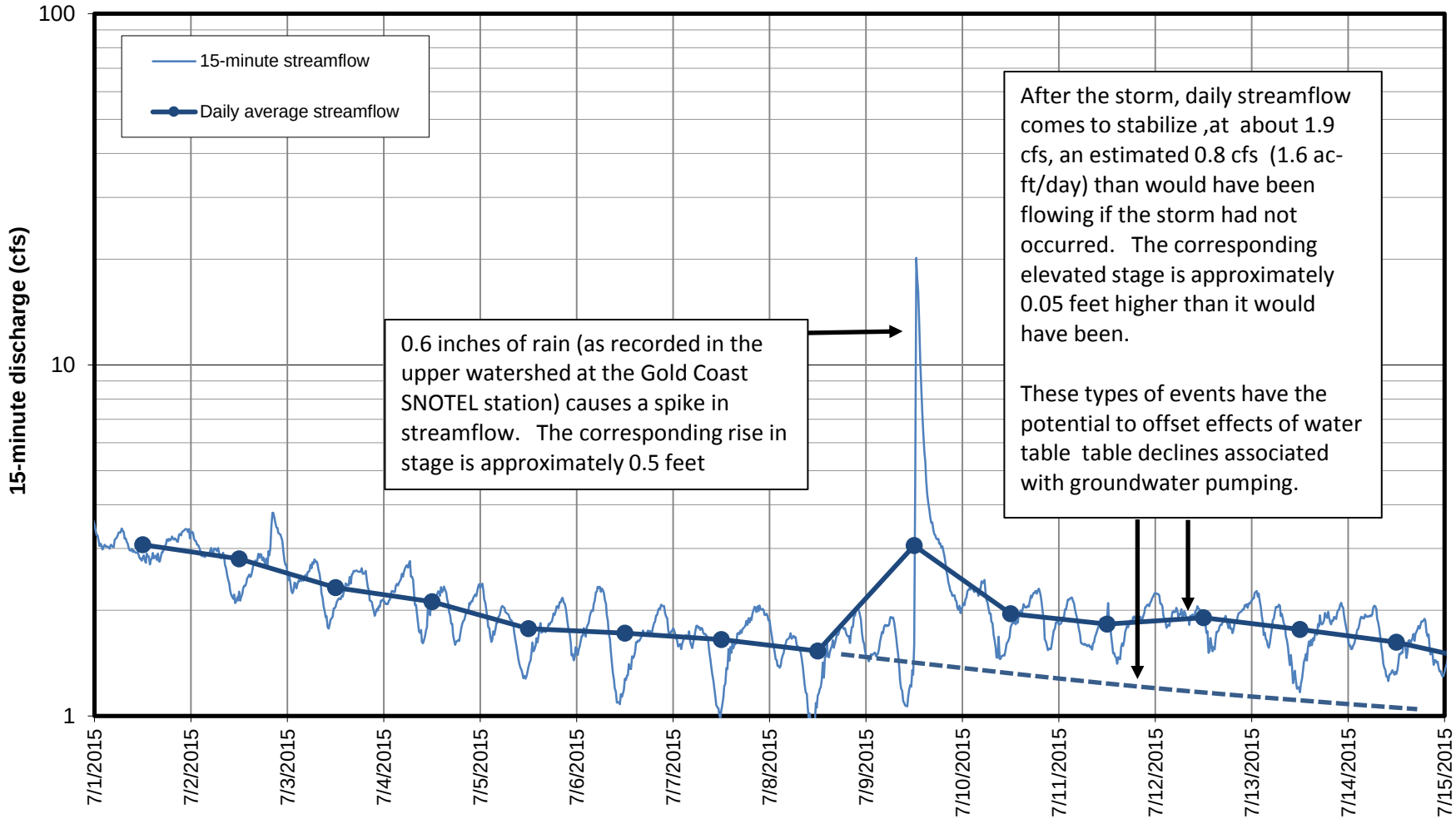

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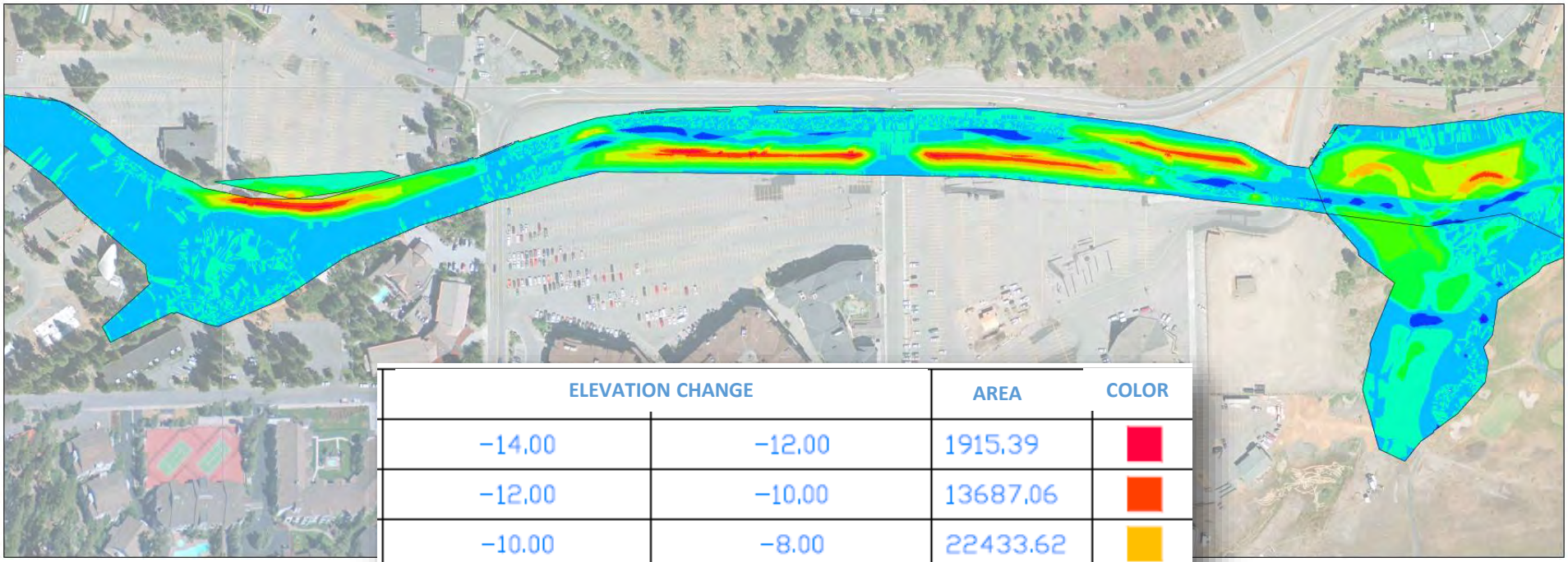
Figure 4. Squaw Creek streamflow during a summer rainstorm, Village at Squaw Valley Specific Plan, Placer County, California

Runoff generated by a 0.6-inch rainstorm in the upper watershed has the capacity to increase streamflow and stage in the Squaw Creek channel, with associated benefits to refugia pools, riparian habitat, and in certain locations, can increase the rate of groundwater recharge.

211022_SCGC_15-min_ds.xlsx,Figure 5 Flow



ELEVATION CHANGE		AREA	COLOR
−14.00	−12.00	1915.39	
−12.00	−10.00	13687.06	
−10.00	−8.00	22433.62	
−8.00	−6.00	39297.85	
−6.00	−4.00	52314.12	
−4.00	−2.00	59127.95	
−2.00	0.00	183819.27	
0.00	2.00	351299.76	
2.00	4.00	9838.50	
4.00	6.00	41.84	
6.00	8.00	0.37	

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Figure 5. Cut-fill analysis of the proposed Squaw Creek Restoration Project, Village at Squaw Valley Specific Plan, Placer County, California
Change in elevation is based on comparison between existing and proposed elevations at a given point.