Evaluation of Wyckoff Groundwater Level Data September 22, 2012 through December 20, 2012

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This memorandum summarizes the Wyckoff groundwater level results for the 90-day monitoring period of September 22 through December 20, 2012.

Summary/Recommendations

- Hydraulic containment was maintained in all 10 well pairs over the 90-day monitoring period: MW14/CW05, MW18/02CDMW01, PO03/99CDMW02A, CW03/CW02, VG-2U/VG-2L, VG-3U/VG-3L, VG-5U/VG-5L, PO13/VG-1L, CW13/VG4L, and CW08/P-4L.
- The groundwater elevation data from the new transducers in the 10 well pairs should be downloaded again in March 2013 to maintain a quarterly schedule consistent with the definition of hydraulic containment.

Water Level Data Collection

The September 22 through December 20, 2012 time period represents the next 90-day monitoring period in succession from the previous groundwater level data evaluation memorandum (June 24 – September 21, 2012). The locations of the wells are shown in Figure 1 and wells with transducers are listed in Table 1. Model 705 KPSI^{TM} Level and Pressure Transducers are installed in 22 upper aquifer wells and 18 lower aquifer wells and were calibrated on November 26, 2012, during this monitoring period. The transducers were most recently calibrated in January 2013. Several of the transducers showed minor out-of-calibration values. The required corrections ranged from 2 to 4 inches. The transducers were recalibrated on January 31, 2013, after discussions with the vendor.

All data are available in e-format upon request.

Table 1 – Wells with Transducers, September 22 – December 20, 2012

Upper Aquifer		Lower Aquifer	
CW03	PO13	02CDMW01	PZ03
CW08	RPW-1	99CDMW02A	SE02
CW13	RPW-2	CW02	VG-1L
E-02[1]	RPW-4	CW05	VG-2L
E-04[1]	RPW-5	CW09	VG-3L
E-06[1]	RPW-6	P-1L	VG-4L
E-07[1]	PW-8	P-2L	VG-5L
MW14	PW-9	P-3L	
MW18	VG-2U	P-4L	
MW21	VG-3U	P-5L	
PO03	VG-5U	P-6L	

[1] The E-0x series of wells are located within the Pilot Test sheet pile wall.

Hydraulic Containment / Isolation Evaluation

The hydraulic containment/isolation performance at the Wyckoff site is evaluated based on water level data from 10 upper and lower aquifer well pairs: MW14/CW05, MW18/02CDMW01, PO03/99CDMW02A, CW03/CW02, VG-2U/VG-2L, VG-3U/VG-3L, VG-5U/VG-5L, PO13/VG-1L, CW13/VG-4L, and CW08/P-4L (See Figure 1 for these locations). The hydraulic containment at each well pair is evaluated by first calculating the average groundwater elevations of the upper and lower aquifers using the water elevation data recorded every 15 minutes during the 90-day monitoring period. Then the average groundwater elevations of the upper and lower aquifers at each well pair are compared relative to each other. If the average lower aquifer groundwater elevation is greater than that of the upper aquifer, an overall net upward gradient of groundwater is indicated and hydraulic containment is demonstrated. If a well pair meets the definition of hydraulic containment, the ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for that well pair is greater than 1. A secondary evaluation of hydraulic containment/isolation performance is conducted through examination of the short term periods when downward hydraulic gradients occur within well pairs.. In addition, groundwater elevations for each well pair are compared at each 15 minute recording, and the summary statistics are evaluated. The maximum, average, and minimum change in groundwater elevation for each well pair is calculated, along with percent duration of the 90-day monitoring period when net downward gradients occur. Hydrographs for each well pair have been prepared and are presented in Figures 2a through 2j.

The hydraulic evaluation data for the well pairs are summarized together in Table 2. This table presents the average groundwater elevations for each well pair, the ratio of the average upper to lower aquifer groundwater elevation, and summary statistics on the short-term change (compared at each 15-minute recording) in groundwater elevations between the upper and lower aquifers.

- All ratios are greater than 1, indicating hydraulic containment is maintained.
- Short term vertical gradient data (short-term change per 15-minute recording) indicate that an upward gradient is sustained at all times during the 90-day monitoring period at two of the monitoring well pairs (VG-2U/VG-2L and VG-3U/VG-3L).

- A series of short duration downward gradient periods occur in the other eight monitoring well pairs. In three of these eight well pairs (MW14/CW05, MW18/02CDMW01, and CW03/CW02), the percent duration of the 90-day period is less than 10 percent.
- Five well pairs have a percent duration of the 90-day monitoring period greater than 10 percent (PO03/99CDMW02A, VG5U/VG5L, PO13/VG1L, CW13/VG-4L, and CW08/P4L). Two of these five wells have a percent duration exceeding 30 percent (CW13/VG4L at 36.6% and CW08/P4L at 30%).

Table 2
Summary of Groundwater Elevation Data by Well Pair

				Summary Statistics Short Term Comparison - Water Level Difference between the Upper and Lower Aquifer wells			Duration Analysis – Downward (neg.) Gradient			
Well Pair	Upper Aquifer Average Groundwater Elevation (ft MLLW)	Lower Aquifer Average Groundwater Elevation (ft MLLW)	Ratio (Avg Lower Aq WL / Avg Upper Aq WL)*	Average	Max	Min	Number Neg Grad Events	Average Duration Neg Grad (hours)	Total Duration Neg Grad (days)	Percent Duration of 90-day monitoring period
MW14/CW05	7.43	9.68	1.30	2.26	5.80	-2.97	45	4.59	8.6	9.6%
MW18/02CDMW01	5.50	9.26	1.68	3.76	7.56	-1.30	3	0.83	0.1	0.1%
PO03/99CDMW02A	7.25	9.76	1.35	2.52	6.63	-2.74	37	6.40	9.9	11.0%
CW03/CW02	7.21	9.22	1.28	2.01	4.48	-0.88	32	3.03	4.0	4.5%
VG-2U/VG-2L	7.57	8.72	1.15	1.15	1.99	0.01	none			
VG-3U/VG-3L	6.70	10.36	1.55	3.66	5.76	0.69	none			
VG-5U/VG-5L	9.34	11.08	1.19	1.74	5.02	-2.40	53	6.86	15.15	16.8%
PO13/VG-1L	7.46	9.49	1.27	2.02	5.45	-3.47	70	4.21	12.3	13.7%
CW13/VG-4L	11.04	11.37	1.03	0.33	6.23	-8.33	44	17.99	33.0	36.6%
CW08/P-4L	8.27	9.25	1.12	0.97	5.10	-5.51	102	6.35	27.0	30.0%

*** Ratio > 1 = Hydraulic Containment was Achieved**

Treatment Plant Operations and Effects on Groundwater Flow

The treatment plant and the majority of the extraction well systems were operated 24 hours per day and 5 days per week through October 22, 2012. During this time period, select wells were shut down for an extended period due to low water levels. Following the weekend shutdown ending October 22, 2012, the extraction well system operated 24 hours per day and 7 days per week for the remainder of the 90-day monitoring period. The dates during which the extraction wells were shut down for periods greater than 24 hours are listed in Table 3. These periods are graphically overlaid with the precipitation records and are shown in Figure 3. The total volume of water pumped was 6,676,563 gallons during the 90-day monitoring period which equates to about 52 gpm over the entire period including all down time regardless of cause. [Note, when fully operating, the system can pump about 72 gpm.]

Table 3 – Former Process Area (FPA) Extraction Well Pump Shut down Periods Greater than 1 Day

Date	Wells Shut Down	Reason
September 10 – October 16, 2012	PW-9	Shutdown due to low water level
September 21 – September 24, 2012	PW-1, PW-2, PW-4, PW-5, PW-6, PW-8, EW-2, EW-6	Weekend shutdown
September 25 – October 16, 2012	PW-6, PW-1	Shutdown due to low water level
September 25 – November 1, 2012	EW-2	Shutdown due to low water level
September 28 – October 1, 2012	PW-2, PW-4, PW-5, PW-8, EW-6	Weekend Shutdown
October 5 – October 8, 2012	PW-2, PW-4, PW-5, PW-8, EW-6	Weekend shutdown
October 12 – October 15, 2012	PW-2, PW-4, PW-5, PW-8, EW-6	Weekend shutdown
October 19 – October 22, 2012	PW-1, PW-2, PW-4, PW-5, PW-6, PW-8, PW-9, EW-6	Weekend shutdown
October 24 – October 29, 2012	PW-9	Shutdown due to low water level

During this 90-day monitoring period, there were numerous days from October 29 through December 20, 2012 where single-day precipitation amounts were greater than one inch, and three single-day amounts of 2.5 inches and greater. The groundwater levels in upper aquifer wells display a rapid response to the increased rainfall followed by a moderate decline due to continual pumping of the extraction wells.

The gradient evaluation documented in the previous section indicates that operation of the extraction well system 24 hours per day and 7 days per week during the rainy season is capable of maintaining overall hydraulic containment during periods of increased rainfall; however, the increased precipitation results in decreased displacement and a greater occurrence of negative gradients. The well pair with the greatest percentage of negative gradients during the 90-day monitoring period is CW13/VG4L, which is

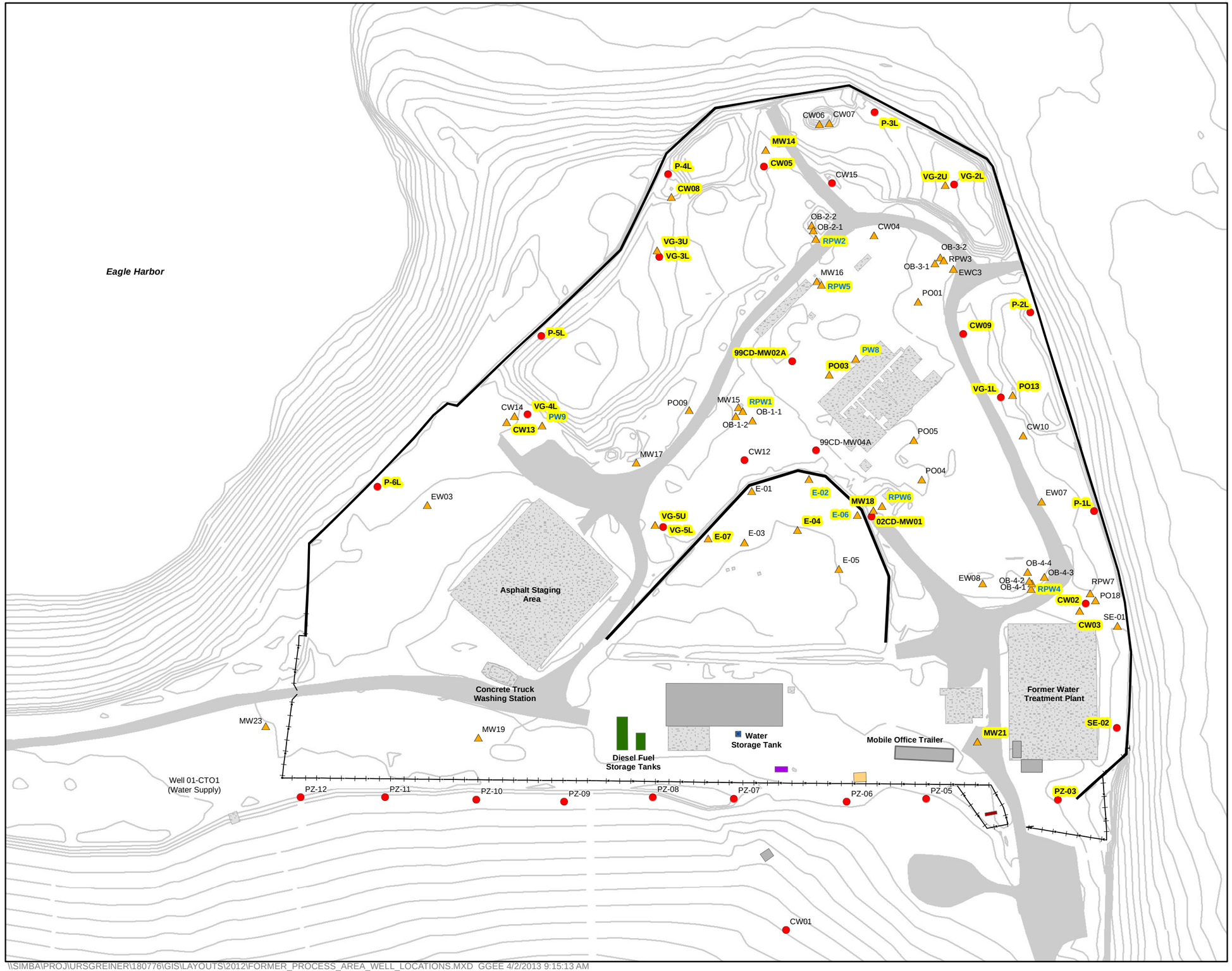
adjacent to production well PW-9. Because PW-9 has been shown to have little influence on surrounding wells (See previous quarterly water level report), the increased rainfall, and surface flooding in December 2012 in the vicinity of PW-9, had the greatest influence on hydraulic containment in the area surrounding this extraction well.

Summary and Conclusion

Hydraulic containment and the effects of treatment plant operations on groundwater flow are evaluated using groundwater level data monitored using pressure transducers installed in 22 upper aquifer wells and 18 lower aquifer wells. Results of the evaluation indicate the following:

- Hydraulic containment was maintained in all 10 well pairs for the duration of the 90-day monitoring period with 24/7 pumping of the extraction wells after increased rainfall began in late October 2012.
- Because of the limited influence of PW-9 on adjacent well pair CW13/VG4L, the greatest number and longest duration negative gradients are observed for this well pair during increased rainfall coupled with continuous pumping of the extraction wells.

Because of the limited displacement estimated at PW-9 and CW-13 using the previous quarterly data, as well as a history of pump cycling at PW-9 and its limited influence on nearby observation wells, evaluation of the next 90-day monitoring period should focus on containment effectiveness in this area. Enhancing the influence of groundwater extraction in this area may require well development or modification of the pump equipment.



LEGEND

- Lower Aquifer Well
- Upper Aquifer Well
- Fence
- Wall
- Roads
- Buildings
- Concrete Slab

Well labels:

highlighted - well is monitored with transducer
blue text - production well

N

0 50 100 Feet

FIGURE 1

Former Process Area Well Locations

WYCKOFF/EAGLE HARBOR SUPERFUND SITE

\\SIMBA\PROJ\URSGREINER\180776\GIS\LAYOUTS\2012\FORMER_PROCESS_AREA_WELL_LOCATIONS.MXD GGEE 4/2/2013 9:15:13 AM

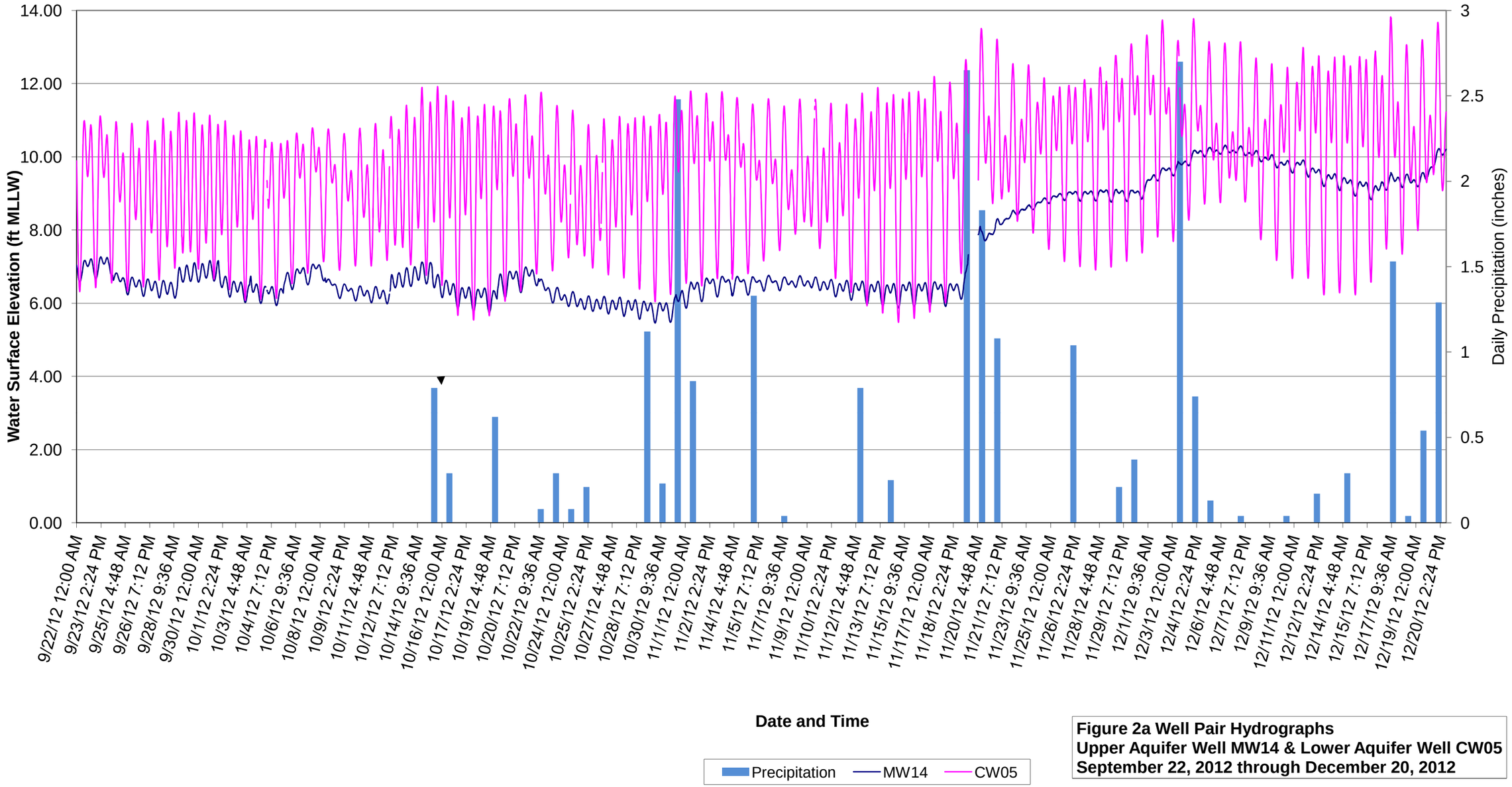


Figure 2a Well Pair Hydrographs
Upper Aquifer Well MW14 & Lower Aquifer Well CW05
September 22, 2012 through December 20, 2012

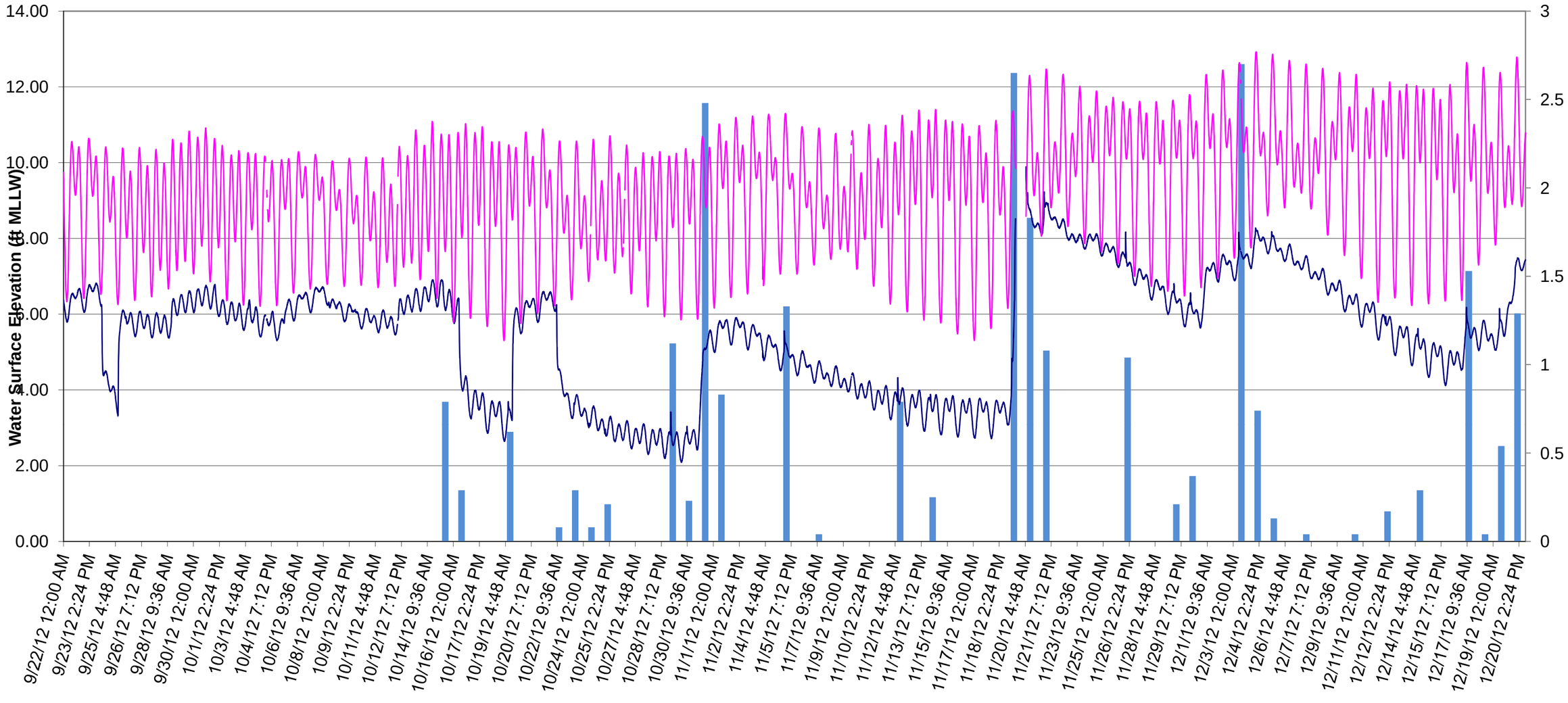


Figure 2b Well Pair Hydrographs
Upper Aquifer Well MW18 & Lower Aquifer Well CDMW01
September 22, 2012 through December 20, 2012

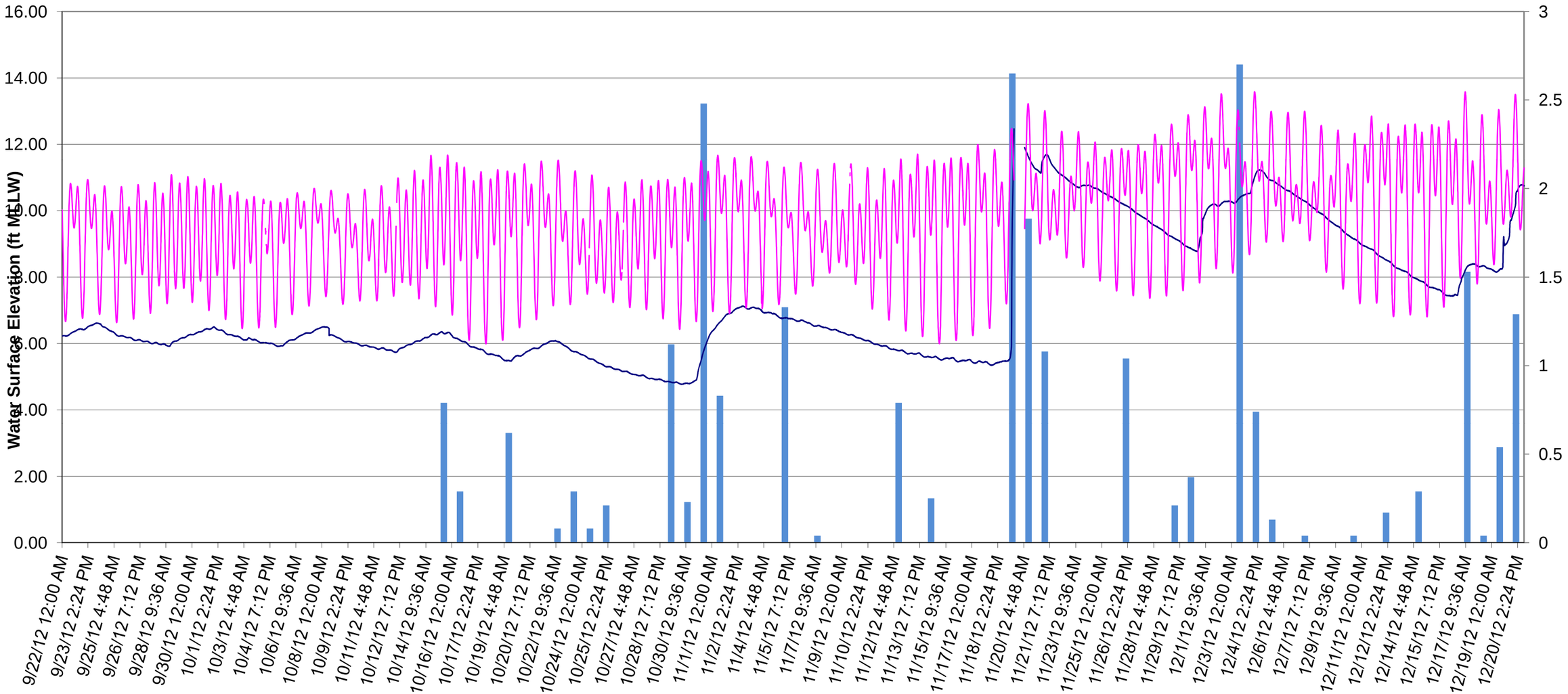


Figure 2c Well Pair Hydrographs
Upper Aquifer Well PO03 & Lower Aquifer Well CDMW02
September 22, 2012 through December 20, 2012

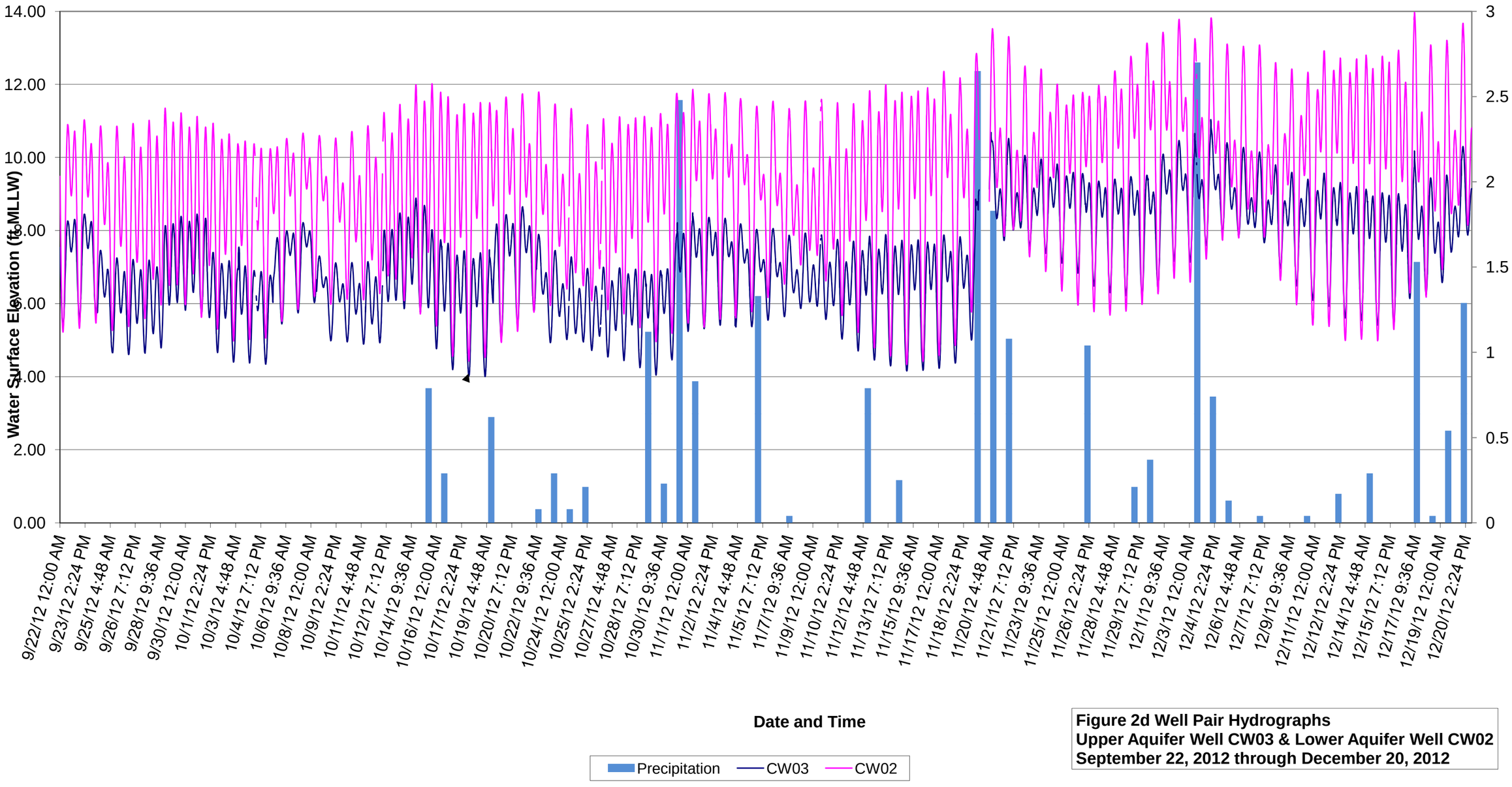


Figure 2d Well Pair Hydrographs
Upper Aquifer Well CW03 & Lower Aquifer Well CW02
September 22, 2012 through December 20, 2012

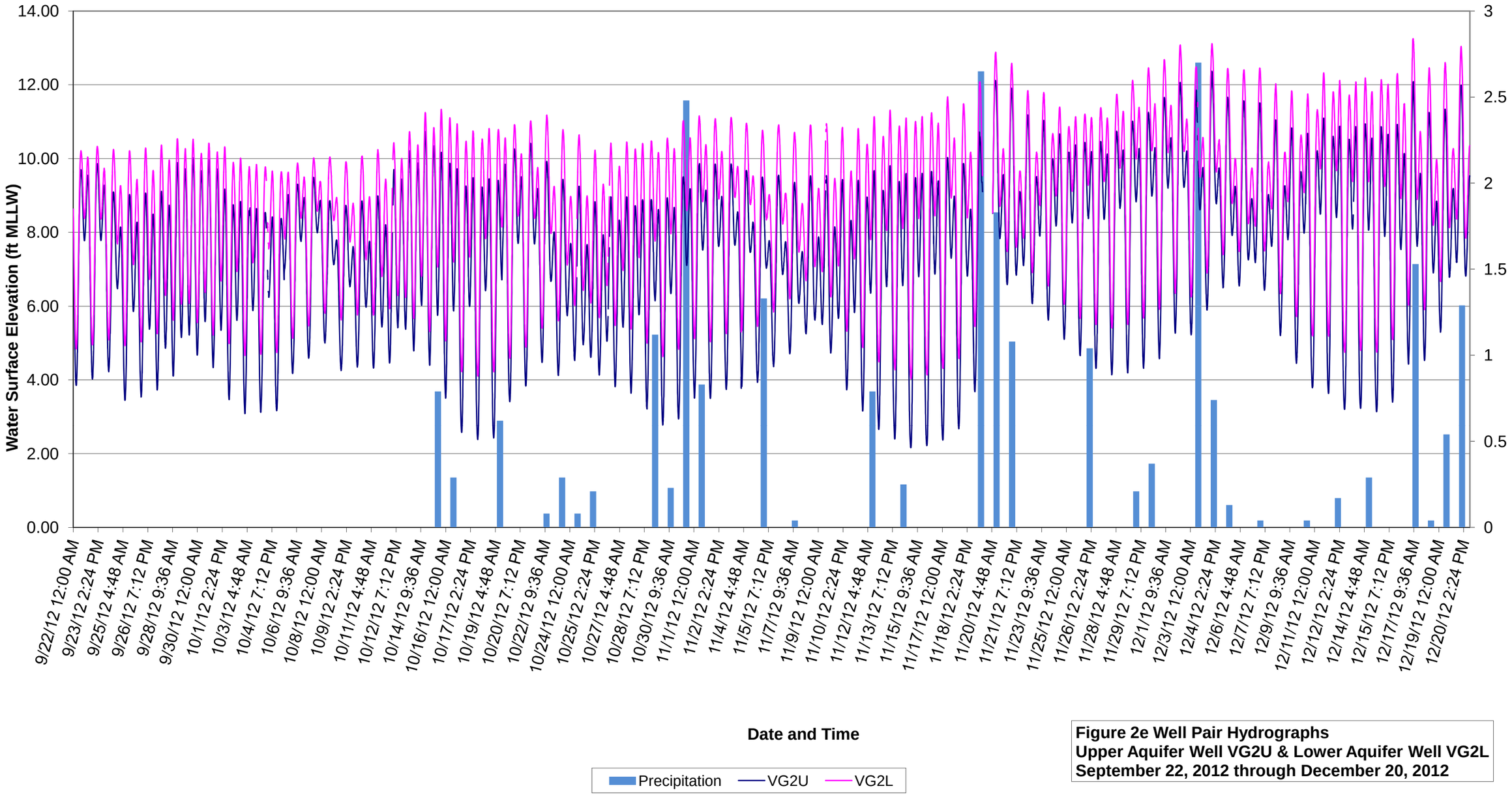


Figure 2e Well Pair Hydrographs
Upper Aquifer Well VG2U & Lower Aquifer Well VG2L
September 22, 2012 through December 20, 2012

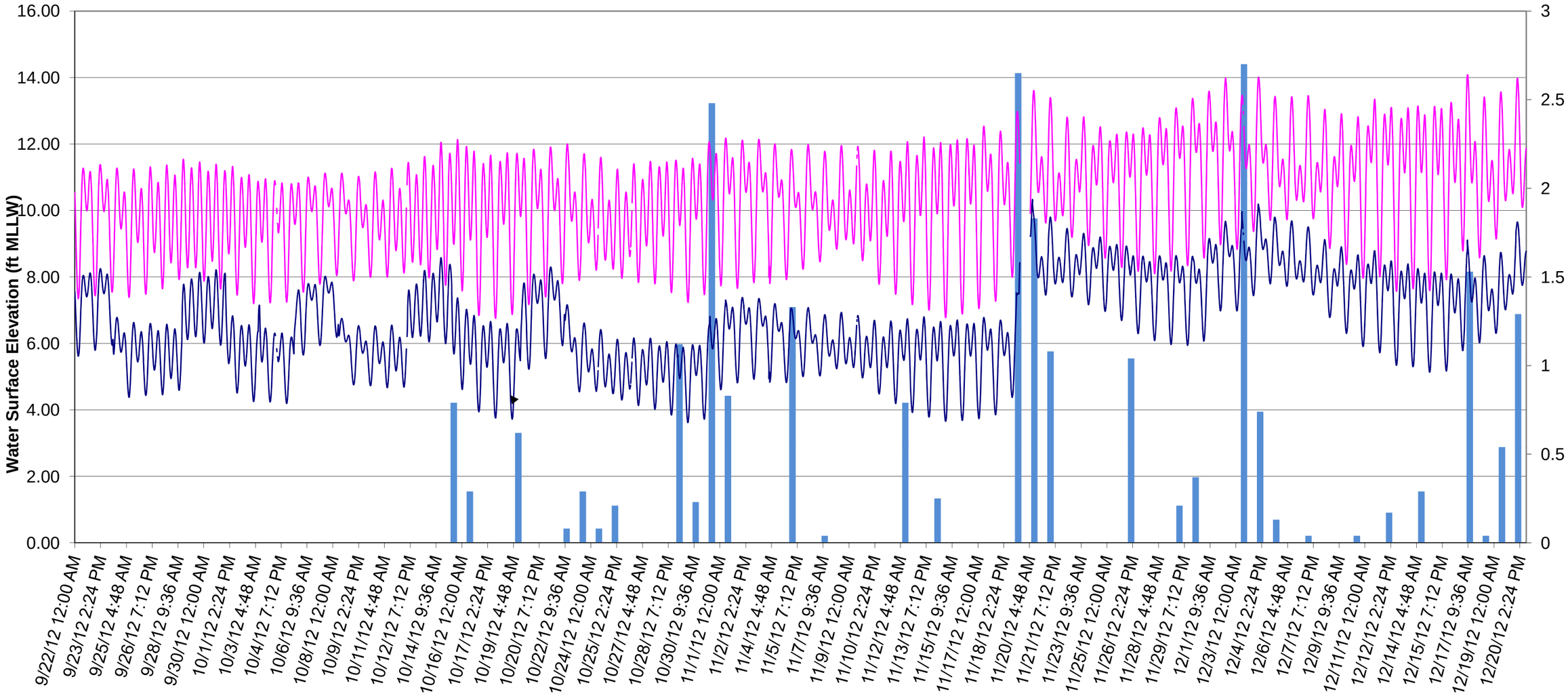


Figure 2f Well Pair Hydrographs
Upper Aquifer Well VG3U & Lower Aquifer Well VG3L
September 22, 2012 through December 20, 2012

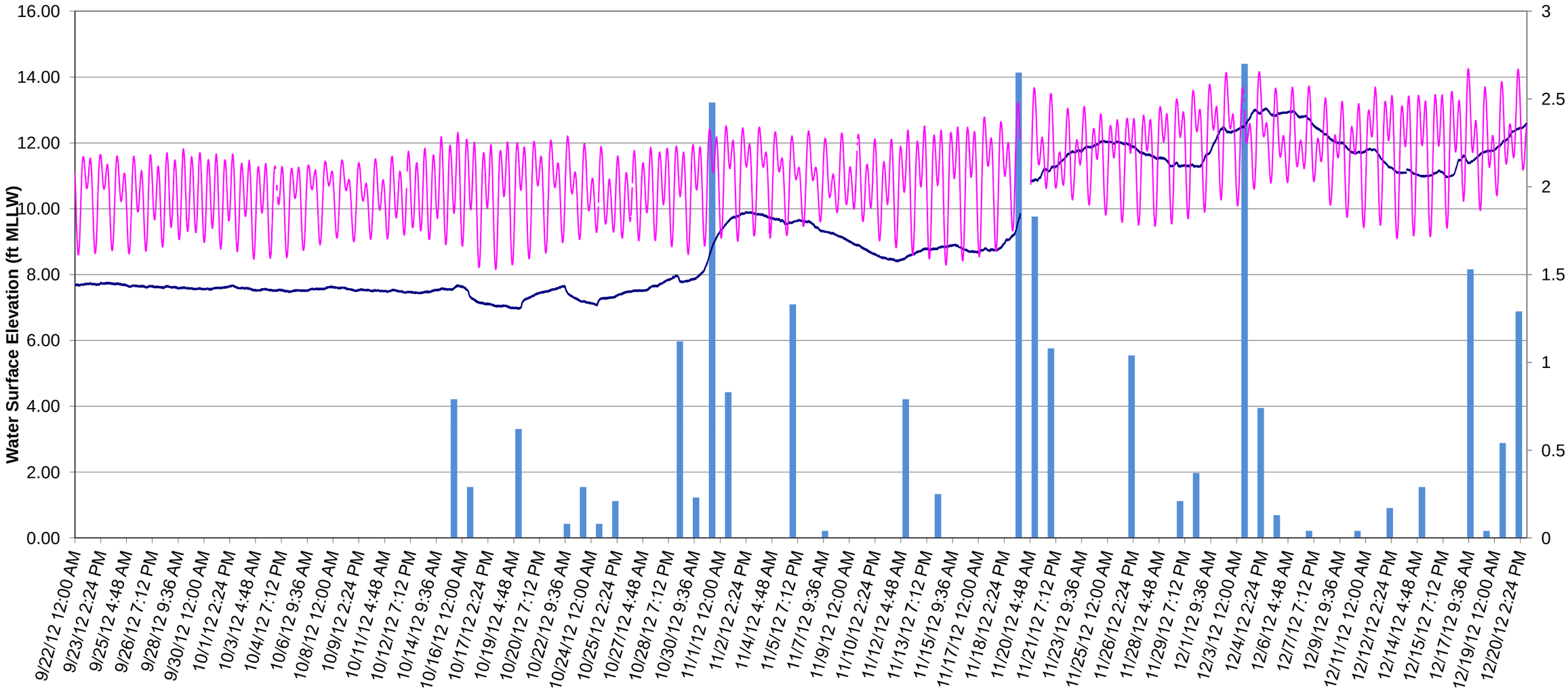


Figure 2g Well Pair Hydrographs
Upper Aquifer Well VG5U & Lower Aquifer Well VG5L
September 22, 2012 through December 20, 2012

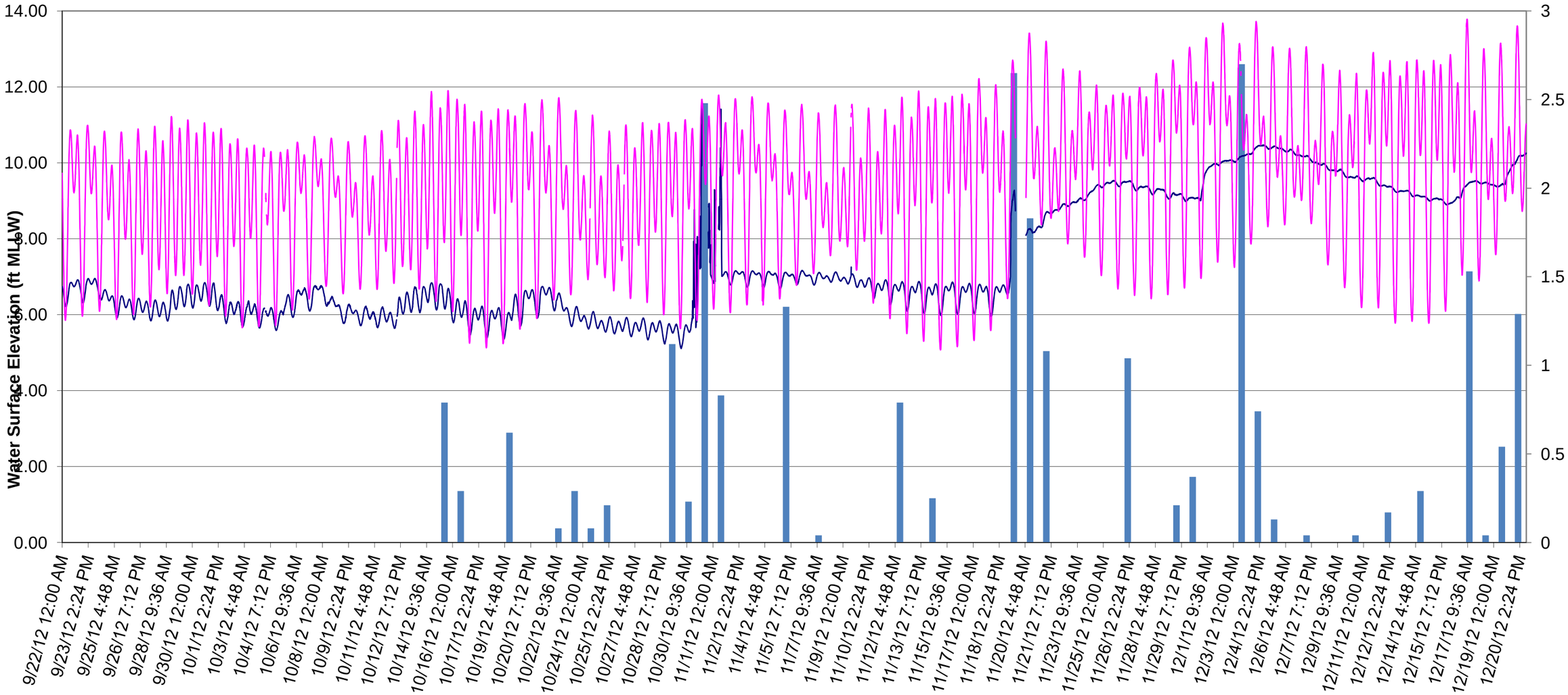


Figure 2h Well Pair Hydrographs
Upper Aquifer Well PO13 & Lower Aquifer Well VG1L
September 22, 2012 through December 20, 2012

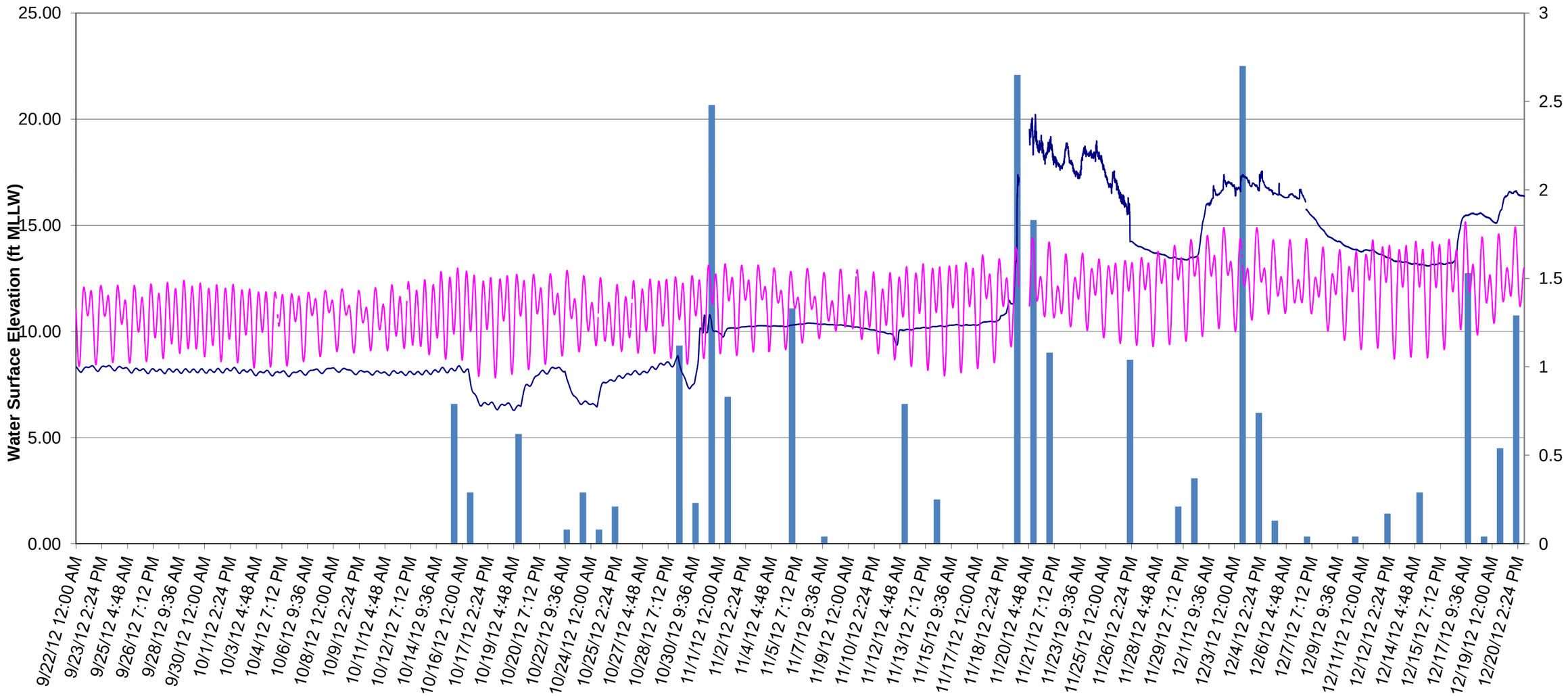


Figure 2i Well Pair Hydrographs
Upper Aquifer Well CW13 & Lower Aquifer Well VG4L
September 22, 2012 through December 20, 2012

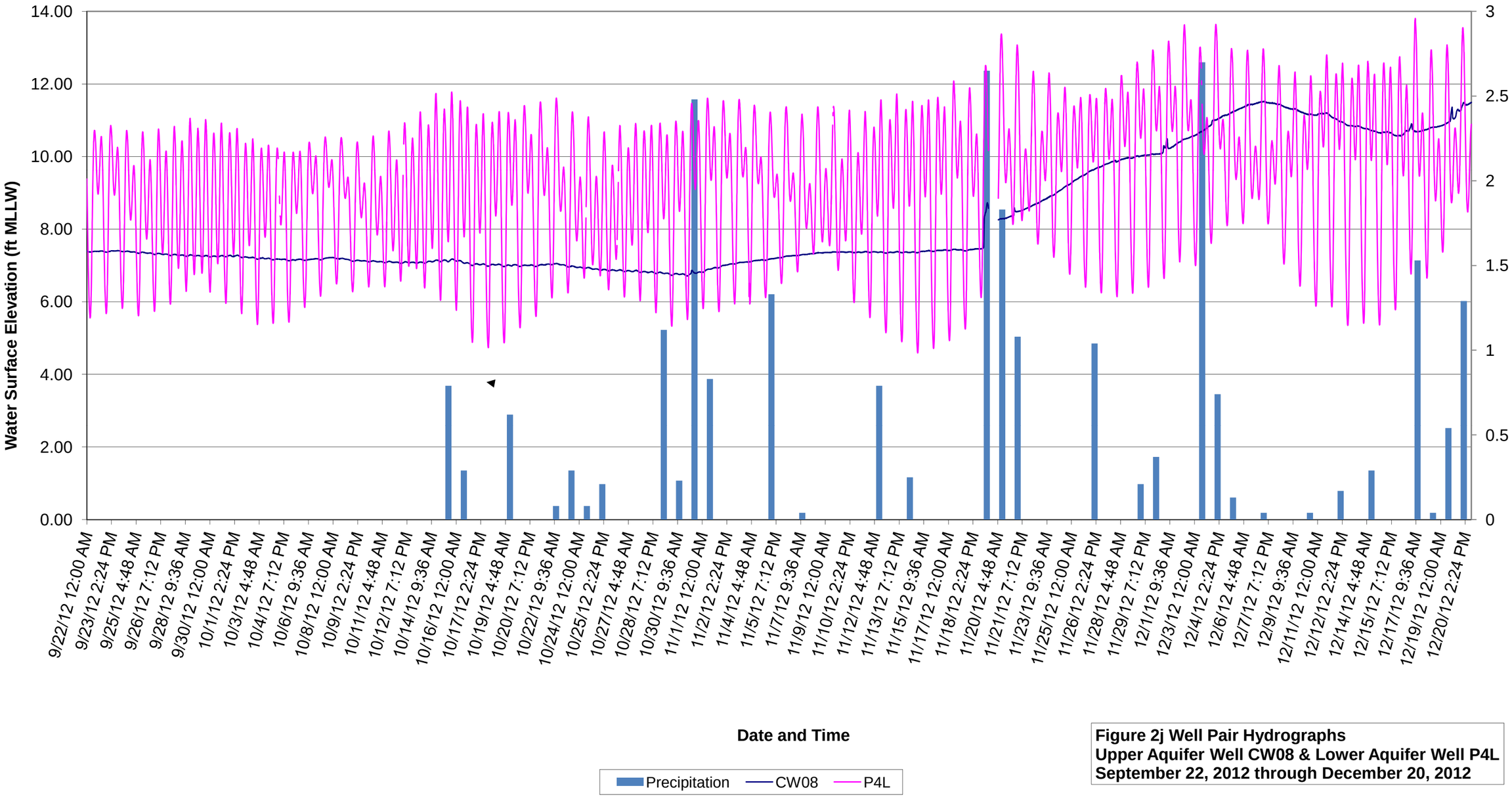


Figure 2j Well Pair Hydrographs
Upper Aquifer Well CW08 & Lower Aquifer Well P4L
September 22, 2012 through December 20, 2012

Maximum Downward Flow Potentials

MW14/CW05	12/12/2012
MW18/02CDMW01	11/20/2012
PO03/99CDMW02	11/25/2012
CW03/CW02	11/25/2012
VG2U/VG2L	none
VG3U/VG3L	none
VG5U/VG5L	12/4/2012
PO13/VG1L	10/31/2012
CW13/VG4L	11/23/2012
CW08/P4L	12/12/2012

Well(s) Off
September 10 - October 16, 2012 (PW-9)
September 21 - 24, 2012
(PW-1, PW-2, PW-4, PW-5, PW-6, PW-8, EW-2, EW-6)

September 25 - October 16, 2012 (PW-6, PW-1)
September 25 - November 1, 2012 (EW-2)
September 28 - October 1, 2012 (PW-2, PW-4, PW-5, PW-8, EW-6)

Well(s) Off
October 5 - October 8, 2012 (PW-2, PW-4, PW-5, PW-8, EW-6)
October 12 - October 15, 2012 (PW-2, PW-4, PW-5, PW-8, EW-6)

Well(s) Off
October 19 - October 22, 2012
(PW-1, PW-2, PW-4, PW-5, PW-6, PW-8, PW-9, EW-6)
October 24 - October 29 (PW-9)

Daily Precipitation (inches)

Cumulative Precipitation (inches)

Date

Daily Precipitation
Cumulative Precipitation

Figure 3 Wyckoff Site Precipitation, Well Field Shutoff, and Max Downward Flow Potential Summary September 22, 2012 through December 20, 2012