Evaluation of Wyckoff Groundwater Level Data, April 2011 – June 2011

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The purpose of this memorandum is to summarize the Wyckoff groundwater level results for the 90-day monitoring period of April 1 through June 29, 2011.

Summary/Recommendations

- Hydraulic containment was maintained in all of the 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/P4L.
- The Leveloggers should be downloaded again in November 2011 to maintain a quarterly schedule consistent with the definition of hydraulic containment.

Water Level Data Collection

Solinst Leveloggers are installed in 11 upper aquifer wells and 18 lower aquifer wells. The loggers were downloaded on August 24, 2011. For this memorandum, the data set was truncated at June 29, 2011 and analyzed with the April 1, 2011 to May 12, 2011 data collected during the previous download on May 12, 2011. The remaining data from this August 24, 2011 download (June 30, 2011 to August 24, 2011) will be included in the next memorandum with the next set of downloaded data. The locations of the wells are shown in Figure 1 and wells with loggers are listed in Table 1. All data are available in e-format upon request.

Table 1 – Wells with Data Loggers, May 12, 2011 – August 24, 2011

Upper Aquifer		Lower Aquifer		
CW03	PO13	02CDMW01	VG-1L	P-3L
CW08	VG-2U	99CDMW02A	VG-2L	P-4L
CW13	VG-3U	CW01	VG-3L	P-5L
MW14	VG-5U	CW02	VG-4L	P-6L
MW18		CW05	VG-5L	
MW21		PZ03	P-1L	
PO03		PZ11	P-2L	

Hydraulic Containment / Isolation Discussion

The hydraulic containment/isolation performance at the Wyckoff site has been 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. The hydraulic containment at each well pair is evaluated in two steps. First, the average groundwater elevations of the upper and lower aquifers are calculated by averaging the water level data (converted to elevations) recorded every 15 minutes during the monitoring period. Second, the average groundwater elevations are compared. If the average lower aquifer groundwater elevation is greater than that of the upper aquifer, indicating an overall net upward movement of groundwater, then hydraulic containment is demonstrated. If a well pair meets the definition of hydraulic containment, then the ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for that well pair will be greater than 1.

Data collected from the Leveloggers indicate that some of the logger timers drifted over the data collection period (May 12, 2011 to August 24, 2011). In cases where the logger timer did "drift", the logger time was almost always ahead of the actual clock time. The exceptions were the loggers in wells P2L, P4L, and PZ11, where the logger time was behind actual clock time by 7 minutes, 27 minutes, and 4 minutes, respectively. In most of the drift cases, the logger timer drift was small (less than 15 minutes ahead of clock time). The average timer drift was calculated to be 6 minutes for the August 24, 2011 download. The loggers in two wells (P3L and P6L), however experienced significant drift over the data collection period. The logger time was ahead of actual clock times by 53 minutes in P3L and 55 minutes in P6L. However, because hydraulic containment is defined by the average lower and upper aquifer water level elevations over the monitoring period, small errors in the recorded logger time have no effect on the hydraulic containment results presented in this memorandum.

Hydrographs from the 10 well pairs are shown in Figures 2 through 11 for the monitoring period.

Well Pair MW14/CW05

90-Day Monitoring Period (April 1 through June 29, 2011)

The hydrograph for well pair MW14/CW05 (Figure 2) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 13.81 feet MLLW in the lower aquifer (Well CW05) and 8.24 feet MLLW in the upper aquifer (Well MW14). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair MW14/CW05 was calculated to be 1.68, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, there were no occurrences of downward flow potential for well pair MW14/CW05.

Well Pair MW18/02CDMW01

90-Day Monitoring Period (April 1 through June 29, 2011)

The hydrograph for well pair MW18/02CDMW01 (Figure 3) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 9.21 feet MLLW in the lower aquifer (Well 02CDMW01) and 1.89 feet MLLW in the upper aquifer (Well MW18). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair MW18/02CDMW01 was calculated to be 4.88, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, there were no occurrences of downward flow potential for well pair MW18/02CDMW01.

Well Pair PO03/99CDMW02

90-Day Monitoring Period (April 1 through June 29, 2011)

The hydrograph for well pair PO03/99CDMW02 (Figure 4) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 17.08 feet MLLW in the lower aquifer (Well 99CDMW02) and 4.97 feet MLLW in the upper aquifer (Well PO03). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair PO03/99CDMW02 was calculated to be 3.44, thus demonstrating hydraulic containment.

Over the 90-day period, there were no occurrences of downward flow potential for well pair PO03/99CDMW02.

Well Pair CW03/CW02

90-Day Monitoring Period (April 1 through June 29, 2011)

The hydrograph for well pair CW03/CW02 (Figure 5) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 7.91 feet MLLW in the lower aquifer (Well CW02) and 6.20 feet MLLW in the upper aquifer (Well CW03). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair CW03/CW02 was calculated to be 1.27, thus demonstrating hydraulic containment.

Over the 90-day period, 49 periods of downward flow potential occurred for well pair CW03/CW02. The sum of all downward flow potential periods over the entire monitoring period was 137 hours (approximately 5.5 days). The average duration of an event was approximately 3 hours. The maximum duration of an event was 4 hours and 45 minutes. The average downward flow potential was calculated to be – 0.24 feet. The maximum downward flow potential was calculated to be -0.67 feet and occurred on April 7, 2011 at 14:45.

Well Pair VG-2U/VG-2L

90-Day Monitoring Period (April 1 through June 29, 2011)

The hydrograph for well pair VG-2U/VG-2L (Figure 6) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 8.41 feet MLLW in the lower aquifer (Well VG-2L) and 6.83 feet MLLW in the upper aquifer (Well VG-2U). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair VG-2U/VG-2L was calculated to be 1.23, thus demonstrating hydraulic containment.

Over the 90-day period, there were no occurrences of downward flow potential for well pair VG-2U/VG-2L.

Well Pair VG-3U/VG-3L

90-Day Monitoring Period (April 1 through June 29, 2011)

The hydrograph for well pair VG-3U/VG-3L (Figure 7) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 10.77 feet MLLW in the lower aquifer (Well VG-3L) and 5.63 feet MLLW in the upper aquifer (Well VG-3U). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair VG-3U/VG-3L was calculated to be 1.91, thus demonstrating hydraulic containment.

Over the 90-day period, there were no occurrences of downward flow potential for well pair VG-3U/VG-3L.

Well Pair VG-5U/VG-5L

90-Day Monitoring Period (April 1 through June 29, 2011)

The hydrograph for well pair VG-5U/VG-5L (Figure 8) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 11.05 feet MLLW in the lower aquifer (Well VG-5L) and 8.04 feet MLLW in the upper aquifer (Well VG-5U). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair VG-5U/VG-5L was calculated to be 1.37, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, 19 periods of downward flow potential occurred for well pair VG-5U/VG-5L. The sum of all downward gradient periods over the monitoring period was 76 hours (approximately 3 days). The average duration of an event was approximately 4 hours. The maximum duration of an event was 7 hours. The average downward flow potential was calculated to be – 0.56 feet. The maximum downward flow potential was calculated to be – 1.50 feet and occurred on April 4, 2011 at 13:30.

Well Pair PO13/VG-1L

90-Day Monitoring Period (April 1 through June 29, 2011)

The hydrograph for well pair PO13/VG-1L (Figure 9) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 9.03 feet MLLW in the lower aquifer (Well VG-1L) and 6.59 feet MLLW in the upper aquifer (Well PO13). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair PO13/VG-1L was calculated to be 1.37, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, 60 periods of downward flow potential occurred for well pair PO13/VG-1L. The sum of all downward gradient periods over the monitoring period was 218 hours and 15 minutes (approximately 9 days). The average duration of an event was approximately 3 hours and 38 minutes. The maximum duration of an event was 6 hours and 45 minutes. The average downward flow potential was calculated to be – 0.71 feet. The maximum downward flow potential was calculated to be – 2.21 feet and occurred on April 7, 2011 at 14:15.

Well Pair CW13/VG-4L

90-Day Monitoring Period (April 1 through June 29, 2011)

The hydrograph for well pair CW13/VG4L (Figure 10) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 11.56 feet MLLW in the lower aquifer (Well VG-4L) and 9.63 feet MLLW in the upper aquifer (Well CW13). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair CW13/VG4L was calculated to be 1.20, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, 62 periods of downward flow potential occurred for well pair CW13/VG4L. The sum of all downward gradient periods over the monitoring period was 418 hours and 30 minutes (approximately 17 days). The average duration of an event was approximately 6 hours and 45 minutes. The maximum duration of an event was 47 hours and 45 minutes. The average downward flow potential was calculated to be – 1.17 feet. The maximum downward flow potential was calculated to be – 3.52 feet and occurred on April 3, 2011 at 12:15.

Well Pair CW08/P-4L

90-Day Monitoring Period (April 1 through June 29, 2011)

The hydrograph for well pair CW08/P-4L (Figure 11) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 9.24 feet MLLW in the lower aquifer (Well P-4L) and 8.11 feet MLLW in the upper aquifer (Well CW08). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair CW08/P-4L was calculated to be 1.14, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, 109 periods of downward flow potential occurred for well pair CW08/P-4L. The sum of all downward gradient periods over the monitoring period was 625 hours and 15 minutes (approximately 26 days). The average duration of an event was approximately 5 hours and 44 minutes. The maximum duration of an event was 10 hours and 45 minutes. The average downward flow potential was calculated to be – 1.35 feet. The maximum downward flow potential was calculated to be -3.93 feet and occurred on April 8, 2011 at 15:30.

Treatment Plant Operations and Precipitation Effects on Vertical Gradients

During the April 1, 2011 through June 29, 2011 monitoring period, Former Process Area (FPA) groundwater extraction well pumps periodically had to be shut down. The majority of the shut downs during this monitoring period were due to well maintenance or low water level. Shutdowns of the extraction well pumps that occurred for periods of one day or longer (as noted in CH2M HILL operation records) are listed in Table 2. These periods are graphically overlaid with the precipitation records and are shown in Figure 12.

The treatment plant and extraction well systems were operated 24 hours per day and 7 days per week, with the exception of the dates listed in Table 2, when the treatment plant was shut down due to well maintenance or low water level. The total volume of water pumped was 6,259,414 gallons during the 90-day monitoring period which equates to about 48 gpm over the entire period including all down time regardless of cause. [Note, when fully operating, the system can pump about 57 to 60 gpm.]

During the April 1, 2011 through June 29, 2011 monitoring period, downward flow potentials were associated with precipitation events and treatment plant and extraction well systems shutdowns.

Figure 12 shows the cumulative precipitation of 6.41 inches at the site for the monitoring period, with the heaviest precipitation occurring in May. Downward flow potentials were observed in 5 of the monitored well pairs during the monitoring period. The maximum downward flow potential observed for 4 of the 5 well pairs, CW03/CW02, VG5U/VG5L, PO13/VG1L, and CW08/P4L, occurred April 4 through April 8, 2011, immediately following a 0.95-inch single-day precipitation event on April 4, 2011. The maximum downward flow potential observed for the remaining well pair, CW13/VG4L, occurred on April 3, 2011, one day before the 0.95-inch single day rainfall on April 4, 2011.

Many of the upper aquifer hydrographs show a slight rise in groundwater levels following the 0.95-inch rainfall event on April 4, 2011 and the 1.65-inch rainfall event on May 16, 2011. However, with the extraction and treatment system operating 24/7, the water levels in the upper aquifer wells were maintained at levels lower than those in lower aquifer wells for the majority of the monitoring period, thus maintaining hydraulic containment in all well pairs throughout the monitoring period. This demonstrates that maximizing upper aquifer "recharge storage potential" by keeping the extraction operations at full capacity before and during the wet season allows hydraulic containment to be maintained when the heavy rains begin in the late fall through spring. The recently completed installation of new water level transducers in all the monitoring and extraction wells and the centralized real-time data acquisition system will allow for better optimization of the extraction system.

Table 2 – Former Process Area (FPA) Extraction Well Pump Shutdown Periods Greater than 1 Day

Date	Wells Shut Down	Reason
June 1 – June 15, 2011	PW-9	Low water level
June 2 – June 10, 2011	PW-8	Well maintenance, electrical
June 7 – June 8, 2011	PW-5	Well maintenance
June 9 – June 23, 2011	PW-5	Well maintenance
June 17 – July 18, 2011	PW-9	Low water level
June 28 --	PW-8	Pump replacement