

Internal Monitoring Report

Policy # O-2E Sustainability
Frequency: Twice a year

Date: January 23, 2018

Policy Language:

Madison residents will benefit from a sustainably managed ground water supply to ensure that water is available to protect public health, and to maintain and improve the economy and environment in Madison, now and in the future.

Accordingly,

1. Aquifers and wells will be monitored and the data evaluated to identify trends in water levels and potential contaminants.
2. Appropriate city, county, state and federal agencies will be called upon to enforce all pollution control and prevention measures within their authority, in order to protect water quality in the well head protection area of each unit well.
3. The adopted Conservation Plan shall be monitored and evaluated regarding progress to fulfill its goals. Plan goals should include reductions in energy use, avoiding the cost of additional wells, and minimizing complications related to over-pumping the groundwater system.
4. The water supply system shall be expanded so that the pumpage from individual unit wells shall not exceed 50% of the annual rated capacity of the unit well.
5. The Utility shall track the carbon footprint of Utility operations using quantitative tools (for example, energy intensity analysis) so that sustainability may be considered in planning for water treatment facilities, distribution system improvements, and other infrastructure projects.
6. Water rates will complement economic growth in Madison (as stated in 0-2D).

General Manager's interpretation and its justification:

This policy prescribes certain activities intended to ensure the long term environmental, public health, and economic sustainability of Madison's water supply. Our actions relating to these objectives are detailed below.

Data directly addressing the General Manager's interpretation:

1. Aquifers and wells will be monitored and the data evaluated to identify trends in water levels and potential contaminants.

Water Levels

The water levels in the aquifers beneath Madison continue to be monitored on a routine basis. A deep groundwater monitoring well located in the basement of the State Capitol has provided water levels since 1946. A review of the monthly data indicates levels continue to vary on a seasonal basis, a direct result of demand (pumping) and recharge (precipitation.)

As in past years, summer levels were lower than those experienced during the winter. Levels were as much as 13 feet lower during the months of May through October. Overall, aquifer levels appear to be increasing or rebounding with an increase of approximately 12 - 14 feet

since 2005. This is a good indication that the local aquifers are in the process of rebounding/recovering to pre-pumping levels. The most recent data suggest that this rebound might be slowing or leveling off. The water levels beneath the central part of our city during the last 30 years are displayed in Figure 1.

The static and pumping water levels in many of MWU's wells varied slightly during the second half of 2017. Variations, however, were significantly less than those experienced during past years (i.e., 2012) when we were subject to extremely hot and dry summer conditions. Water levels in MWU's wells continue to fluctuate seasonally and are greatly influenced by precipitation events. A review of the recent water level data indicates that, with the exception of UW 11, water levels in the wells are rising as winter demands decrease. UW 11 levels have declined throughout the year and are continuing to do so. Water levels in this well are approximately 10 - 14 feet lower than normal for this time of year. Nearby UW 9 has been out of service since mid-August and UW 11 has been pumped significantly more than normal to meet demand. Water levels at UW 11 should recover once UW 9 is back in service later this year.

The increase in water levels is consistent with those of last year at this time and the levels in all of the wells appear to be sustainable for the near future. Average static and pumping water levels between January 2013 and December 2017 are depicted in Table 1.

Total precipitation in 2017 was above average. We received 38.3 inches of precipitation in 2017 which is about 3.9 inches (11.3%) more than the annual average of 34.4 inches. It is anticipated that precipitation amounts in the Madison area will continue to be above average into the near future.

Madison Kipp Corporation/UW #8 Sentinel Well

The Madison Kipp Corporation (MKC) continues to run its groundwater extraction and treatment system at its Waubesa Street site. The remedial system is being utilized to remove volatile organic compound (VOC) mass and hydraulically contain VOC contaminated groundwater present in the upper bedrock aquifer beneath the site.

The pumped groundwater is still being treated using an air stripper located on-site. The treated water (~40 - 45 gpm) is discharged to the storm sewer under a WPDES Discharge Permit. The most recent compliance samples were below WPDES discharge limits. The recovery operation began in early July of 2015 and is expected to operate for a number of years.

Between January 1, 2017 and June 30, 2017 they pumped and treated slightly over 11.2 million gallons of contaminated groundwater. Approximately 147 pounds of VOCs were removed from the groundwater during this period. Since the system started in 2015, approximately 36.4 million gallons of water have been treated, 500 pounds of VOCs removed and concentrations in water from the recovery well have fallen.

The Soil Vapor Extraction system at the MKC site also continues to run. This system has operated continuously for more than 3 years. PCE concentrations in the soil are decreasing.

MWU continues to work with MKC, their consultant, the WDNR, and the WGNHS on the area's groundwater contamination issues. Eric Oelkers and SCS Engineers completed their hydrogeological evaluation of the potential impact of the MKC plume on UW 8. A final report entitled "PCE Plume Evaluation, Unit Well 8" was issued on October 13, 2017. Some of the major findings include:

- The contaminant plume is stable or declining to the south, east and west of the MKC property. However, it appears to be expanding to the north, which is in the opposite direction of UW 8.
- The zone of influence for the MKC extraction well is limited to on-site and will not stop the migration of contaminants existing outside it.
- The cis-1,2-dichloroethene detected in UW 8 does not appear to be from the MKC plume and breakthrough of the plume has not occurred at the well.
- The Dane County groundwater flow model suggests that un-retarded travel times between MKC and UW 8 range from 6 to 46 years. There are a number of naturally occurring processes that could increase these times considerably.
- We currently do not know if the contaminants have penetrated the underlying Eau Claire Aquitard. If so, the movement toward the well would be at a much quicker rate.
- SCS recommends that a monitoring well be installed in the Mt. Simon Formation between the MKC site and UW 8. Several different locations are suggested.

MWU has asked SCS Engineers to narrow potential sites down to one. A deep monitoring well is scheduled to be installed later this summer. This well will serve as a sentinel system.

Groundwater at and adjacent to the facility continues to be monitored routinely for VOCs. Groundwater samplings, conducted in January and April of 2017, indicate that PCE levels in the groundwater between the site source and UW 8 remain relatively constant. The southeastern extent of the plume appears stable with the edge approximately 600 horizontal feet from UW 8. Levels within the extraction well's zone of contribution continue to decrease (improve).

UW 29 Sentinel Well

Water from the sentinel well located between UW 29 and the Sycamore Landfill continues to be monitored for both inorganic and volatile organic compounds on a semi-annual basis. Sampling is typically conducted in April and October of each year with seventeen samplings conducted to date.

The second round of sampling this year was conducted in November, which is several weeks later than usual.

In terms of Volatile Organic Compounds (VOCs), the samples are analyzed for a total of 51 different compounds. Results from the latest November 2017 sampling revealed one minor VOC detect.

- Trichlorofluoromethane was detected in the shallowest port at a level of 0.44 ug/l. This detect is below the level of quantification (1.1 ug/l) and there is no MCL for this compound. Trichlorofluoromethane exists in the water table aquifer at low concentrations throughout the area and is not related to the landfill.
- No VOCs were detected in water from UW 29.

For inorganics, a total of 22 different parameters are analyzed for. Several different inorganics were detected at elevated levels in the water tested in November.

- Port 1 had a chloride concentration of 259 mg/l this round (MCL = 250). Chloride levels in this port have steadily increased over the last six years and are likely a result of local road salt practices.
- As in past samplings, elevated levels of manganese were detected in the water from Port #5 (190 ug/l) and Port #6 (93 ug/l). It is believed that the manganese is naturally occurring and exits at these depths throughout the area.
- Water from UW #29 tested high for iron (0.286 mg/l) and manganese (64 ug/l). Water from this well is filtered for these two constituents prior to entering the distribution system.

Sampling indicates that the migration of contaminants from the Sycamore landfill is not a significant threat to water quality at Unit Well 29 at this time. This well continues to pump at half capacity on a 24/7 basis.

UW 14 - Chloride Study

The investigation into potential sources of chloride contamination at Well 14 is on-going. In December, two water table monitoring wells were installed in Spring Harbor Park. The wells were drilled to depths of seventeen and eighteen feet; they were initially sampled in early January. Monthly monitoring for chloride and sodium will continue through June 2019. Utility staff is exploring options to continuously monitor the water level and specific conductance at the monitoring wells. Finally, a project page and email distribution list have been developed to keep neighbors and customers informed about the progress of the project.

UW 27 - Radium Study

MWU, with the assistance of the Wisconsin Geologic and Natural History Survey, has initiated a subsurface study for radium in the UW 27 area. Plans are underway to drill and install a deep monitoring well in the nearby Klief Park. UW 27 was taken off line at the end of December and the pump is scheduled to be pulled in the near future. After the pump and column are removed, the well hole will be televised and geophysically logged. This will allow correlation with the Klief Park test hole site.

UW 31 - Zone 4 Production Well

Construction of the well facility at 4901 Tradewinds Parkway began in 2017 and should be complete by the end of 2018. When complete, this well will be able to provide 2.5 - 3.0 million gallons of water a day into Zone 4.

The WDNR continues to monitor the groundwater monitoring and remedial activities associated with the GE Health care site, a contaminated site located to the northeast. There are no new updates to report for this site. To date, no TCE or any other volatile organic compounds have been detected at the Tradewinds Parkway well. The Tradewinds Parkway site is located over 6000 feet from the source of the TCE contamination.

2. Appropriate city, county, state and federal agencies will be called upon to enforce all pollution control and prevention measures within their authority...

As previously mentioned, MWU continues to work with the Mayor's office and the WDNR in monitoring the remediation of the PCE contaminated groundwater at the Madison Kipp site. At the request of the WDNR, the Madison Water Utility, City Engineering, and Public Health continue to review the remedial strategies and plans proposed by MKC and their consultants. MWU continues to remind the WDNR of the City's plans to upgrade UW #8 with an iron and manganese filter.

3. The adopted Conservation Plan shall be monitored and evaluated regarding progress to fulfill its goals. Plan goals should include reductions in energy use, avoiding the cost of additional wells, and minimizing complications related to over-pumping the groundwater system.

MWU pumped a total of 9,418,637,000 gallons of water to the distribution system during 2017. This is approximately 4.4% less than the 9,848,137,000 gallons pumped last year - 2016.

Average Day: 25,804,000 gpd (last year 26,907,000 gpd)

Max Day: 38,887,000 gpd on June 16 (38,270,000 gpd on July 15)

Min Day: 16,800,000 gpd on November 24 (19,540,000 gpd on December 25)

As mentioned earlier in this report, precipitation for the year was above average. In addition, rainfall events occurred on a fairly regular basis limiting the number of heavy pumpage days.

Residential consumption in gallons per capita by year:

1980-2000	81.5	
2002-2007	71.8	
2008	69.8	
2009	67.8	
2010	65.0	
2011	65.2	
2012	70.3	
2013	61.0	
2014	62.2	
2015	60.9	55.0*
2016	55.4	
2017	Pending	

Goal: 2020 58.0

* Average per-person daily consumption for **all** Madison residents - includes people living in apartments. MWU is now able to include all residents in this calculation whereas before it was only single family and duplexes.

Energy Conservation Assessment

Adam Luthin, a new graduate student with MWU, has recently began working on some energy conservation and system optimization projects. His research is likely include:

- 1) Identifying pumping design criteria that will optimize energy conservation.
- 2) Identifying projects with the highest potential for energy reduction.
- 3) Evaluating, recommending, and demonstrating energy conservation projects to MWU.
- 4) Laying the framework for system operational optimization.

4. The water supply system shall be expanded so that the pumpage from individual unit wells shall not exceed 50% of the annual rated capacity of the unit well.

Our service level for capacity planning is 50% utilization and system expansion is being planned to accomplish this level. MWU continues to propose and build additional booster stations and new well facilities to help achieve this goal. In addition, variable speed drives (VFDs) are being added to existing motors/pumps each year to optimize system flows.

Overall, utilization rates during 2017 were very similar to those experienced in 2016. Through December 31, 2017, six different wells exceeded the 50% utilization rate. Well repair/reconstruction projects and the necessary use of seasonal wells on a year round basis continue to significantly influence individual well rates.

- The utilization rate at UW 6 dropped dramatically in 2017 (45.4% to 16.1%). This well was out of service during the months of July through December for booster pump repairs.
- As mentioned earlier, UW 11 was pumped significantly more during 2017 than normal. As a result, its utilization rate of 56.9% was higher than our goal. On the other hand, UW 9, the well it was assisting pumped less – only 31.2% of its capacity.
- Unfortunately, the 50% goal was significantly exceeded again at UW 12 (79.8%). The use of this site will likely lesson with the addition of VFDs on its booster pumps, a project scheduled for next year.
- Ground storage reservoir 113 was completed in late 2016 and was in service for all of 2107. This 1 million gallon reservoir floats on Zone 6E. The use of this storage tank allowed us to significantly reduce the utilization rate of UW 13, a well located at the far north edge of the pressure zone, during 2017. We are currently running UW 13 primarily at night when electrical rates are less expensive. The water from the 113 reservoir is then used during the day or during on peak hours.
- The 50% goal was also exceeded again at UW 14 (56.2%). This well was out of service for two months for repairs. The utilization rate would have been even higher if not for the down time. The use of this site is not likely to lesson without the addition of a Zone 8/Zone 6W booster/transfer station (BS 114).
- UW 26's utilization rate was reduced to 56.0% by leaving UW 28 in service over the winter months. MWU plans to reduce the use of UW 26 even more this year.
- The utilization rate at UW 29 was 51.5%. The well/motor here had to be run at a slightly higher rate to compensate for some vibration problems.

- Although UW 30 was slightly above 50% in 2017 (53.6%), MWU was able to reduce the amount of electricity it used by running it at a slower flow rate.

The addition of VFDs on the deep wells at several of the sites has allowed MWU to directly minimize the utilization rates of these wells. In addition, they will help in lowering MWU's electrical costs. Five deep wells currently have VFDs – 7, 15, 25, 29, and 30. Wells 12, 17, 23, and 31 are scheduled to get VFDs in the coming year. Indirectly, VFDs on booster pumps have also allowed us to minimize deep well pumping at some sites. MWU installed VFDs on the booster pumps at Wells 16 and 17 in 2017. The booster pumps at Wells 12, 19, and 27 will have VFDs installed in the near future. Actual utilization rates for 2016 and 2017 are depicted in Tables 2 and 3.

Current construction projects which will affect utilization rates:

- The reconstruction of UW 12, making it a two zone well, will reduce utilization rates in the far west pressure zones (UW 12, UW 20, and UW 26). This project is scheduled to be complete in 2019.
- The connection of Zone 11 to Zone 10 and the construction of the Blackhawk Tower (228) on the far west side will help reduce the utilization rate of UW 26/Tower 126. This project will be complete in 2018.
- Construction of UW 31 began last year and the well should be in service by spring of 2018. The addition of this well will significantly lower the utilization rate of UW 9, the only other well in Zone 4.

5. The Utility shall track the carbon footprint of Utility operations using quantitative tools (for example, energy intensity analysis) so that sustainability may be considered in planning...

The City of Madison (COM) calculates the carbon footprint of all of its departments every two years. COM completed an analysis in 2014 and is currently working on one for 2016. MWU is in the process of tracking down the 2014 results and will participate in the 2016 analysis. Because it is part of the City, MWU has access to the software and tools utilized in calculating a footprint. Obtaining these will allow us to complete an in-house analysis using 2017 numbers, the results of which will be reported separately.

6. Water rates will complement economic growth in Madison (as stated in O-2D).

Please refer to the Monitoring report for the Affordability Outcomes Policy (O2-D).

I report compliance.

Attachments:

Aquifer Water Levels Graph
Unit Well Water Levels Table
Unit Well Capacity Tables

Figure 1: Aquifer Water Levels - State Capitol Well

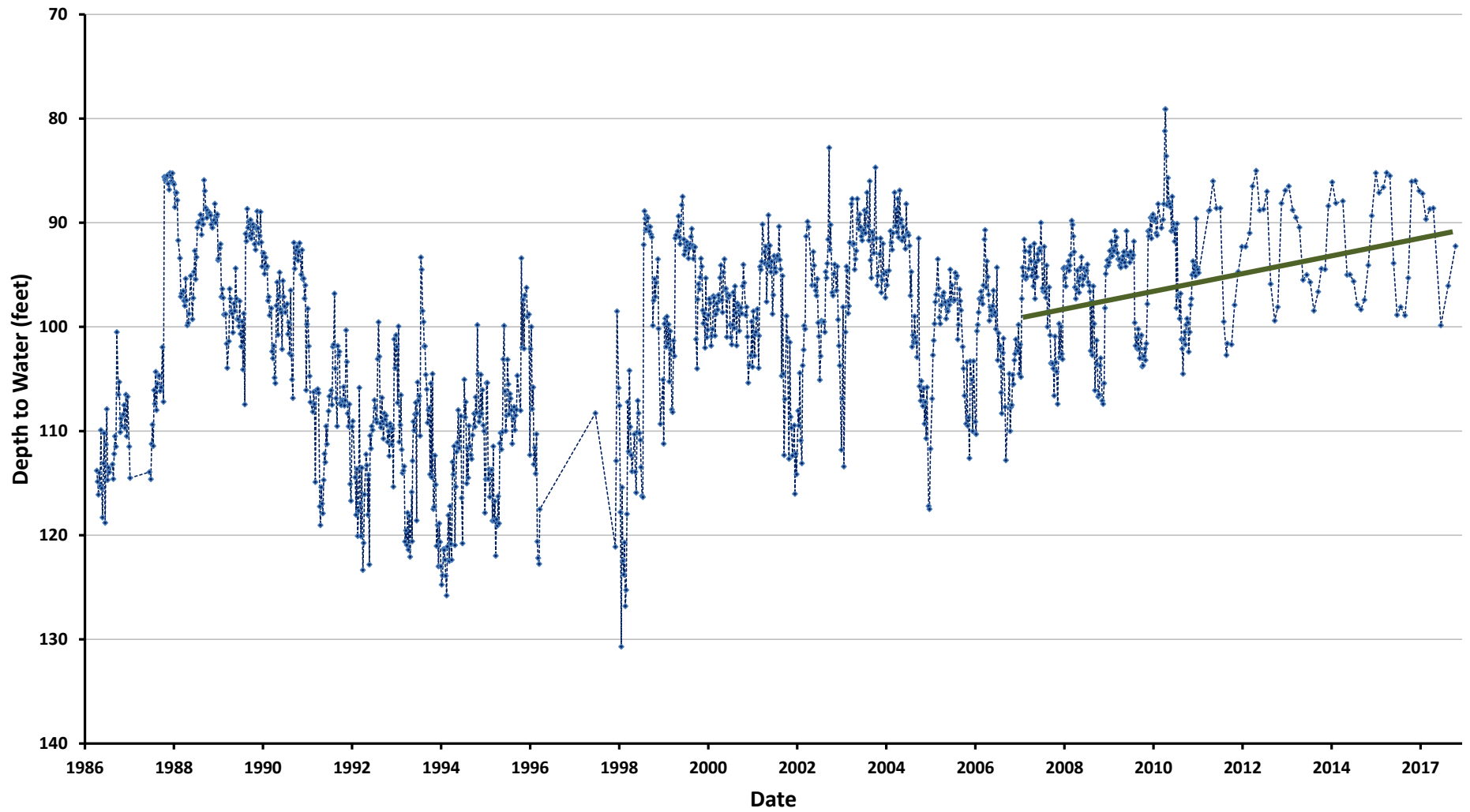


Table 2: 2016 Unit Well Capacity

Start Date: January 01, 2016

End Date: December 31, 2016

Unit Well	DW Capacity GPM	Total Daily Capacity MGD	Total Capacity To Date Mil Gal	Actual Pumpage To Date Mil Gal	% DW Utilization		DW Run Hours To Date	DW Rest Hours To Date	% DW At Rest To Date	% DW Running To Date
6	2,840	4.1	1,496.8	678.9	45.4%		4,513.4	4,270.6	48.6%	51.4%
7 *	2,200	3.2	1,159.5	295.0	25.4%		2,948.4	5,835.6	66.4%	33.6%
8	1,980	2.9	1,043.5	18.1	1.7%		136.4	8,647.6	98.4%	1.6%
9	1,720	2.5	906.5	443.6	48.9%		4,262.4	4,521.6	51.5%	48.5%
11	2,090	3.0	1,101.5	403.3	36.6%		3,149.3	5,634.7	64.1%	35.9%
12	2,430	3.5	1,280.7	811.0	63.3%		5,876.3	2,907.7	33.1%	66.9%
13	2,625	3.8	1,383.5	826.0	59.7%		5,463.0	3,321.0	37.8%	62.2%
14	2,000	2.9	1,054.1	830.1	78.8%		7,353.4	1,430.6	16.3%	83.7%
15 *	2,200	3.2	1,159.5	365.3	31.5%		4,737.8	4,046.2	46.1%	53.9%
16	2,300	3.3	1,212.2	571.3	47.1%		4,138.6	4,645.4	52.9%	47.1%
17	2,290	3.3	1,206.9	303.8	25.2%		2,105.9	6,678.1	76.0%	24.0%
18	1,715	2.5	903.9	371.7	41.1%		3,133.5	5,650.5	64.3%	35.7%
19	2,020	2.9	1,064.6	203.9	19.2%		1,451.2	7,332.8	83.5%	16.5%
20	2,025	2.9	1,067.1	534.0	50.0%		4,403.9	4,380.1	49.9%	50.1%
23	1,310	1.9	690.4	51.4	7.4%		680.1	8,103.9	92.3%	7.7%
24	2,025	2.9	1,067.3	442.8	41.5%		3,611.7	5,172.3	58.9%	41.1%
25 *	2,000	2.9	1,054.1	336.9	32.0%		3,714.7	5,069.3	57.7%	42.3%
26	2,010	2.9	1,059.4	607.6	57.4%		4,999.6	3,784.4	43.1%	56.9%
27	1,775	2.6	935.5	178.7	19.1%		1,454.2	7,329.8	83.4%	16.6%
28	2,380	3.4	1,254.3	230.8	18.4%		1,688.9	7,095.1	80.8%	19.2%
29 *	2,200	3.2	1,159.5	680.4	58.7%		8,649.0	135.0	1.5%	98.5%
30	2,460	3.5	1,296.5	663.6	51.2%		5,008.1	3,775.9	43.0%	57.0%

* Denotes wells with variable frequency drives (VFDs)

Table 3: 2017 Unit Well Capacity

Start Date: January 01, 2017

End Date: December 31, 2017

Unit Well	DW Capacity GPM	Total Daily Capacity MGD	Total Capacity To Date Mil Gal	Actual Pumpage To Date Mil Gal	% DW Utilization		DW Run Hours To Date	DW Rest Hours To Date	% DW At Rest To Date	% DW Running To Date
6	2,650	3.8	1,392.8	224.1	16.1%		1,504.5	7,255.5	82.8%	17.2%
7 *	2,200	3.2	1,156.3	507.8	43.9%		4,919.8	3,840.2	43.8%	56.2%
8	1,980	2.9	1,040.7	67.6	6.5%		569.1	8,190.9	93.5%	6.5%
9	1,720	2.5	904.0	281.9	31.2%		2,699.4	6,060.6	69.2%	30.8%
11	2,090	3.0	1,098.5	624.8	56.9%		4,724.0	4,036.0	46.1%	53.9%
12	2,160	3.1	1,135.3	905.7	79.8%		6,960.4	1,799.6	20.5%	79.5%
13	2,620	3.8	1,377.1	370.4	26.9%		2,363.2	6,396.8	73.0%	27.0%
14	2,450	3.5	1,287.7	723.6	56.2%		5,089.9	3,670.1	41.9%	58.1%
15 *	2,200	3.2	1,156.3	366.3	31.7%		4,712.0	4,048.0	46.2%	53.8%
16	2,300	3.3	1,208.9	548.3	45.4%		3,864.9	4,895.1	55.9%	44.1%
17	2,290	3.3	1,203.6	279.9	23.3%		2,070.9	6,689.1	76.4%	23.6%
18	1,720	2.5	904.0	391.5	43.3%		3,841.8	4,918.2	56.1%	43.9%
19	2,150	3.1	1,130.0	486.7	43.1%		3,505.4	5,254.6	60.0%	40.0%
20	2,025	2.9	1,064.1	504.3	47.4%		4,163.0	4,597.0	52.5%	47.5%
23	1,310	1.9	688.5	21.6	3.1%		295.8	8,464.2	96.6%	3.4%
24	2,025	2.9	1,064.3	430.4	40.4%		3,566.7	5,193.3	59.3%	40.7%
25 *	2,000	2.9	1,051.2	335.9	32.0%		3,505.8	5,254.2	60.0%	40.0%
26	2,010	2.9	1,056.5	591.7	56.0%		4,973.1	3,786.9	43.2%	56.8%
27	1,775	2.6	932.9	246.7	26.4%		2,243.1	6,516.9	74.4%	25.6%
28	2,380	3.4	1,250.9	237.6	19.0%		1,762.4	6,997.6	79.9%	20.1%
29 *	2,200	3.2	1,156.3	595.9	51.5%		8,274.8	485.2	5.5%	94.5%
30 *	2,400	3.5	1,261.4	675.9	53.6%		7,863.9	896.1	10.2%	89.8%

* Denotes wells with variable frequency drives (VFDs)