Memorandum

Bonestroo

2335 Highway 36 W
St. Paul, MN 55113

Tel 651-636-4600
Fax 651-636-1311

www.bonestroo.com

TO:	DARREN AMUNDSEN, DICK FOSTER	PROJECT:	ENCLAVE OF MEDINA	DATE:	JUNE 9, 2010
FROM:	MARK JANOVEC	CLIENT:	CITY OF MEDINA		
RE:	PROPOSED ENCLAVE IRRIGATION WELLS			FILE NO:	190-10000-1

Overview

The following addresses a worst-case scenario for the Enclave of Medina's potential irrigation system wells. This analysis assumes that wells directly feed the irrigation system and is its only water source. The actual system will need to be designed to use the stormwater ponds and wells only as a supplemental water source.

The proposed installation of high capacity irrigation wells at the Enclave of Medina development required an analysis to determine if potential drawdown interference from these wells is likely to impact the adjacent City of Medina well field. At present, the Enclave development proposes to install six total irrigation wells, including five high-capacity wells pumping approximately 420gpm each and one medium-capacity well pumping 40gpm. The locations of the proposed wells are shown in Figure 1. The 420gpm wells will have an average run time of 2.5 hours, three times a week. The 40gpm well will have an average run time of 13.5 hours, three times a week. All six proposed wells are likely to be installed in the Jordan sandstone aquifer.

City of Medina Well Field

The City of Medina operates a nearby well field that currently has three high capacity wells (Wells 5-7), with a fourth well (Well 8) planned for the near future. All wells, except Well 5, are completed in the Jordan aquifer. Well 5 is completed in a sand and gravel drift aquifer that overlies the Jordan sandstone in the eastern portion of the well field. (Note: This sand and gravel drift aquifer does not appear to be present in the west portion of the Medina well field and is likely not present within the Enclave development.) Well 5 and 6 have a pumping capacity of 400gpm. Well 7 has a pumping capacity of 800gpm. Future Well 8 will likely be developed with a capacity of 400gpm in order to reach a desired total well field discharge of 1600gpm. An additional well, Well 9 may also be added sometime in the future as a backup well, for instances when one of the other wells is out of service. However, the total well field discharge is not expected to exceed 1600gpm at any given time.

In June 2008, Bonestroo conducted an analysis of the Medina well field to determine if the performance of the Jordan aquifer will sustain the existing wells and allow for the addition of Well 8. The analysis relied upon two aquifer performance tests that were conducted on both Well 6 (April 2007) and Well 7 (June 2008). The results of these tests indicated that the Jordan aquifer in the area has an average transmissivity of 28,000gpd/ft and a storage coefficient in the range of 0.0003-0.0008. A numerical model was utilized to predict drawdown at the Medina well field, combining the effects

of well interference to determine the maximum drawdown that can be expected at the existing and proposed well sites. (Note: Well 5 was not included in this analysis, since it was completed in the different aquifer.)

The results of the June 2008 analysis indicated that drawdown in Wells 6-8 can expect to see 74-91 feet of drawdown following seven days of continuous pumping of all three wells. The amount of available drawdown (the difference between the static water level and the top of the Jordan aquifer, minus 30 feet for the pump installation) is approximately 160 feet at these wells. This means that the wells should be able to accommodate the predicted levels of drawdown, with a margin of safety of roughly 69-86 feet.

Enclave Irrigation Well Interference

The proposed addition of five high capacity wells in the nearby Enclave development raised the concern about possible adverse impacts to the Medina well field wells. The June 2008 analysis has been revisited, adding the five proposed high capacity irrigation wells to the predictive model. For this effort, the following assumptions/conditions were modeled:

1. All Enclave development high-capacity irrigation wells are to be completed in the Jordan aquifer, each with a pumping capacity of 420gpm. The medium capacity (40gpm) irrigation well was not modeled, as its impact on the Medina wells is likely to be negligible.
2. The transmissivity and storage of the Jordan aquifer in the Enclave development is assumed to be similar to that observed in the Medina well field, barring the availability of any other site-specific data.
3. The Medina wells were modeled as running continuously for seven consecutive days, to simulate a period of high demand (such as a dry summer period). Future Well 9 was not added to the model, since that well will only serve as a backup should one of the other wells not be in service.
4. The Enclave wells were modeled as all running simultaneously at 420gpm each for a continuous 24-hour period, during the seventh day of the Medina well field pumping period. While the Enclave wells are only expected to run 2.5 hours at a time, on average, this 24-hour modeled pumping scenario was expected to produce more conservative estimates of potential drawdown.

The results of the modeling effort are displayed in Table 1. The predicted total drawdown at the City of Medina wells, under this scenario, ranges from 85-103 feet. This includes 11-12 feet of additional drawdown created by the proposed Enclave wells. This additional drawdown could reduce the efficiency of the Medina wells somewhat (resulting in higher operating costs to pump the water). Overall, the predicted total drawdown is still expected to be somewhat less than the available drawdown of 150-160 feet at the Medina well field. As such , there appears to be sufficient hydraulic head in the aquifer to accommodate the additional drawdown.

The Enclave wells are predicted to have drawdown of approximately 84-99 feet after 24 hours of continuous pumping. It is unlikely that such a pumping scenario will take place at these wells, since actual pumping periods are expected to be much shorter. However, the actual performance of the Jordan aquifer within the Enclave development cannot be truly known until wells are installed and aquifer tests are conducted. If the aquifer performance at the Enclave wells is worse than observed at the Medina well field, the actual observed drawdown could be greater than predicted. Additionally, the performance of the Medina wells was only obtained after careful and thorough development of the well after drilling. If less care is taken to develop the Enclave irrigation wells, the actual well performance could be worse than predicted by the above analysis.

Conclusions

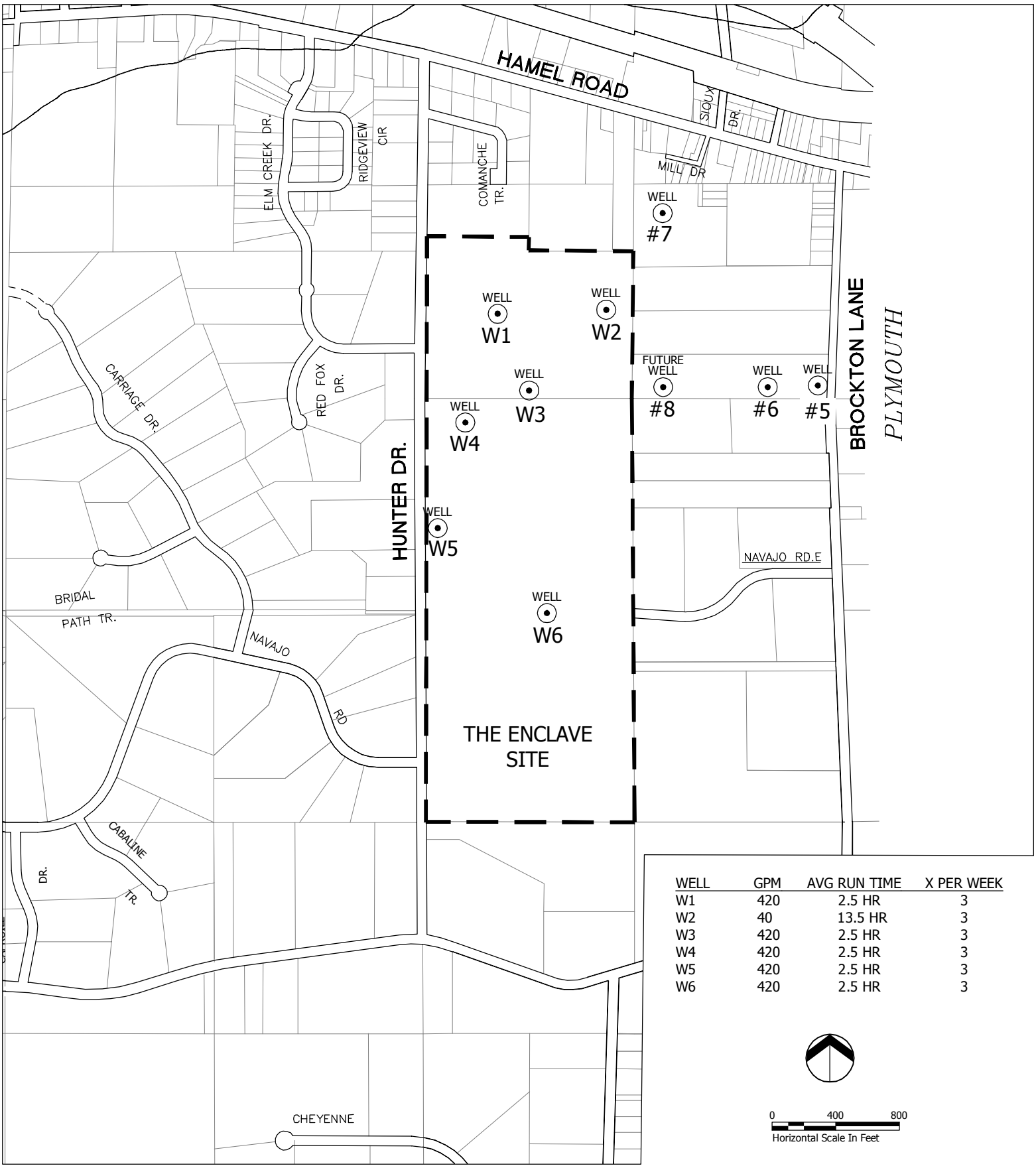
1. The predicted maximum drawdown of the Medina wells, with the Enclave wells in operation ranges from 85 feet to 103 feet. This is 11-12 feet greater drawdown than what was predicted without the Enclave wells. However, it is still less than the 150-160 feet of available drawdown present at the Medina well sites. While the additional drawdown might reduce the operating efficiency of the Medina wells, it appears that sufficient hydraulic head is available to accommodate the well interference.
2. The predicted maximum drawdown at the Enclave wells is 84-99 feet, under conservative modeling conditions. Actual drawdown at these wells will largely be controlled by aquifer conditions and the quality of the well development.

Recommendations

1. The City of Medina should tentatively design future Well 8 to handle at least 100 feet of drawdown under operating conditions. Upon completion of the drilling and development of Well 8, an aquifer pumping test should be conducted on this well to verify that the performance of the Jordan aquifer at this location is consistent with Well 6 and Well 7. An aquifer test will not only help refine the results of this analysis, but will also help in selecting the optimal pump size and setting for this well.
2. The Enclave of Medina developers should take measures to ensure their irrigation wells are properly and fully developed, to increase well performance and reduce drawdown during operating conditions.
3. Since the modeling analysis presented above is based on assumptions of aquifer homogeneity, the Enclave of Medina developers should consider conducting aquifer performance tests on at least the first two high capacity irrigation wells to be installed. These aquifer performance tests will not only help to verify the performance of the Jordan aquifer within the Enclave development, but will also help to refine the predictions of drawdown. Both Medina and the Enclave development will benefit from having this data available.

TABLE 1 : PREDICTED DRAWDOWN INTERFERENCE - MEDINA JORDAN WELL FIELD AND ENCLAVE DEVELOPMENT

Pumping Well	Pumping Rate (gpm)	Pumping Duration (days)	Drawdown Interference at Wells (feet)							
			Medina Well 6	Medina Well 7	Future Medina Well 8	Enclave W1	Enclave W3	Enclave W4	Enclave W5	Enclave W6
Medina Well 6	400	7	51.5	8.1	9.4	6.9	7.3	6.6	6.1	6.6
Medina Well 7	800	7	12.9	74.1	14.8	12.9	11.9	10.3	8.5	8.2
Future Medina Well 8	400	7	9.4	9.0	51.5	8.6	9.8	8.2	7.1	7.1
Enclave W1	420	1	2.5	3.5	4.1	49.1	6.4	5.3	3.1	2.1
Enclave W3	420	1	2.8	3.1	5.3	6.4	49.1	7.2	4.1	3.1
Enclave W4	420	1	2.2	2.3	3.5	5.3	7.2	49.1	4.5	3.3
Enclave W5	420	1	1.7	1.5	2.7	3.1	4.1	4.5	49.1	4.5
Enclave W6	420	1	2.2	1.4	2.7	2.2	3.1	3.3	4.5	49.1
All Wells			85.2	103.0	94.0	94.5	98.9	94.5	87.0	84.0
Available Drawdown (feet)			160	160	~150	NA	NA	NA	NA	NA



WELL	GPM	AVG RUN TIME	X PER WEEK
W1	420	2.5 HR	3
W2	40	13.5 HR	3
W3	420	2.5 HR	3
W4	420	2.5 HR	3
W5	420	2.5 HR	3
W6	420	2.5 HR	3

0 400 800
Horizontal Scale In Feet

WELL LOCATIONS

MEDINA

FIGURE: 1

THE ENCLAVE OF MEDINA

Bonestroo

DATE: 6/10/10

I:\190\190GEN\PLATS\PLATS L-10-053-\PLAT L-10-055 THE ENCLAVE OF MEDINA\WELL LOCATIONS.DWG

COMM: 000190-10000-1