**Madison Water Utility**
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# MEMORANDUM

Date: February 26, 2019

To: Tom Heikkinen, General Manager

From: Al Larson, Principal Engineer – Water

**Re:** **Shut Down of Well 15 and Well 16**

**Subject:** **Water Supply Contingency Plan**

## Well 15

| | |
|---|---|
| **Construction date:** | **1965** |
| **Average pumpage, 2015-18:** | **357 million gallons a year** |
| **Improvements:** | **Volatile Organic Compound (VOC) treatment, 2012-13** |
| | **Variable frequency drive (VFD), 2013** |
| **Service area:** | **Northeast corner of Madison** |

**SUMMARY**

Shutting down Well 15 would impact the operation of a large part of the city's water system that serves the area from the northern and northeastern city limits to the Yahara River on the west and Buckeye Rd. on the south. The area includes Pressure Zones 3, 5, and 6e and is referred to as Region A.

Without Well 15 in service, Madison Water Utility would increase production of all seven other wells in the area by an average of 15.2%. Well 8 and Well 23, which are used sparingly due to high levels of iron and manganese, would likely be used heavily during periods of low rainfall and may be required year round. One of the biggest challenges would be filling Reservoirs 229, 113, and 115.

Facilities within Region A have an age range from 74 years to new. The older facilities, Wells 8, 11, 13, and 23, have outdated and obsolete equipment, which means parts are not readily available and may require custom fabrication. Failure of these critical assets could result in a facility being out of service for anywhere from 2 to 20 weeks or longer. To decrease the likelihood of failure, MWU would need to maintain or replace the 40 assets

that have the highest likelihood of failure. That maintenance/replacement cost is estimated to be $4.7 million.

According to the City of Madison Planning Department, continued growth is expected in the northeastern part of the city, which is currently served by Wells 15 and 29. If Well 15 is shut down, another municipal well facility would need to be drilled and constructed at an estimated cost of $7 million and put into service sometime in the next 5 to 15 years.

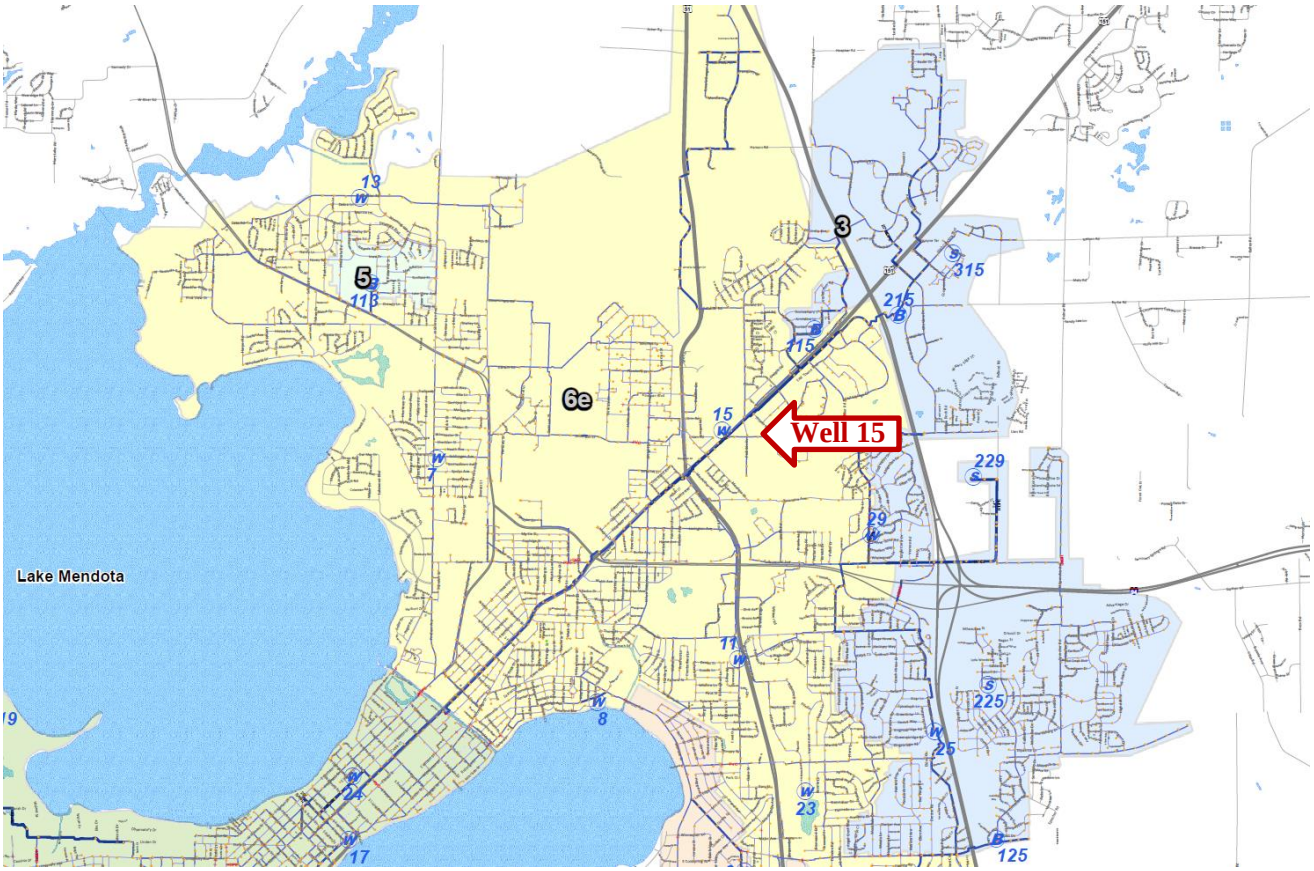


*Figure 1 - Map of Region "A" Water Service Area*

**EAST SIDE WATER SUPPLY – Region A**

The Region A service area is bounded by the city limits to the north and east, the Yahara River on the West and Buckeye Road on the south. Region A includes Pressure Zones 3, 5, and 6e. The map above, Figure 1, illustrates the Region A service area.

Region A is served by eight (8) operating wells. Total capacity of these 8 wells is illustrated in the tables below. The first table provides current capacity of operating wells. Total capacity assumes that all wells are on line and running 24 hours per day. The Annual Average Day Capacity is based on the MWU Level of Service for supply capacity goal of limiting total annual individual well production to 50%. Firm capacity is the capacity of the system with the largest source out of service. In this case, the largest producing well will be assumed to be off line due to mechanical breakdown or power outage. Firm capacity is required by the DNR and is standard water supply practice to provide a reasonable level of

reliability and redundancy in the system. The largest producing well on the east side is Well 13. Well 13 is assumed to be off line for this evaluation.

The second table indicates the change in water supply capacity to Region A if Well 15 is shutdown. Each column is as noted above. Once Well 15 is shutdown, it will be assumed that it is not available.

The final table looks at available supply capacity if Wells 8 and 23 are removed due to water quality issues. Well 8 and Well 23 have a history of elevated iron and manganese.

**Table 1 - Current Supply Pumping Capacity**

| PZ | Well | Current (gpm) | Total Capacity (MGD) | Avg Day Capacity (Operation 12 hrs/day) | Firm Capacity by Pressure Zone |
|---|---|---|---|---|---|
| 3 | 25 | 1800 | 2.6 | 1.3 | 2.6 |
| 6e | 7 | 2200 | 3.2 | | |
| 6e | 8 | 1960 | 2.8 | | |
| 6e | 11 | 2150 | 3.1 | | |
| 6e | 13 | 2600 | 3.7 | | Off Line |
| 6e | 15 | 2150 | 3.1 | | |
| 6e | 29 | 1100 | 1.6 | | |
| 6e | 23 | 1230 | 1.8 | 9.6 | 15.5 |
| | | **Total (MGD)** | **21.9** | **10.9** | **18.1** |

**Table 2 - Supply Pumping Capacity – Well 15 Shutdown**

| PZ | Well | Current (gpm) | Total Capacity (MGD) | Avg Day Capacity (Operation 12 hrs/day) | Firm Capacity by Pressure Zone |
|---|---|---|---|---|---|
| 3 | 25 | 1800 | 2.6 | 1.3 | 2.6 |
| 6e | 7 | 2200 | 3.2 | | |
| 6e | 8 | 1960 | 2.8 | | |
| 6e | 11 | 2150 | 3.1 | | |
| 6e | 13 | 2600 | 3.7 | | Off Line |
| 6e | 15 | 2150 | Shutdown | | |
| 6e | 29 | 1100 | 1.6 | | |
| 6e | 23 | 1230 | 1.8 | 8.1 | 12.4 |
| | | **Total (MGD)** | **18.8** | **9.4** | **15.0** |

**Table 3 - Supply Pumping Capacity – Well 15 Shutdown – Wells 8 and 23 out due to WQ**

| PZ | Well | Current (gpm) | Total Capacity (MGD) | Avg Day Capacity (Operation 12 hrs/day) | Firm Capacity by Pressure Zone |
|---|---|---|---|---|---|
| 3 | 25 | 1800 | 2.6 | 1.3 | 2.6 |
| 6e | 7 | 2200 | 3.2 | | |
| 6e | 8 | 1960 | Shutdown due to WQ | | |
| 6e | 11 | 2150 | 3.1 | | |
| 6e | 13 | 2600 | 3.7 | | Off Line |
| 6e | 15 | 2150 | Shutdown | | |
| 6e | 29 | 1100 | 1.6 | | |
| 6e | 23 | 1230 | Shutdown due to WQ | 5.8 | 7.8 |
| | **Total (MGD)** | | **14.2** | **7.1** | **10.4** |

## REGION A WATER DEMAND

Region A water demand varies throughout the year. It is at it's minimum during the winter and typically at a maximum during the summer months. In the Madison System maximum demand typically occurs in July. Historically, due to wet weather, changes in the plumbing code, and the loss of the Oscar Meyer packing plant, Region A water demand has been in decline over the past several years.

Water demand from 2007 to 2018 for Region A is presented in Table 4 below.

Table 4
Region A Water Demand by Year

| | Average Day MGD | Average Summer Day MGD | Average July Day MGD |
|---|---|---|---|
| 2007 | 11.47 | 12.98 | 14.17 |
| 2008 | 11.08 | 12.44 | 12.46 |
| 2009 | 9.30 | 10.39 | 10.68 |
| 2010 | 9.69 | 10.92 | 11.08 |
| 2011 | 9.67 | 11.21 | 11.56 |
| 2012 | 8.99 | 11.13 | 12.10 |
| 2013 | 8.37 | 9.22 | 9.23 |
| 2014 | 8.33 | 9.18 | 9.29 |
| 2015 | 8.30 | 9.16 | 9.23 |

| Table 4<br>Region A Water Demand by Year | | | |
|---|---|---|---|
| | Average Day MGD | Average Summer Day MGD | Average July Day MGD |
| 2016 | 8.15 | 9.02 | 9.16 |
| 2017 | 7.92 | 8.17 | 7.86 |
| 2018 | 7.65 | 8.21 | 8.56 |

Water demand projections are dependent upon development trends and density. As a part of the Water Master Plan update, a range of future water demands was developed. This range assumes that conservation will continue to improve and growth of the City will proceed as anticipated by City Planning. The rate of the anticipated growth is unknown and can be greatly variable. Projected increase in water demand based on low rate and high rate of development growth is presented in Figure 2 for the average day.

Figure 2 shows a steep decrease in water demand in Region A from 2011 to 2013. From 2013 to 2018, Madison has experienced very wet summer weather that tends to drive water demand down. In 2015 Oscar Meyer started the process of shutting down their packing plant taking a large water user off the system. The Oscar Meyer packing plant was totally shut down in 2017. New development is slowly starting to grow in the area and it is anticipated that water demand will start to rise due to these new customers. If the area experiences an extended dry weather period during the summer months in the coming years, this will drive water demand up significantly.

Three possible scenarios exist within Region A with regard to average daily water supply. The current goal is to have sufficient well capacity in the system to meet the annual average day with a 50% limitation on well production. Essentially this is operating available wells no more than 12 hours per day or operating wells at 50% of full capacity for 24 hours.

Three horizontal lines are presented in Figure 2 and represent 1) 50% of current total capacity; 2) 50% of total capacity with the shutdown of Well 15 and 3) 50% of the total capacity with Wells 8 and 23 offline due to water quality issues in addition to the Well 15 shutdown.

With no shutdown of Well 15, the system has sufficient average day supply capacity to meet the low growth water demand projection. For the high growth projection, the average demand exceeds the 50% supply capacity threshold in 2035.

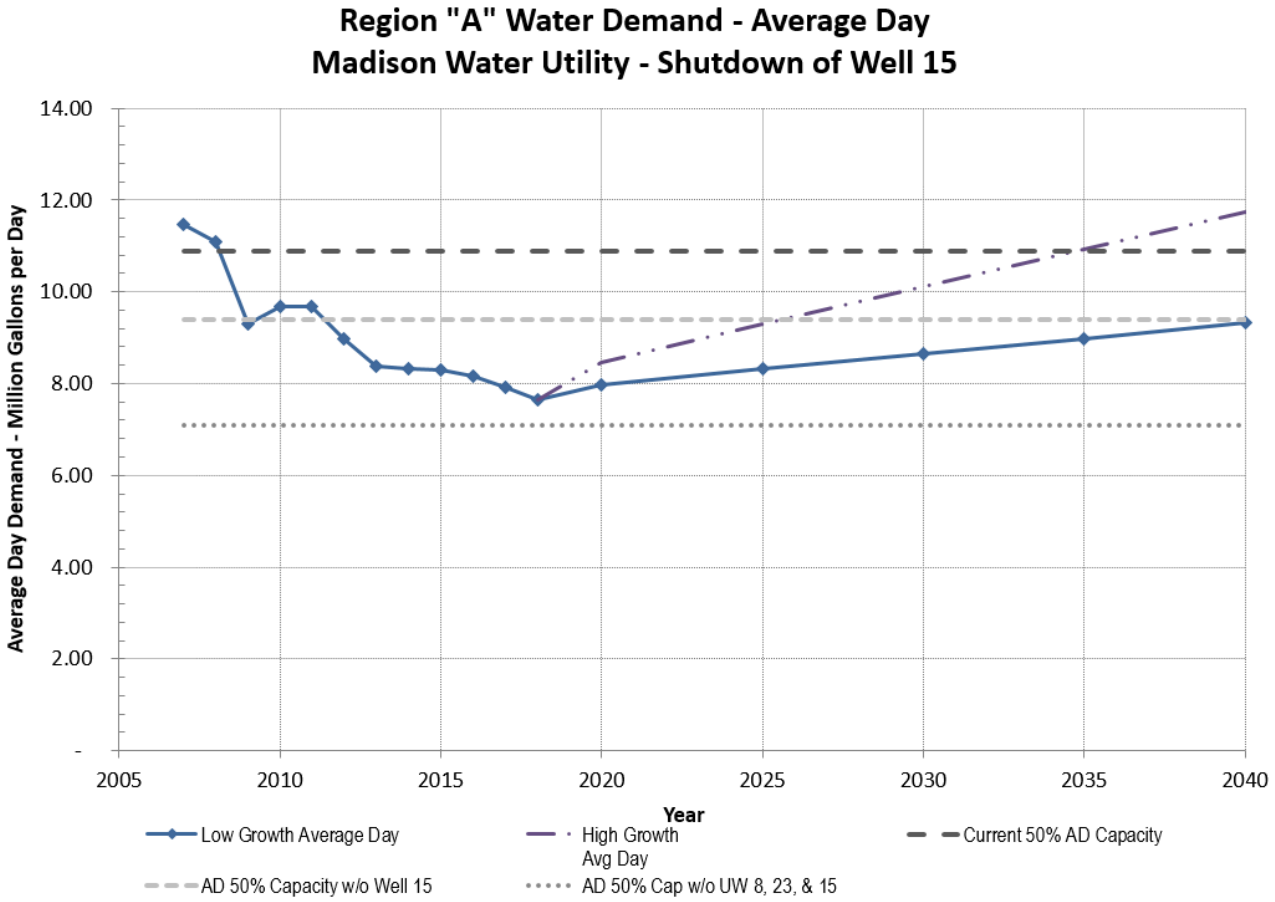


*Figure 2 - Average Day Water Demand Trends and Supply Capacity*

If Well 15 is shutdown, demand reaches the 50% supply capacity limit for the low growth rate around 2040. The high rate growth demands exceed the 50% supply capacity limit in 2026.

If Wells 15, 8, and 23 are all out of service, the well supply system cannot currently meet the 50% supply capacity limit.

It is understood that operating the wells for long periods of time at production rates exceeding 50% of full capacity is possible and is a reasonable operational scenario. Putting this additional strain on the well supply may increase groundwater drawdown and MWU could see a rise in required maintenance of their wells. Shutting down Well 15 will also increase production from Wells 8 and 23.

To evaluate high demand periods and potential fire flow capacity, a plot was developed using historical data from 2007 to 2018 and demand projections to 2040 for low growth rate and a high growth rate. Figure 3 illustrates high water demand projections for Region A to the year 2040. Water demand projections for an average summer day and for an average July day will establish water supply capacity requirements for the system.

Operating well Firm Capacity establishes a reliable water supply system. Firm Capacity is defined as the well capacity available with the largest source off line. Well 13 is the largest

source of supply and is therefore taken off line in each case. Firm well supply capacity for existing conditions, Well 15 shutdown, and Wells 15, 8 and 23 shutdown is plotted as a horizontal line in Figure 3.

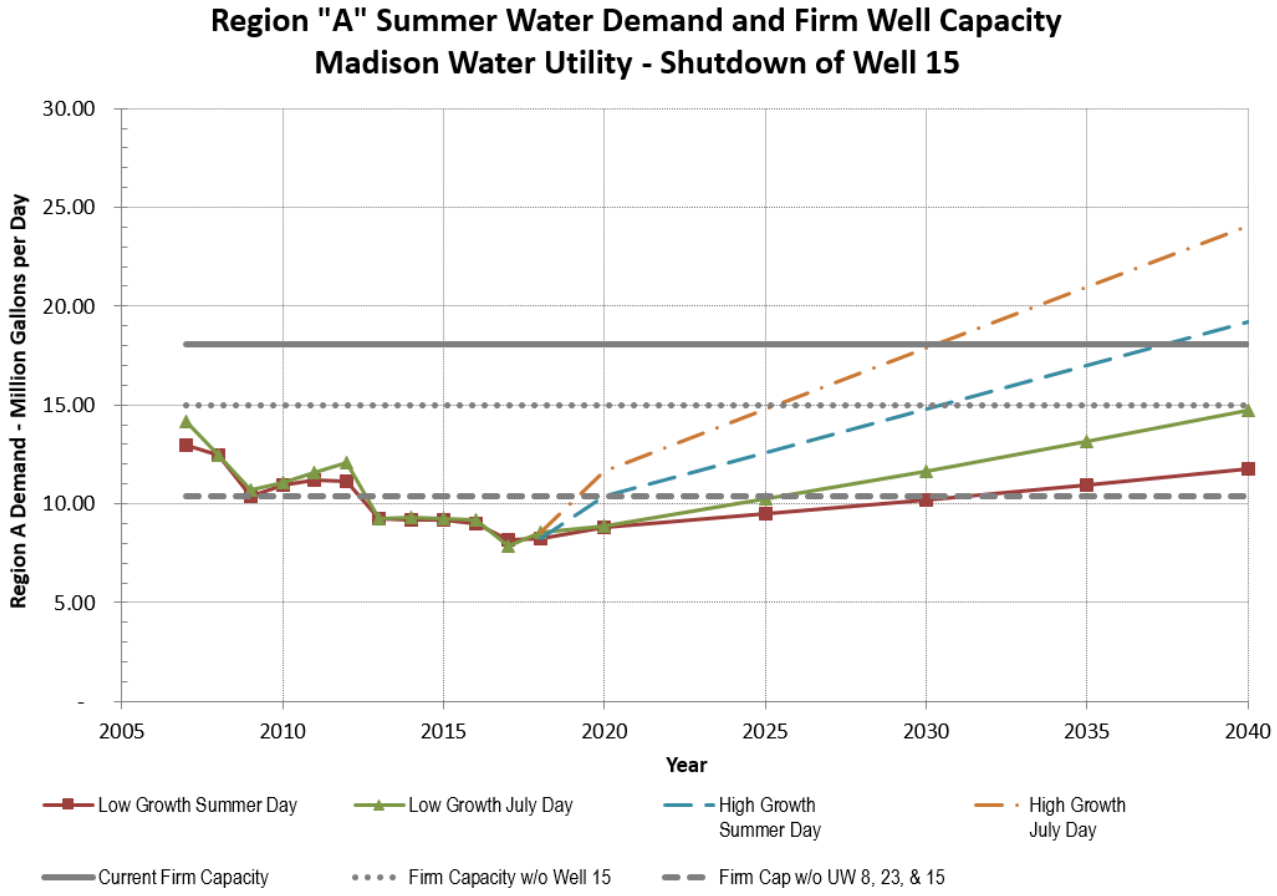


*Figure 3 - Summer Demand Trends and Supply Capacity*

When considering current Firm Capacity, Well 13 is off line, supply capacity is exceeded in 2031 for the high growth rate average July day projections and in 2037 for the high growth rate average summer day projections.

Shutting down Well 15 with a Firm Capacity with both Well 15 and Well 13 off line, results in a supply capacity issue for the high growth rate average July day in 2025, for the high growth rate average summer day in 2031, and the low growth rate average July day in 2040.

Considering Wells 15, 23, and 8 are all shutdown, results in supply capacity issues in 2020 for either high growth rate projection. The supply capacity is exceeded for the low rate average July day in 2025 and for the low rate average summer day in 2030.

As a part of the Water Master Plan water supply criticality analysis, a computer scenario was developed that looked at a 10 summer day peak demand period considering a medium growth rate for the year 2030. Looking at the 10 day peak period is considered to be a realistic stress test of the water supply system. Wells 13 and 15 were off line in this analysis to evaluate the system's ability to recover from a sustained peak demand period. Without Wells 15 and 13 in operation, the computer simulation indicated that Reservoirs 229, 113, and 313 would all be empty within a few days. Figure 4 below is included as an illustration of the supply shortage resulting from this scenario. Plots for Reservoir 113 and 313 indicated similar results and are attached. It is also noted that Reservoir 115 has difficulty filling during this scenario. Draining these reservoirs depletes the system fire protection and emergency supply reserves and significantly increases the risk of putting customers out of water. Without Well 15 there is only one well in the NE portion of the service area, Well 29.

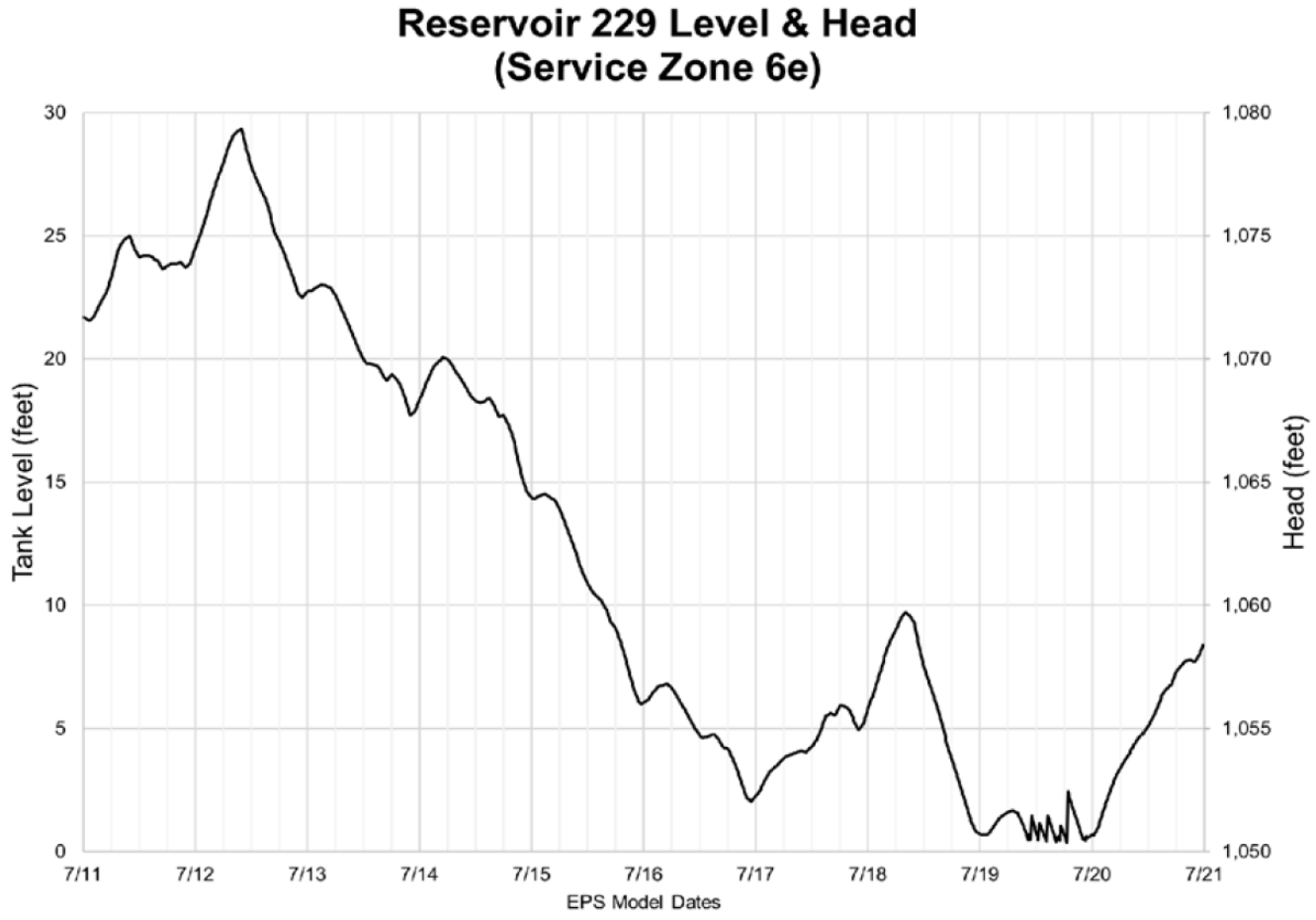


*Figure 4 - Reservoir Level Plot for Loss of Wells 13 and 15 with Medium Growth Projections*

With only Well 29 serving the northeast corner of the system, moving water from wells in the southern part of Region A to the northeastern section is difficult. Draining several reservoirs in Region A would result in a significant fire protection capacity deficiency. With only Well 29 serving the northeast corner of the system and several reservoirs empty, low pressures occur around East Towne mall area, along N. Packers Avenue, and along Commercial Avenue.

**ASSET MANAGEMENT**

An Asset Management Program identifies, assesses and prioritizes maintenance and capital investment in a Utility's assets. Doing the right project, for the right reasons, at the right time for the right cost, optimizes return on investment. To achieve this objective, MWU has developed an Asset Management Program to optimize level of service and prioritize capital projects. Replacing capital assets in Region A reduces the risk of failure.

As part of MWU's Asset Management Program, the Utility has written an asset management plan for the repair and maintenance of all well facilities. As part of that plan a risk register (a list of assets and their attributes) was created that provides an estimate of the likelihood of failure for all well assets.

Facilities within Region A have an age range from 74 years to new. The older facilities, Wells 8, 11, 13, and 23, have outdated and obsolete equipment. Parts are not readily available and may require custom fabrication. Failure of these critical assets could result in a facility being out of service for anywhere from 2 to 20 weeks or longer.

A shutdown of Well 15 would place additional burden on the remaining wells within Region A. Increasing production from the remaining wells increases the likelihood of failure of the remaining assets. The risk register for the remaining wells have a combined 246 assets, 40 of which have a probability of failure from 3 (fair) to 5 (failed). (See attached table) To decease the likelihood of failure, MWU would need to maintain/replace the 40 assets that have the highest likelihood of failure. The maintenance/replacement cost is estimated to be approximately $4.7 million. Additional cost detail is attached. Cost per well and project priority is included in Table 5.

Table 5 – Estimated Maintenance Costs per Facility

| Priority | Facility | Cost |
|---|---|---|
| 1 | Unit Well 13 | $ 586,000 |
| 2 | Unit Well 11 | $ 682,000 |
| 3 | Unit Well 25 | $ 60,000 |
| 4 | Unit Well 29 | $ 273,000 |
| 5 | Unit Well 8 | $ 578,000 |
| 6 | Unit Well 23 | $ 2,497,000 |
| | Total | $ 4,676,000 |

**Well 16**

| | |
|---|---|
| **Construction date:** | **1967** |
| **Average Annual Well 16 pumpage, 2015-18:** | **468 million gallons a year** |
| | **or 1.28 million gal/day** |
| **Improvements:** | **none** |
| **Service area (Region D):** | **Far West Side, West of Whitney Way** |
| **Pressure Zones:** | **8, 10 and 11** |
| **Total Avg Annual Water Demand (Region D), 2015-18:** | **1.39 billion gallons per year** |
| | **or 3.80 million gal/day** |
| **Region D Average July Day Demand, 2015-18** | **4.37 million gal/day** |
| **Region D Projected Max 10 Days – 2020** | **7.76 million gal/day** |
| **Total Well Capacity (Wells 16, 26, & 28):** | **9.7 million gal/day** |
| **Total Well Capacity (Region D) Well 16 shut down:** | **6.2 million gal/day** |

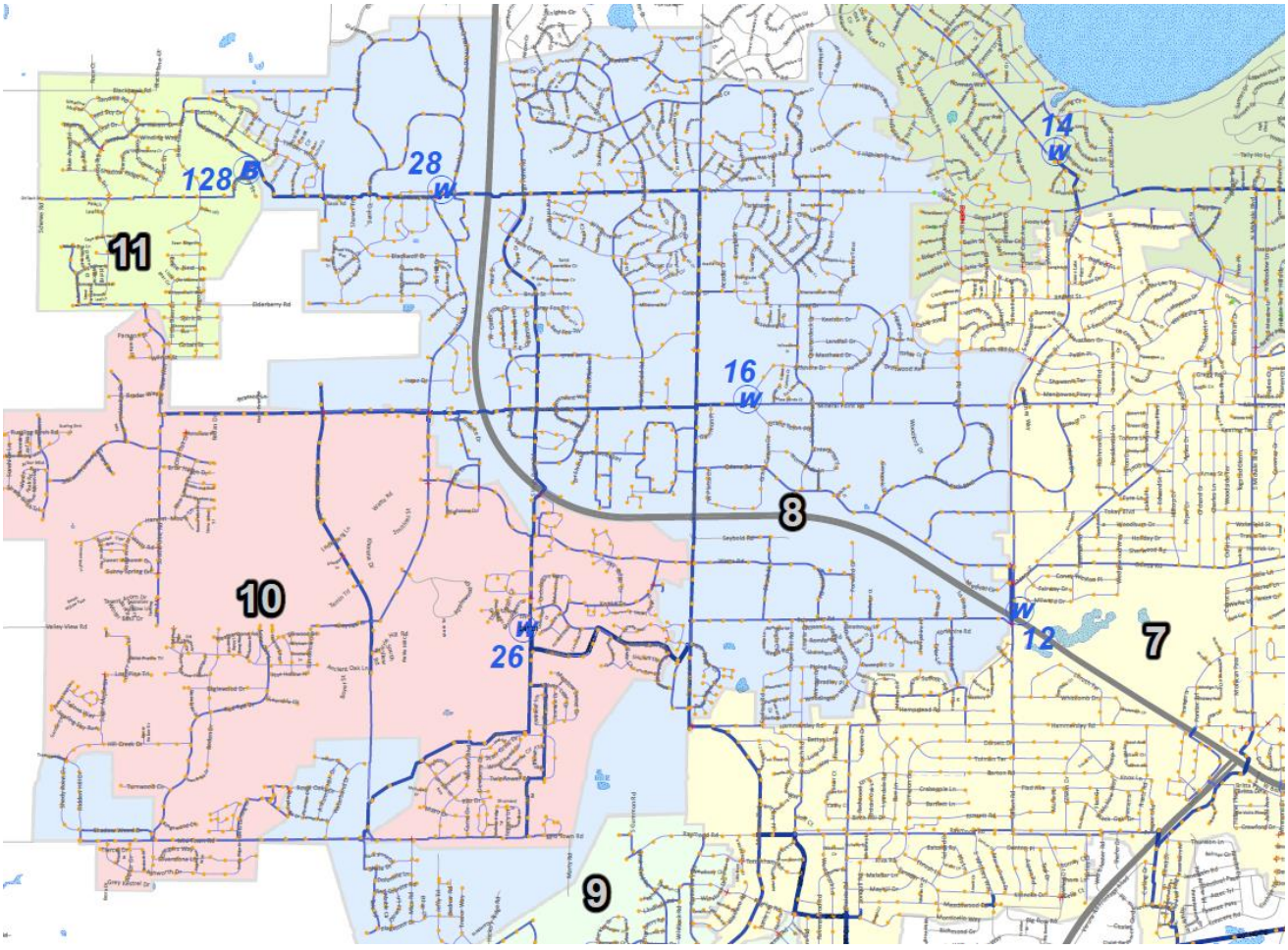


*Figure 5- Region D Service Area - Pressure Zones 8, 10, & 11*

## WELL 16 SHUTDOWN

Region D includes Pressure Zones 8, 10, and 11 and is fed by three wells, 16, 26, & 28. The map included above in Figure 5 outlines the Region D service area. Taking Well 16 off line would remove all supply redundancy in Region D. The total remaining supply capacity equals 6.2 million gallons per day. The Region D Water Demand projection for 2020 for the maximum 10-day period is 7.76 million gallons per day. Supply cannot meet demand and the 4 MG reservoir on High Point Road will be empty in 80 hours, see Figure 6 below. This eliminates firefighting and emergency reserves from Region D. Operating without Well 16 would result in mandatory summer water restrictions to sustain firefighting capacity and emergency reserves.

Region D on the far west side is at the highest elevation and there is no way to move water from lower zones without a pump station. Well 12 is planned be converted to a two zone well and will help provide redundancy and reliability to Region D. An additional well at a cost of over $7 million will be required in the next 5 years in Region D. Until improvements are made, Region D relies solely on Wells 16, 26, and 16 for supply. With Well 16 shutdown and the resulting limited supply to Region D, far west development cannot proceed and growth will slow.

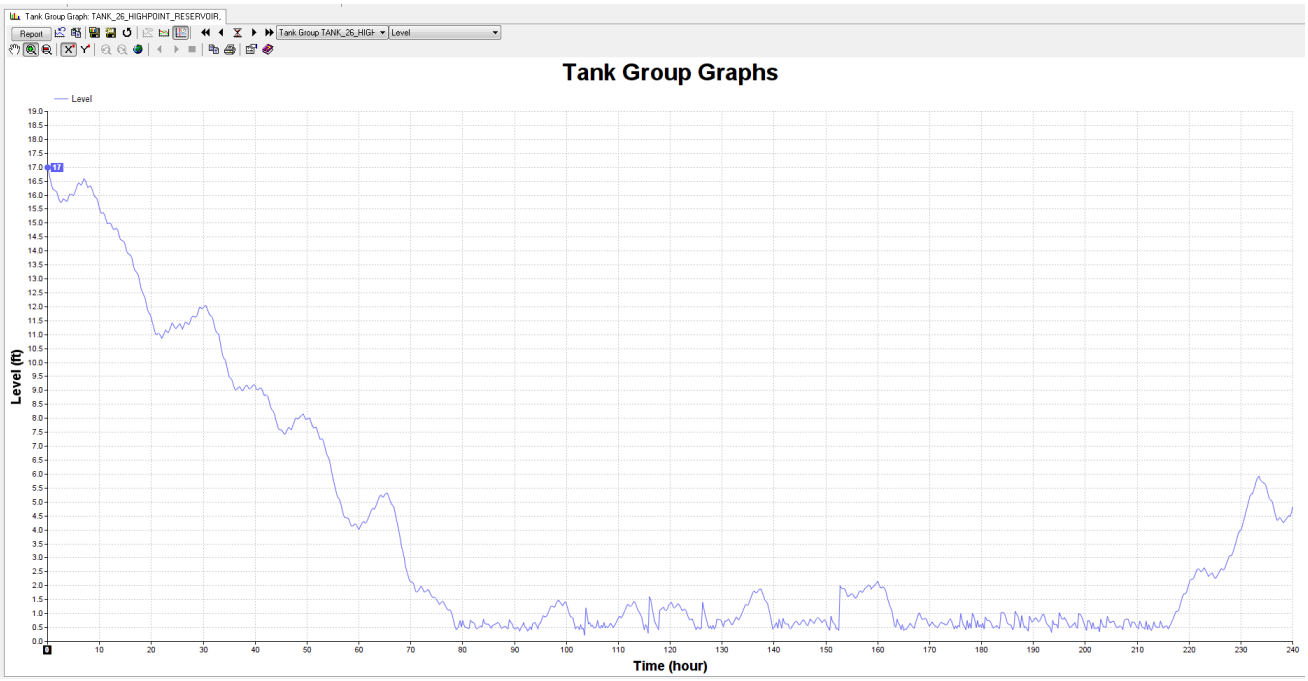


*Figure 6 - High Point 4 MG Reservoir Level - 10 Day Period*

## WELL 15 SUMMARY

Shutting down Well 15 would significantly impact the water supply system in Region A during the high demand summer months. In 10 to 15 years, the loss of Well 15 could start to limit development of the area. This impact would be amplified significantly by an extended dry period. Specific issues of concern include but are not limited to:

1. Shutting down Well 15 leaves the system with limited supply redundancy that exposes the system to a significant risk of loss of supply due to mechanical breakdown of one of the remaining seven wells serving the area.
2. Without Well 15 available, the loss of a second well during the summer months would result in water supply restrictions.
3. Shutting down Well 15 will make it difficult to maintain full reservoirs in Region A during peak summer months.
4. Not being able to fill reservoirs impacts firefighting capacity and emergency reserves.
5. The northern part of Region A is primarily supplied by Wells 15 and 29. Shutting down Well 15 will make it challenging to move water from the remaining seven wells to the north end of Region A and this impacts firefighting capacity and emergency reserves.
6. Shutting down Well 15 will increase reliance on Wells 8 and 23.
7. Due to iron and manganese and the resulting risk of colored water, operating Wells 8 and 23 will have a direct impact on the neighborhoods these two wells serve.
8. Over the next 5 to 10 years, shutting down Well 15 would impact development in the northeast corner of the Madison service area.

**WELL 16 SUMMARY**

Shutting down Well 16 would significantly impact the far west side water supply system and would limit development of the area. This impact would be amplified by an extended dry period. Specific issues of concern include but are not limited to:

1. Shutting down Well 16 leaves Region D with no supply redundancy. Water supply to Region D would be considered unreliable by the DNR.
2. No new development would be permitted within Region D.
3. Without Well 16, a mechanical failure at one of the remaining two wells results in a high risk of loss of water supply to Region D.
4. Mandatory water restrictions would be necessary during summer months.
5. Maintaining the water level in the 4 million gallon reservoir at Well 26 without Well 16 would be difficult or impossible. This impacts firefighting capacity and emergency reserves.
6. Currently there is no capacity to move water from lower pressure zones to supply Region D. The Well 12 two zone conversion project could be prioritized to meet water supply reliability requirements in Region D.
7. Shutting down Well 16 would require an expedited well siting and well replacement project to replace lost supply capacity in Region D.