Time of Day Watering Restrictions
Fort Worth's Summer 2006 Experience

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INTRODUCTION

The Texas Commission on Environmental Quality required utilities to update their water conservation plans by May 1, 2005. At the same time, the Regional Planning groups were in the process of updating regional water plans. It was known that conservation and reuse would become a larger component of the updated Region C plan. In addition, the Fort Worth Water Department (FWWD) has been challenged with meeting a rapidly growing population's water demands. While the Fort Worth conservation plan adopted in April 2005 did not contain any mandatory measures, it did contain a provision to establish a Water Conservation Advisory Committee. The committee was formed in August 2005 and consists of representation from all customer classes. The committee's role is to provide guidance and direction to the FWWD as it considers the implementation of water conservation best management practices.

One of the first items recommended by the Customer Advisory Committee was to adopt time of day watering restrictions. Similar restrictions had already been adopted in Dallas and Arlington. The Committee advised that the time of day watering restrictions contain the same time restrictions (10 a.m. to 6 p.m.) as other utilities. In April 2006, the Fort Worth City Council approved the recommendation to prohibit outdoor lawn watering from 10 a.m. to 6 p.m. from June 1 and continuing through September 30 every year.

The time of day watering restrictions significantly changed the daily potable water usage patterns. In order to address this challenge, our production division operations groups were required to revise tasks such as pumping times and durations as well as storage tank fill periods.

This paper documents the road to implementing the time of day watering restrictions, presents lessons learned from the first year of time of day watering restrictions and describes potential impacts of time of day watering restrictions on capital project planning.

OPERATIONAL CHALLENGES

The Water Production Division of the FWWD operates and manages the water treatment, pumping, and storage facilities. Prior to the 10-6 watering restrictions going into place, the Production Division was already faced with meeting demands from a growing population and service area while under drought restrictions. Under terms of an agreement with the Tarrant Regional Water District negotiated in 2005, during the drought conditions in 2006 and expected in 2007, the FWWD would limit itself to 70,000

acre-feet of usage from the West Fork of the Trinity River, a significant reduction from the normal 100,000 acre-feet allotment.

Eagle Mountain Lake and Lake Worth are water supply reservoirs located in the West Fork of the Trinity River watershed. Three of the city's four water treatment plants are supplied from the West Fork of the Trinity River, including the Eagle Mountain Plant, which gets its source water from Eagle Mountain Lake, the North Holly Plant, which gets its source water from Lake Worth, and the South Holly Plant, which gets its source water from either Lake Worth or from the Clear Fork of the Trinity River via release from Lake Benbrook. The fourth and largest treatment plant, Rolling Hills, gets its source water from three sources, Cedar Creek Reservoir, Richland Chambers Reservoir, and Lake Benbrook.

Under these drought conditions, Water Production was forced to operate the Rolling Hills water treatment plant at a higher than normal rate as required to move treated water into areas normally served by the Eagle Mountain and North Holly water treatment plants. In addition, Water Production was required to treat Lake Benbrook water via the Clear Fork Pump Station at the South Holly water treatment plant due to the limitations on the usage of raw water from the West Fork system. During the summer of 2006, the complexity of operating the water system was even further increased by the implementation of the 10-6 watering restrictions.

A shift in the usage pattern was recognized almost immediately after the 10-6 watering restriction went into effect on June 1, 2006. Previous to the watering restrictions, the typical summer usage pattern exhibited higher demands during the daytime. The normal summer operating procedure was to continue to maintain high flows from the treatment plants after the daily peak demand declined in order to fill the storage tanks and reservoirs in preparation for the following day's peak demand. The treatment plant capacity would be reduced once the system storage capacity had recovered. Characteristically, the usage would decline approximately around 8:00 –10:00 p.m. and the lull in demand would last until approximately 5:00 a.m. the following morning, providing about 7-8 hours to refill the system during the night. This usage pattern was typical until the watering restrictions went into effect.

Once the 10-6 watering restrictions went into place, the usage pattern changed significantly. Therefore, the operation methodology of the distribution system had to be revised. During the 10-6 watering restrictions, the lull in usage would typically begin approximately 10:00-11:00 a.m. and would last until approximately 4:00-6:00 p.m. providing about six hours during the middle of the day where storage could be refilled.

What were the system implications? The storage tanks could be filled over a longer period of time and while under lower demand conditions under normal operating procedures as opposed to during water restrictions.

Therefore, the retraining of staff to operate the distribution system had to occur. What once was considered normal and safe operating ranges in terms of cycling tanks and

reservoirs up and down to manage water quality issues associated with summertime temperatures was no longer valid. Operations staff had to determine new safe operating ranges for individual storage tanks based on very limited data related to the demand patterns resulting from watering restrictions.

POPULATION PROJECTIONS AND CIP PLANNING

The Fort Worth Water Department completed its latest Water Master Plan in 2004. This plan documents the historical population and water usage, makes projections of future population growth trends, and develops a twenty year capital improvement program to support the projected population growth and associated water demands.

The master plan population projections were based on North Central Council of Government's (NCTCOG) population projections and were adjusted slightly (upwards) based on preliminary plats and concept plans submitted by developers. Based on these numbers, annual growth rates for Fort Worth's retail base were expected to increase between 3.0% and 3.5% per year during the twenty year planning period. Wholesale customer demand was expected to grow at a lower rate.

TABLE 1 – MASTER PLAN POPULATION PROJECTIONS

	2010 Master Plan	2015 Master Plan	2020 Master Plan	2025 Master Plan
FW Retail Customers	693,342	811,541	929,741	1,047,940
FW Wholesale Customers	380,283	414,131	450,993	491,481
Total Population	1,073,625	1,225,672	1,380,734	1,539,421
% Wholesale customers	35.4%	33.8%	32.7%	31.9%

The NCTCOG numbers are significantly higher than those contained in the Senate Bill 1 projections. Staff was initially skeptical of the higher numbers presented by the Master Plan consultant. However, time has showed that the numbers contained within the Master Plan actually significantly under predict actual growth.

TABLE 2 – ACTUAL POPULATION GROWTH AND REVISED PROJECTIONS

	2003	2004	2005	2006	2007	2008	2009	2010
Revised retail pop.	579,878 (actual)	599,616 (actual)	624,850 (actual)	661,850 (actual)	691,850	721,850	751,850	781,850
Revised growth rate	4.0% (actual)	3.4% (actual)	4.2% (actual)	5.9% (actual)	4.5% revised	4.3% revised	4.2% revised	4.0% Revised
Master plan Retail pop.	570,008	581,217	592,724	610,301	629,875	648,452	667,026	685,602
Master plan Growth rate	2.2%	2.0%	2.0%	3.0%	3.2%	3.3%	3.2%	3.2%
Difference	9,870	18,399	32,126	51,549	61,975	73,398	84,824	96,248

In order to plan future capital projects, water demand projections were performed based off historical usages and population projections. The historical usages were broken down between residential and industrial/commercial accounts. For demand projections, commercial and industrial users were classified as any user with an average annual demand greater than 0.04 MGD. For these customers, average day demand projections were based off statistical trending. Max day demands were based on multiplying the average day demand by a peaking factor of 1.5. Peak hour demands were determined by multiplying the peak day demands by a peaking factor of 1.5.

Historical residential demands were developed by taking the total demands and subtracting out the industrial/commercial accounts. The average day per capita usage for each pressure plane was then calculated for historical years 1998 through 2001. For this time period, the average usage across the City of Fort Worth was 209 gallons per capita day (gpcd), with a low of 139 gpcd in our eastside pressure plane to a high of 274 gpcd in our Northside III pressure plane. In general, the older parts of town exhibited a lower per capita usage than the newer parts of town, especially those areas experiencing rapid growth.

The max day to average day residential peaking factors were then determined for the historical data from 1998 through 2001. The average max day to average day peaking factor for the entire system was 2.26. The range of individual pressure plane peaking factors ranged from a low of 1.87 to a high of 3.56. Residential max hour to max day peaking factors averaged 1.57 with a low of 1.14 and a high of 1.73.

The table below presents the overall water system data, taken on a fiscal year basis (October 1 – September 30th). The inclusion of the industrial/commercial customers lowers the residential only peaking factors described in the preceding paragraph.

TABLE 3 – HISTORICAL FORT WORTH WATER SYSTEM USAGE

Category	**1999**	2000	2001	2002	2003	2004	2005	*2006*
Total pumpage (MG)	55,574	62,978	58,107	58,416	60,144	58,121	63,593	*75,723*
Avg. daily use (mgd)	152.8	171.4	161.5	160.1	164.8	159.2	174.3	*207.5*
Max day usage (mgd)	296.4	315.6	313.9	273.5	335.2	265.4	305.0	*350.8*
Max hour usage (mgd)	392.4	405.0	406.6	341.0	423.7	332.9	391.7	*473.3*
Retail pop.	511,897	534,694	540,950	557,750	579,878	599,616	624,850	*661,850*
Wholesale pop.*	267,433	275,705	285,630	295,913	307,377	315,057	323,240	*331,141*
Total Population	779,330	810,399	826,580	853,663	887,255	914,673	948,090	*992,991*
Total gpcd – average day	196.1	211.5	195.4	187.5	185.7	174.1	183.8	*209.0*
Total gpcd –	380.3	389.4	379.8	320.4	377.8	290.2	321.7	*353.3*

max day								
Ann Precip. (in)	23.59	36.26	38.14	44.42	24.55	47.57	18.97	*29.75*
Precip, Jul-Sep (in)	3.07	0.16	10.29	5.92	5.83	9.42	4.56	*4.90*
Jul-Sep avg. high temp (F)	96.0	97.4	91.5	92.5	92.9	90.9	96.1	*95.9*
Avg day/Max Day Ratio	1.94	1.84	1.94	1.71	2.03	1.67	1.75	*1.69*
Max day/Max hour Ratio	1.32	1.28	1.30	1.25	1.26	1.25	1.28	*1.35*

* - wholesale population is an estimated number

IMPLICATION OF WATER RESTRICTIONS ON CIP PLANNING

Max day demand projections (non-coincidental) are utilized by the Fort Worth Water Department to size water treatment plants, pump stations and ground storage reservoirs. Max hour demands are utilized, along with fire flow requirements, to size transmission mains and elevated storage tanks.

Though data is only available from one summer's worth of 10-6 watering restrictions, it appears that the data supports the conclusion that the watering restrictions do increase the max day to max hour peaking factor. As shown from Table 3, last year exhibited a very high max day to max hour peaking factor. The high max hour demand would seem logical due to the shorter allowable irrigation time period.

Figures 1 and 2 provide an illustration of the diurnal curve for a single day's demand in the Northside III pressure plane for August, 22nd, 2006 and 2005 respectively. The Northside III pressure plane is a high growth area of new developments. As can be seen from these curves, the peak hour demand increased substantially from 2005 to 2006, while the minimum hourly flows remained somewhat constant.

This particular pressure plane is used as an example to highlight the effects that high peak hour demands may have on capital project scheduling. This particular pressure plane currently has a maximum pump station capacity providing service to it of about 33 MGD. Additional pumping and elevated storage was scheduled to be in service for the summer of 2007 and 2008 respectively. By looking at the 2006 diurnal curve, one can tell that even with maximum pumping into the pressure plane, the elevated storage tank would be draining from about 4:30 to 7:00 in the morning. For this particular pressure plane, operators were very careful to make sure that the elevated storage tank was full prior to going into the morning demand period.

FIGURE 1 – 2006 DIURNAL CURVE FOR HIGH GROWTH PRESSURE PLANE

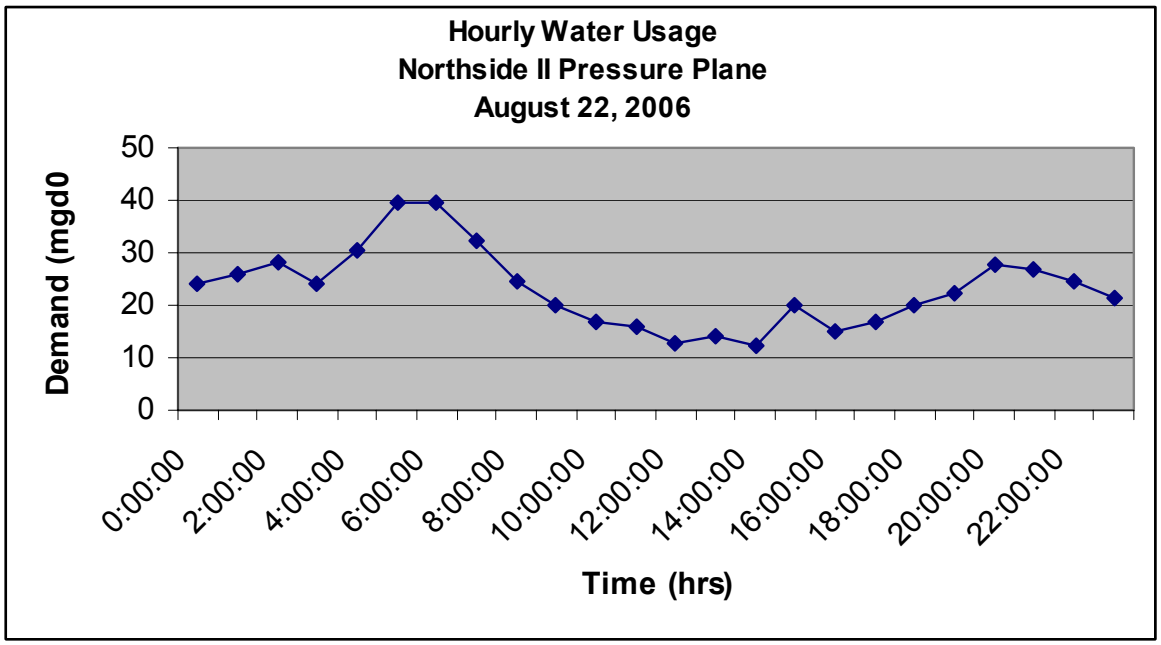
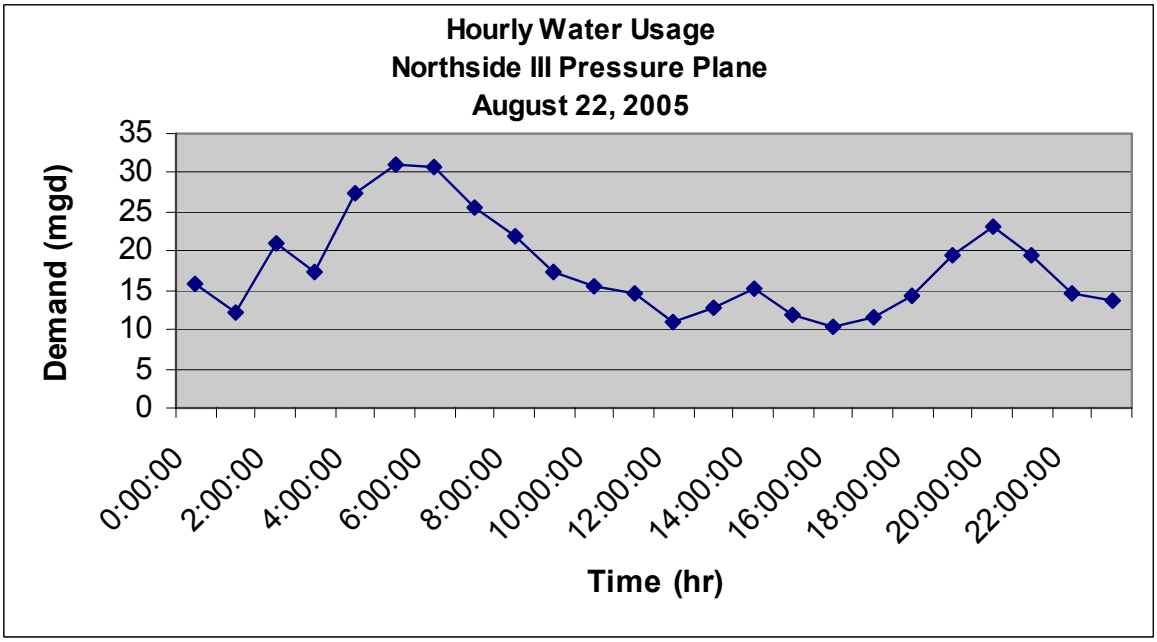


FIGURE 2 – 2005 DIURNAL CURVE FOR HIGH GROWTH PRESSURE PLANE



Less conclusive is whether the 10-6 watering restrictions lower the max day to average day peaking factors. When comparing the 2006 numbers versus the historical peaking factors, it does appear to have some influence. The lower average day to max day

peaking factor would seem to indicate that less total irrigation occurs due to the limited watering time period. However, more data is needed by Fort Worth in order to justify this conclusion.

With the population Fort Worth is experiencing, keeping ahead of the water demands is extremely challenging from a financing, engineering, and construction perspective. Since Fort Worth will be utilizing 10-6 watering restrictions from June 1 through September 30th on a yearly basis, the effect on max day and max hour demands need to be quantified in order to accurately project required in-service dates for water facilities.

During the summer of 2007, additional information will become available on the effectiveness at reducing per capita usage and reducing average day to max day demands. If a reduction of the average day to max day ratio can be quantified, the overall cost savings to the FWWD could be substantial by allowing the deferment of pumping station and water plant construction. However, this potential advantage could be balanced by the accelerated need for elevated storage and additional pipeline capacity resulting from the higher max hour to max day ratio.