
SECTION 2

HYDRAULIC MODEL UPDATE

An important component to providing a comprehensive evaluation of the distribution system is developing a computerized hydraulic model to assist with the evaluation of complex hydraulic situations. The Town previously had H2O Engineering Consultants, Inc. develop a hydraulic model of the distribution system. PARE utilized that model as a basis for our model development, but updated system demands and the infrastructure database. The hydraulic model was updated in general accordance with American Water Works Association (AWWA) Document M32 – *Distribution Network Analysis for Water Utilities*. PARE updated the Town of Southborough’s hydraulic model using Bentley’s WaterCAD software, which is CAD-based modeling software. The model components were developed based on record information, including meter records, facility drawings, hydrant flow test records, H2O’s original model, and Southborough personnel input. Portions of the model were developed using GIS-based information provided by the Town, which was later converted into CAD-based files and imported into the hydraulic model.

The model was used to evaluate the system’s performance relative to guidelines and standards established by AWWA, as well as *Recommended Standards for Water Works (Ten State Standards)* and the Massachusetts Department of Environmental Protection’s *2001 Guidelines and Policies for Public Water Systems*.

As part of the system evaluation, PARE evaluated system-wide water demand. From our evaluation of system water demand, PARE updated the demand database in the hydraulic model.

2.1 WATER DEMAND EVALUATION / DEMAND DATABASE UPDATE

When evaluating system demand and establishing a demand database, there are three primary water demand scenarios – average day demand (ADD), maximum day demand (MDD), and peak hour demand (PHD). The ADD, as defined by AWWA M32, is “the annual water consumption divided by 365 days” and represents the average water demand that a given water distribution system experiences over a one-day period. The MDD is defined as, “the water consumption, in volume of water used on the highest consumption day in a year.” The MDD is typically the most critical water



demand scenario and is usually the scenario by which system adequacy is measured. The PHD is defined as, “the maximum total 1-hour water demand, in units of volume per day, a given distribution system experienced or would experience during a particular year or other time period.” The PHD is a higher consumption rate than MDD but given the short duration of high water demand (i.e., 1-hour), it is not considered as critical as the MDD.

PARE reviewed the following information provided by the Town as part of our water demand evaluation and demand database update:

- Customer meter records for the years 2005, 2006, and 2007;
- Pump station pumping records for the years 2005, 2006, and 2007 as reported in the Town’s Annual Statistical Reports to the Massachusetts Department of Environmental Protection (MA DEP), and information provided by MWRA (refer to Appendix D & E); and
- Tank chart records from two of the three water storage tanks – the Tara Road Tank and the Oak Hill Tank, for select days during the years 2005, 2006, and 2007 (refer to Appendix F). Please note that chart records are not maintained for the Clear Hill Tank, which is presumed to fill and drain in conjunction with the Oak Hill Tank.

2.1.1 *Average Day Demand*

Based on the information provided in the Annual Statistical Reports, the Town pumped a total of 1,192 million gallons (MG) from the MWRA between 2005 and 2007. The average daily pumpage, which was used for the average day demand (ADD), was **1.09 MGD**, or 757 gpm.

2.1.2 *Maximum Day Demand*

The maximum day demand was obtained by identifying the single highest day of purchased water from the MWRA between 2005 and 2007, which occurred on August 13, 2005. On that day, the MWRA supplied 2.77 MG. In addition, over the course of that day, the system storage tanks filled by a net volume of 13,200 gallons. The total water supplied less the amount going into the system tanks is the total system demand on a maximum day, in this case **2.76 MGD** or 1,916 gpm. The maximum day multiplier for the system is calculated by dividing the maximum day demand by the average day demand, in this case 2.53. Therefore, PARE used a maximum day multiplier of 2.53 in



the hydraulic model.

2.1.3 Peak Hour Demand

The peak hour demand is typically a time when system water sources are supplying water at full, or near full capacity and system storage tanks are draining at their highest, or near highest rates. The single highest hour of water demand between 2005 and 2007 occurred on August 13, 2005 between 5:00 am and 6:00 am. Over that hour, the MWRA supplied water at a rate of approximately 1,955 gpm, and the system storage tanks drained at a rate of approximately 1,966 gpm, for a net system demand of approximately **3,921 gpm**, or 5.65 MGD. The peak hour multiplier for the system is the peak hour demand divided by the average day demand, in this case 5.18. Therefore, PARE used a peak hour multiplier of 5.18 in the hydraulic model.

The table below summarizes Southborough's water demand and the demand scenarios PARE utilized as part of the hydraulic model development.

TABLE 2-1: Southborough Water System Demand		
	Water Demand (2005-2007)	
	Total Volume (MGD)	System Demand (gpm)
Average Day	1.09	757
Maximum Day	2.76	1,916
Peak Hour	5.65	3,921

2.2 SERVICE AREAS

To further define system demand patterns, PARE subdivided the system in the model into two (2) service areas, the High Service Area and the Low Service Area. PARE distributed the total system demand into each of the service areas based on the percentage of total metered water use in that area. The customers in High Service Area used approximately 53 percent of the total metered water use in the system between 2005 and 2007. Therefore, PARE allocated 53 percent of the total system demand to the High Service Area and 47 percent to the Low Service Area.

Table 2-2 provides the total water demand for each service area for an average day, maximum day,



and peak hour.

TABLE 2-2: Southborough Water demand by Service Area			
	Average Day (GPD)	Maximum Day (GPD)	Peak Hour (GPD)
High Service Area	577,000	1,462,000	2,992,000
Low Service Area	512,000	1,297,000	2,654,000
TOTAL	1,089,000	2,759,000	5,646,000

System-wide, residential customers consumed approximately 78 percent of the total water demand, or 849,000 gpd. Non-residential customers consumed approximately 22 percent of the total water, or approximately 240,000 gpd. The total number of residential customers, based on meter records provided by the Town is 2,848. Therefore, the average residential water demand in Southborough system is approximately 300 gpd per service connection. Based on the current population, approximately 9,350, the average residential per capita water demand is approximately 91 gpd. Please note that in the Town's contract with MWRA, the Town is required to reduce the residential per capita water demand to 65 gpd by the end of 2016.

The total area in Town that is currently developed for non-residential use is 520 acres, out of a total of 948 acres zoned for non-residential use. Therefore, the average non-residential water demand in Southborough system is approximately 500 gpd/acre (gross lot area).

The per service water demand for residential customers and per acre water demand for non-residential customers identified here will be used to project future water demand as part of our system buildout evaluation.

2.3 UNACCOUNTED / UNMETERED WATER USE

In any system there is some unaccounted or unmetered water use. In order to ensure that Southborough's unaccounted/unmetered water use was included in the model, PARE utilized the meter records from the MWRA (in the Annual Statistical Reports), not the customer meter records, to establish the actual system demand. However, PARE distributed water use throughout the system based on customer meter records and address information. Therefore, each area is assigned a portion of the total unaccounted/unmetered water, based solely on how much water



they consumed as a percentage to the total system demand. For example, customers in the High Service Area consumed approximately 492,000 gpd, based on their metered water use, which is 53 percent of total metered water use. The total water supplied to the system is 1,089,000 gpd of which 53 percent equals 577,000 gpd, a difference of approximately 85,000 gpd. The difference is High Service Area's share of the unaccounted/unmetered water use, based on their percentage of total water consumed.

The total unaccounted/unmetered water use that PARE estimated for the model is approximately 15 percent of the total system use. Please note that this should not be considered unaccounted water in the same sense as the MA DEP indicates in their Water System Annual Statistical Reports. This is the percentage of total water supplied to the system that PARE could not assign to a specific node in the model. A portion of this unaccounted/unmetered water is attributable to normal system operations, such as hydrant flushing, water main breaks, temporary construction services, etc. The actual unaccounted for water in the system, as defined by MA DEP, is slightly lower than 15 percent.

2.4 MAJOR USERS

An important component of the hydraulic model development is an evaluation of major users, which are customers that use over 1 million gallons per year (MGY). Major users represent large load centers in the model, which can have a substantial impact on system hydraulics. In some cases, major users might use so much water that they dictate the size and/or configuration of certain infrastructure components, such as pipes, tanks, pumps, etc. Based on the meter records provided by the Town, there are currently 19 major users in the Town of Southborough. The table on the following page is a list of the system major users, their location, usage type, and designation in the model.

Based on meter records, and as illustrated in Table 2-3, major users consume approximately 19 percent of total water use. Thirteen (13) of the nineteen (19) major users are located in the Low Service Area and six (6) major users are in the High Service Area. It is noted that the EMC property, which is located in the High Service Area, used 17 percent of the total water used by major users between 2005 and 2007.



TABLE 2-3: Southborough Major Users

Name	Address	Junction Node	Service Area	Use Type	Water Use	
					MGY	GPD
Fay School	48 Main Street	1022	High	School	3.99	10,932
Superintendent of Schools	49 Parkerville Road	1072	High	School	1.00	2,740
EMC	Coslin Drive	1079	High	Office Park	10.98	30,082
371 Turnpike Road LLC	2 Park Central Drive	1039	High	Commercial	1.75	4,795
Paradigm Properties	352 Turnpike Road	1062	High	Commercial	1.19	3,260
Red Roof Inn	367 Turnpike Road	1045	High	Hotel	3.78	10,356
Carriage Hill Condos	2 Carriage Hill Circle	2157	Low	Residential	3.54	9,690
Southborough Meadows	16 Blueberry Land	2069	Low	Residential	1.21	3,310
Joe Sullivan Golf Course	70 Valley Road	2154	Low	Recreational	1.60	4,384
St. Marks Golf Club	36 Cordaville Road	2042	Low	Recreational	1.32	3,616
NE Center for Children	33 Turnpike Road	2057	Low	School	2.23	6,110
St. Marks School	Marlboro Rd and School St	2002	Low	School	7.89	21,616
153 Cordaville Road LLC	153 Cordaville Rd	2073	Low	Commercial	1.27	3,479
Allied Cold Storage	1 Harvest Lane	2127	Low	Commercial	1.48	4,055
Capital Group Companies	162 Cordaville Road	2072	Low	Commercial	1.16	3,178
Southborough Motor Lodge	44-48 Turnpike Road	2064	Low	Motel/Hotel	1.49	4,082
Nstar Services Co.	157 Cordaville Road	2073	Low	Commercial	1.64	4,493
Realty Ass. Fund VI LT	120 Turnpike Road	2052	Low	Commercial	1.09	2,986
Shrubs and Trees	110 Turnpike Road	2052	Low	Comm./Agri.	5.28	14,466

