

DROUGHT MANAGEMENT PLAN
for the
TOWN OF NORTH READING, MA

November 2013

DROUGHT MANAGEMENT PLAN

NORTH READING, MA

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A	Revised Water Restriction Triggers and Internal Procedures dated 11/12/13 and Water Use Restrictions dated 11/12/13
B	Town of North Reading By Law for Restriction on Water Use

EXECUTIVE SUMMARY

ES.1 OVERVIEW

The scope of this report was to develop a Drought Management Plan (DMP) for the Town of North Reading based upon specific factors related to the Town's water system. A DMP is a necessary tool for a public water supplier to control increased water demands associated with a drought condition.

Drought conditions can occur any time of year when a water system experiences an increase in demand and reduction in water supply. Many reasons can be found for increases in water demand, but in general they include, deficiencies in precipitation, population growth, climate change, and changes in use (outside watering) and are generally responsible for water supply shortages. Balancing the needs of the Town's residents in regard to water demands can be difficult. The goal of the DMP is to identify a clear descriptive process in which anticipation of an unbalanced condition in the water supply and system demand is identified and measures required to prevent a failure of the water system are implemented.

The Town of North Reading is limited in the amount of water it can provide the residents. A Water Registration regulates the amount of water that can be withdrawn from the Town's wells and an Inter-basin Transfer Act (IBTA) regulates the amount of water that can be purchased from Andover. Therefore water restriction measures are critical during periods of increased water demand to maintain the Town's withdrawals within these regulated limits.

ES.2 SUMMARY OF FINDINGS AND RECOMMENDATION

The Town has an existing program in place for managing its water supply during a drought event. The study reviewed the existing program and assessed its performance based on historical records furnished by the Town and drought indicators. The existing program is a first step in drought management but the plan must be revisited on a periodic basis to assess the performance

of said plan. Recommendations are made in the following report to optimize the performance of drought management for the Town of North Reading.

The Town has been active in drought management and has stressed the importance of drought management through the years with public communication through the use of newspapers, signboards, and electronic devices (e.g., the Town's web site on the internet). Communicating the importance of water and sustainable management of water usage during a drought event is critical. However, continued efforts in this regard are recommended to enforce the measures the Town has implemented.

By continuing the efforts of the Town in regards to drought management and incorporating the following recommendations, the Town can more efficiently control the water demand and water supply of their system.

- Mandatory Water Conservation Measures during Normal Drought Conditions.
- Adjustments to the Primary and Secondary Triggers for Andover Water Demand and Sequential 90 degree days.
- Irrigation water usage metered separately and charged a higher rate or annual flat fee.
- Ban on plumbed irrigation systems.
- Providing low cost water reduction devices free of charge.
- Residential water audits provided free of charge.
- Explore supplemental water sources to strengthen the Town's water supply to meet increasing water demands.

Appendix A includes revised Water Restriction Triggers and Internal Procedures dated 11/12/13 and Water Use Restrictions dated 11/12/13 for the Town's use based on the recommendations made in this report.

Section 1

SECTION 1

INTRODUCTION

1.1 GENERAL

The Town of North Reading owns and operates a public water supply that provides water to over 95% of the residents and businesses in the Town. The Town's water system consists of seven (7) public wells, approximately 90 miles of water main and three water storage tanks. The Town also purchases a portion of the water supply from the Town of Andover, which is transported to North Reading through two interconnections. Approximately 40% of the water provided by North Reading is obtained from the Town-owned wells and the remaining portion is purchased from Andover.

The Town is limited in the amount of water it can provide the residents. A Water Registration regulates the amount of water that can be withdrawn from the Town wells as well as an Inter-basin Transfer Act (IBTA) permit regulates the amount of water that can be purchased from Andover. The Town is limited to 0.96 (MGD) million gallons of water per day under the Registration and the IBTA limits purchases from Andover to 1.5 MGD. Withdraws or purchases over the permitted values can result in violations and requires the Town to obtain additional water sources and impose strict water usage management at significant expense.

Many reasons can be found for increases in water demand, but in general they include, deficiencies in precipitation, population growth, climate change, and changes in use are generally responsible for water supply shortages. Balancing the needs of the Town's residents in regard to water withdrawals and the need to sustain healthy waterways, can be a challenge. This Drought Management Plan (DMP) will provide a framework for the monitoring and control of water use under stressed conditions and optimize water use throughout the year, allowing the Town to stay in compliance with its permitted water sources and ensuring adequate water supply is available at the most critical times.

A DMP is designed for each water supplier based upon specific factors related to water sources, storage capacity and system use. The use of the term drought refers to a period when a region is deficient in its water supply and any conditions that put a stress on the amount of water supply by the users of that region (system). In simplest terms a DMP provides a series of escalating controls based upon the demand of the users exceeding the amount of water available. This plan is a necessity in order to withstand the hottest and driest years while controlling increased water demands. The plan identifies a clear descriptive process in which anticipation of an unbalanced condition in the water supply/demand may occur and more drastic measures are required to prevent a failure of the water system. The DMP should be considered at any time of the year that increased demands, water supply reductions, emergency conditions, catastrophic system failures, or drought conditions could occur.

Recent occurrences of low water levels in the Town's three water storage tanks have caused great concern for the Town. In particular the Tower Hill tank is most sensitive to changes in water demands and therefor used for reference when analyzing drought impacts. For instance, on July 25, 2011 between 4:00 a.m. and 6:00 a.m., the water storage tank levels dropped significantly within a span of two hours resulting in a reduction in the available water for supply and fire protection of 360,000 gallons and the tank was 66% full. A Water Conservation Notice was brought to the residents' attention on Friday July 22, 2011 which stated the low levels were due to the "record setting hot weather and high water demand". The concern increased when the tanks were unable to recover (refill with water) following the low levels since the daily water use increased. The Boston Globe article "After winter drought, craving April showers" by David Abel on March 31, 2012 provides some insight on the drought situation that North Reading is facing. In April 19, 2012, an article was published in the Town's newspaper ("Transcript") titled "Dry Weather causes DPW to urge water conservation" on the front page, which once again describes the critical need for water conservation. This DMP has been developed in response to these current events.

North Reading's water sources, system demand history, drought history, and water distribution system have been investigated and considered through the process of developing this DMP. Major components pertaining to water shortages and droughts are also explained.

1.2 IPSWICH RIVER WATERSHED

The Ipswich River Watershed provides about 40% of North Reading's water supply. Overall, this watershed provides as a water source to thirteen other communities and includes portions of at least 22 municipalities. The land use consists of approximately 31% residential land, 4.6% commercial land, 41% forest and open space, 2.3% open water, and 21% wetlands. The river has been known to be one of the most stressed rivers in the country since it is notorious for its extreme flow fluctuations between droughts and floods.

The United States Geological Survey (USGS) has records since the year 2000 of the Ipswich River having the highest and lowest fluctuations in their water flows. These high fluctuations are primarily due to the impervious areas that have recently been constructed such as parking lots, roads, roofs, and other areas that have been built in the place of permeable land such as forests and fields over the years. The rainfall that once fed the forests and fields is currently being collected and piped to the river and its tributaries which accounts for the highest and lowest records. Recent proof of these oscillating flows is when the river has caused some major damage to the neighboring communities from flooding in May of 2006 and April of 2007, and yet on the contrary, the river runs dry frequently during the summer. In addition, damage occurs to the aquatic life as a result of these droughts and dramatic fluctuations.

The USGS graphs, Figure 1-1 and 1-2, display the dramatic changes in flow that occur within the Ipswich River. Figure 1-1 depicts streamflow conditions in April of 2007. The daily discharge rose to be as high as 700 cfs and then dropped to be as low as 4.0 cfs in July of 2007 (a change occurring over only 3 to 4 months). Within that short period of time, the daily discharge decreased by an incredible 99%. Figure 1-2 is more recent data from the USGS website (consistently updated) that also shows dramatic changes.

FIGURE 1-1
USGS DATA RECORDED AT SOUTH MIDDLETON, MA

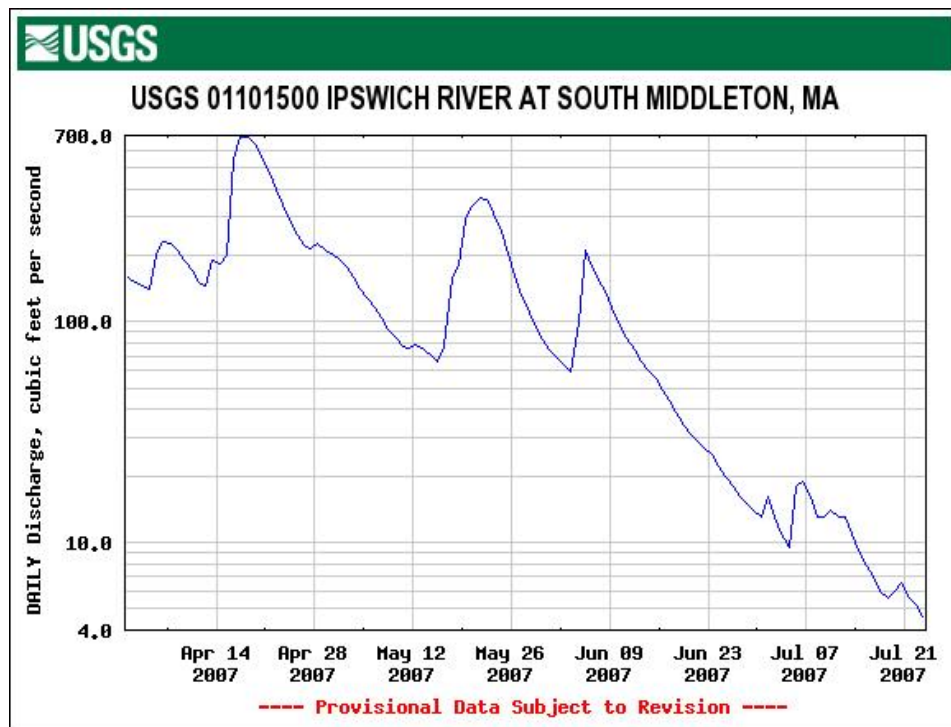
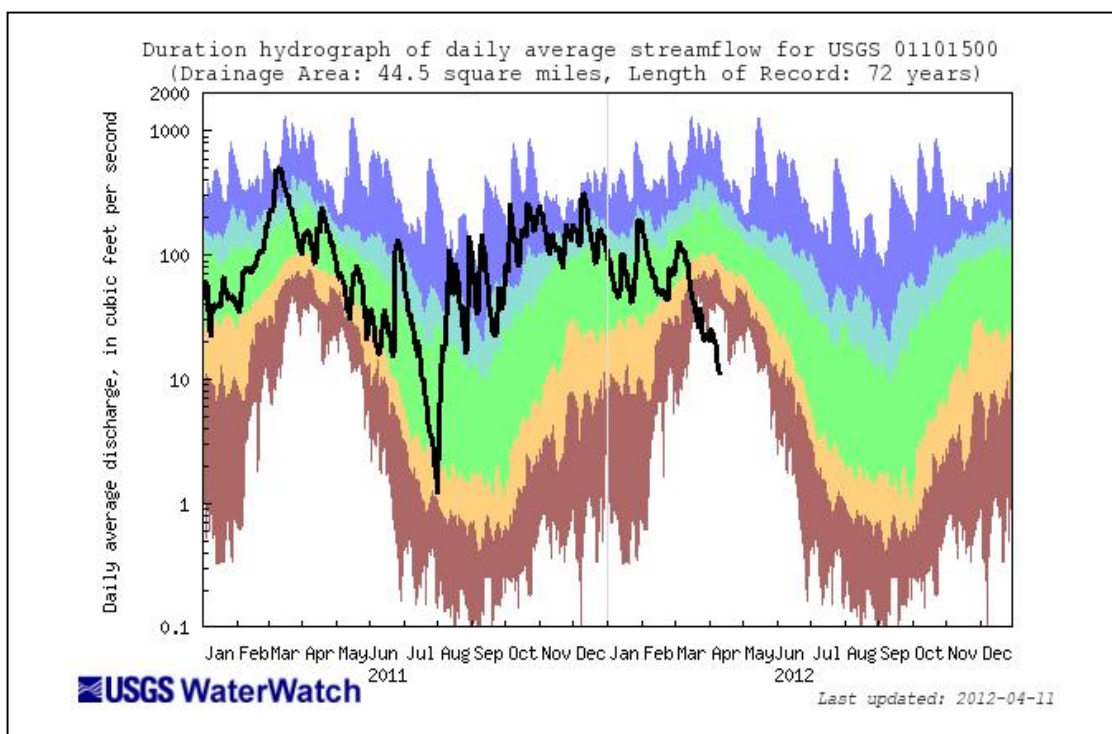


FIGURE 1-2
USGS DATA RECORDED AT SOUTH MIDDLETON, MA



In Figure 1-2, the black line represents the actual flow recorded at South Middleton, MA on the Ipswich River and the colored shading represents the percentile class (brown is <10, orange is 10-24, green is 25-75, teal is 76-90, and blue is >90). Around March of 2011 the daily average discharge reached to about 500 cfs and 4 to 5 months later around July/August 2011 the discharge dropped to almost 1 cfs, more than a two log change in a short time period.

Agencies and organizations such as the Ipswich River Watershed Association, the Massachusetts Department of Environmental Protection (DEP), the Massachusetts Audubon Society, the Reading/ North Reading Stream Team, and other interested parties are seeking alternative ways to minimize impacts to the river. For more information on the watershed, please go to <http://www.mass.gov/eea/agencies/dcr/water-res-protection/ipswich-river-watershed/ipswich-river-watershed.html> .

These extreme high and low flow conditions impact North Reading's water supply since the Ipswich River aquifers are one of the primary sources of water for the Town.

1.3 WATER SOURCES

The Town of North Reading maintains seven public groundwater well sources and purchases the remaining water from the neighboring Town of Andover to meet demand. Each of these sources has permitted limits of water withdrawal.

1.3.1 Ipswich River Watershed

The main component of the North Reading publically owned water supply is the Ipswich River Watershed. Each of the seven groundwater well sources draws water from this watershed.

1.3.2 Railroad Bed Wells (3213000-01G)

This is one of the seven groundwater wells the Town utilizes. The well is a gravel-packed well that has a depth of about 48.5 feet. This well is approved for a daily volume of 0.5 MGD. This well has a Zone I radius of 400 feet.

1.3.3 Lakeside Boulevard Well #2, #3, #4 (3213000-02G, -03G, -07G)

Well #2, #3, and #4 are gravel packed wells that are 42 feet, 38 feet, and 59 feet deep, respectively. The three wells, combined, have a DEP approval daily pumping rate of 0.9 MGD. These wells have a Zone I radius of 400 feet.

1.3.4 Central Street Wellfield (3213000-04G)

This tubular well field has an average depth of approximately 28 feet. The well field has an approved daily pumping volume of 0.4 MGD. The wells located in the wellfield have a Zone I radius of 250 feet.

1.3.5 Route 125 Well (3213000-05G)

This well is a gravel-packed well that has a depth of about 35 feet. This well is approved for a daily volume of 0.19 MGD. This well has a Zone I radius of 400 feet.

1.3.6 Stickney Well (3213000-06G) (Inactive)

Although this gravel-packed well is currently inactive, it may have the potential to become active. The well was closed in 1978 from volatile organic chemical (VOC) contamination and the Town has considered over the years to activate the well but doing so with the high contamination was not economically feasible. The Stickney Well has an Interim Wellhead Protection Area (IWPA) which connects to the Town of Wilmington. This well has a Zone I radius of 400 feet.

1.3.7 Andover Supply (3213000-01P)

North Reading purchases water from the Andover distribution system at about an average of 0.938 million gallons per day based on 2011 pumping records. Andover's main water source is the Merrimack River Basin. North Reading is able to purchase this water through the Inter-basin Transfer Act (IBTA), in which the Town is permitted to take 1.5 million gallons per day.

More information for each of these sources can be found in Section 2.3 Water Production and Availability. There is always the potential of creating new sources either by making more wells or by connecting to another Town. Residents also have the choice to install their own private well, but must follow North Reading's regulations which can be found at http://www.northreadingma.gov/Pages/NReadingMA_Health/wellreg.

1.4 DISTRIBUTION SYSTEM DEMAND HISTORY

The annual average water demand is approximately 1.4 million gallons per day (MGD) for the whole Town. That demand will increase to on average approximately 1.8 MGD during the summer months and the Town will see daily maximum demands just under 2.5 MGD. These increases are a result of increased outdoor water use.

1.5 DROUGHT MANAGEMENT HISTORY

The Town has stressed the importance of drought management through the years with public communication of newspapers, signboards, and electronic devices (e.g., the Town's web site on the internet). A recent publication in the North Reading "Transcript" on April 19, 2012 (Vol. LVI No. 48) reminding the community on the importance of conserving water. Within the article the Department of Public Works (DPW) urged the Town's residents to conserve water, especially outdoor water use such as landscape maintenance, which is not an essential use for the Town's limited water supply especially in stressed conditions. The limited water supply is critical for human consumption and fire protection.

Over the years North Reading has been metering water use, restricting water use, enforcing fines, performing leak detection, replacing and repairing meters, and using water saving devices. Water restrictions during the summer have been put in place as early as 1990. The Town has encouraged residents to install their own well for their outdoor water use. Leak detection surveys have been performed every couple of years to try to eliminate all unaccounted for water (UAW) by repairing leaks. UAW is defined by MassDEP as the difference between water pumped or purchased and water that is metered or confidently estimated. A drought contingency plan was

created in order to enforce fines. Programs were initiated in order to replace and repair meters. Public buildings were required to install water saving devices. On October 11, 2007 a drought advisory was made. On July 22, 2011 North Reading's DPW posted a Water Conservation Notice that asked residents to reduce or stop outdoor water use for seven days and to continue the odd/even water use restrictions that the Town holds at all times.

The Ipswich River Watershed is one of the Town's major water supply sources, so any droughts or shortages occurring to the river will essentially impact the Town as well. Recently on April 16, 2012, the USGS gauge located on the Ipswich River at South Middleton, MA was stated to have a flow rate of 28 cfs. USGS stated this flow rate is the lowest "for this date in the 74 years of record keeping at this gauging station. The previous low flow for this date was 29 cfs recorded in 1966 and the average flow rate for this date is 137 cfs." The Ipswich River is reaching its lowest recorded flows in history, which increases the necessity for the Town to have a conservative drought management plan so the Town will preserve resources, and be able to satisfy the water demand of their system. This also causes concern since these record lows have been reached in April generally a high flow period. Water shortages will continue to be a greater concern/demand in years to follow.

North Reading has watched these drought conditions get progressively worse over the years. Recent evidence suggests that climate change will result in a greater variation in the consistency and intensity of precipitation, which will negatively impact the available supplies. The Town has been able to reduce consumption over the years, but shortages related to excessive demand continues to occur.

Section 2

SECTION 2

DATA MONITORING

2.1 GENERAL

The first step in developing a framework for the control of water demand involves the monitoring of various systems in the Town's water system as well as larger State-wide indicators of the need to control water demand. Data from sources such as the State indices, the Andover drought status, the Ipswich River flow, the Town's storage tank elevations, and Town usage data (from both local sources and Andover interconnection) are considered when determining the monitoring triggers that will be used as part of the DMP. Defining the monitoring period for the triggers is also extremely important for managing a sustainable water supply through a drought condition. High demand is usually associated with warm weather and reduced rainfall. However a high system demand may occur as a result from commercial/industrial use, water main break or specific non-seasonal spikes related to changes in the overall climate of New England.

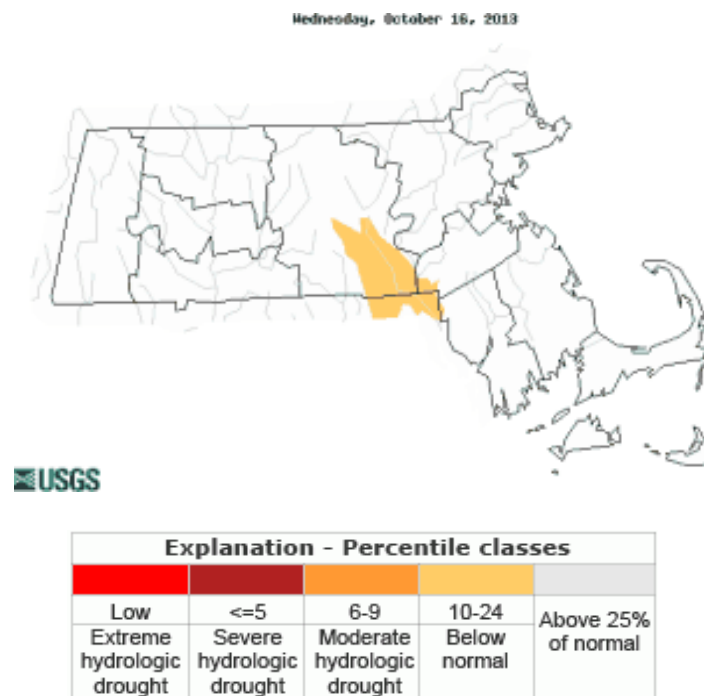
The data monitoring plan should be simple to implement and provide an easy set of responses for the Town to implement the control strategies. A specific set of recommendations is provided in this plan, but the plan must be revisited on a periodic basis to assess the applicability and appropriateness of the recommended measures. Changes in the system, user habits, and changes in the trends will require a review and adjustment of this plan to reflect the most current conditions.

The following describes potential indices, which are available to the Town for the purposes of monitoring system areas as part of the DMP. A sub-set of these indices will be recommended for routine monitoring based upon the sensitivity of the index and its usefulness in understanding North Reading's water demand.

2.1.1 State Indices

Every state has records and data that is interpreted and examined on a routine basis to provide indices for guidance. Comparing averages and outliers in history can help determine and predict future weather patterns and to help prepare when a drought watch or indicate a new drought stage. The state of Massachusetts has a whole webpage dedicated specifically to the "MA Drought Watch". The data provided by the state is strongly considered as one of the drought indicators for this DMP. Please visit the USGS website at <http://ma.water.usgs.gov/drought/> for all of the complete up-to-date information on the MA drought status. These comparisons help the Town to determine the best and efficient plan of action to follow in times of need.

FIGURE 2-1
MASSACHUSETTS DROUGHT WATCH - MAP OF BELOW NORMAL
STREAMFLOWS
(Example dated 10/16/13)



All state drought indices and forecasts can be found on the Massachusetts home page at <http://www.mass.gov/eea/agencies/dcr/water-res-protection/water-data-tracking/drought-status.html> . The drought indices MA uses includes the US drought monitor (the National

Drought Mitigation Center's Drought Monitor Map), Standardized Precipitation Index (Western Regional Climate Center's Index values for MA from the Desert Research Institute, University and Community College System of Nevada), NWS/NOAA's Climate Prediction Center (U.S. Seasonal Drought Outlook), and extended forecasts (National Weather Service Climate Prediction Center's extended forecast; NWS Climate Prediction Center Info: <http://www.cpc.noaa.gov/index.php>. All state indices and forecasts are consistently updated on their home page every month.

2.1.2 Andover Drought Status

Andover has five drought indicators: Fish Brook Pumping Station wet well level, Haggetts Pond reservoir level, raw water operations demand, distribution storage capacity, and the Palmer Drought Index. Andover is dependent on each of these indicators to guide the Town into the different drought phases to help conserve and reserve water. Since a portion of Andover's water supply is provided to North Reading, Andover's drought status is an important factor to monitor routinely. Any information relating to Andover's drought status, or further information about the Andover water demand and history, can be found on Andover's home page: <http://andoverma.gov/>.

2.1.3 Ipswich River Flow

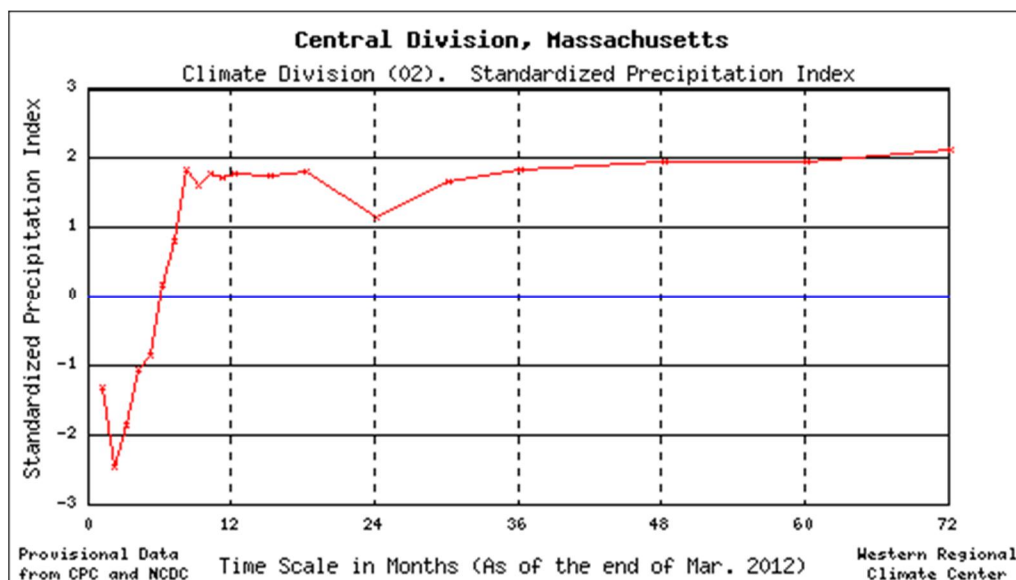
The Ipswich River flow data is a component to help keep North Reading's drought status up-to-date. It provides a strong link to drought conditions, since the Ipswich River is a main source of water for the Town. The data retrieved from the Ipswich River will be analyzed and looked over routinely to determine the region's drought status.

Observation of the Ipswich River historic data has shown that the river has had the greatest hits of shortage during the summer. To find the most recent/updated information and records, the internet provides an accommodating source at this address <http://www.mass.gov/eea/agencies/dcr/water-res-protection/ipswich-river-watershed/>.

2.2 PRECIPITATION

The deficiency of precipitation is a precursor for droughts and water shortage. Precipitation is monitored and recorded on a routine basis to determine the average precipitation. The average is compared to the current data to determine whether the precipitation is above or below the average amount. Monitoring precipitation is the most obvious indication of water shortages and drought potential. Each state has a customized standardized precipitation index. An example of the Massachusetts Index is shown below, which the Town would monitor continuously to determine the most current drought stage for North Reading.

FIGURE 2-2
STATE STANDARDIZED PRECIPITATION INDEX
(72 Month look at SPI, period ending March 2012)



The Massachusetts Standardized Precipitation Index, shown above, illustrates the SPI for the past 72 months with the end date of March 2012 as the final point on the index. When the index is negative it signifies drought conditions whereas the positive is wet conditions using probability. The value of zero is the median. The SPI is completely determined upon precipitation. The SPI is very helpful to monitor to determine the scale or severity of the drought, or vice versa. This index accurately illustrates points on a graph for what the index would be for each month of the

year and is consistently updated to provide the most accurate results. These results aid in monitoring patterns and allow the Town to compare the current data with the historical average.

Additional information can be found at the following:

- National Drought Mitigation Center, <http://www.drought.unl.edu/>
- "Climate of 2013- April U.S. Standardized Precipitation Index"

<http://lwf.ncdc.noaa.gov/oa/climate/research/prelim/drought/spi.html>

2.2.1 Palmer Drought Index

The Palmer Drought Index is one of the five drought indicators that Andover uses to determine their drought status. This index is very helpful since it can reflect conditions of drought or excess rainfall anywhere in the U.S. More information on this index can be found at <http://www.drought.gov/nadm/content/palmer-drought-indices> . Weekly maps and current monitoring is available at

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring. Table 2-1 below is the Palmer Drought Index.

TABLE 2-1
DROUGHT INDICATOR: PALMER DROUGHT INDEX

Palmer Drought Index	
>4.0	Extremely Wet
3.0 to 3.99	Very Wet
2.0 to 2.99	Moderately Wet
1.0 to 1.99	Slightly Wet
0.5 to 0.99	Incipient Wet Spell
0.49 to -0.49	Near Normal
-0.5 to -0.99	Incipient Dry Spell
-1.0 to -1.99	Mild Drought
-2.0 to -2.99	Moderate Drought
-3.0 to -3.99	Severe Drought
-4.0 or less	Extreme Drought

The table above gives an index for the amount of precipitation and the severity associated to the amount.

2.3 WATER PRODUCTION AND AVAILABILITY

North Reading's water supply is derived from seven groundwater well sources and is purchased from the neighboring town of Andover. Each of the well sources in North Reading draws their water from the Ipswich River Watershed. The withdrawal volume from the watershed according to the data from DEP 2012 Public Water Supply Annual Statistical Report (ASR) is listed in Table 2-2 below.

**TABLE 2-2
IPSWICH RIVER WATERSHED**

IPSWICH RIVER BASIN (WATERSHED) (2012)		
Total Raw Pumped in 2012(MGY)	Average Daily Withdrawal (MGD)	Registered Volume (MGD)
212,599	0.58	0.96

Overall, this watershed is able to effectively permit the volume of 0.96 MGD of water to the Town of North Reading. More information on the Ipswich River Watershed can be found at <http://www.mass.gov/eea/agencies/dcr/water-res-protection/ipswich-river-watershed/> .

There are seven groundwater well sources and only one of those sources is inactive. Table 2-3 gives data for each of these sources. Lakeside Boulevard Well #2, 3, and 4 have a combined pump volume so the data for all three wells are combined under Well #4. The inactive source is the Stickney Well.

**TABLE 2-3
2012 ASR DATA ON WELL SOURCES**

SourceID	Source Name	Location	Source Watershed	Active	Well Depth	Total Pumped (MG)	Total # of Days Pumped	Max Day Volume	Average Pumped Per Day
3213000-01G	Railroad Bed Wells	Cold Spring Rd	Ipswich	Yes	48.5	98.353	288	0.500	0.342
3213000-03G*	Lakeside Blvd. Well #3	55 Lakeside Blvd.	Ipswich	Yes	38	*	-	*	-
3213000-02G*	Lakeside Blvd. Well #2	55 Lakeside Blvd.	Ipswich	Yes	42	*	-	*	-
3213000-07G*	Lakeside Blvd. Well #4	66 Lakeside Blvd.	Ipswich	Yes	59	56.850	353	0.373	0.161
3213000-04G	Central Street Wellfield	256 Central St.	Ipswich	Yes	28	17.784	341	0.114	0.052
3213000-05G	Route 125 Well	Off Rte 125	Ipswich	Yes	35	40.411	353	0.161	0.114
3213000-06G	Stickney Well	Off Redmond Ave.	Ipswich	No	35	0	0	0	0

Note: * Combined and reported total on Well No. 4

The Railroad Bed Wells on Cold Spring Road is the largest groundwater well contributing source from North Reading with an average volume pumped per day of about 0.342 MGD. The groundwater well source that is the smallest in size and in flow volume is the Central Street Wellfield located at 256 Central Street and in 2012 average volume pumped per day was 0.052 MGD.

North Reading purchases an average of 0.858 MGD from the Andover distribution system. Table 2-4 provides data on the Andover distribution system from the 2012 ASR.

**TABLE 2-4
PURCHASED WATER FROM TOWN OF ANDOVER (2012)**

ANDOVER SUPPLY (3213000-01P)					
Location	Active	Total Pumped (MG)	Total # of Days Used	Max Day Volume	Average Pumped Per Day (MGD)
Main St (Rte 28) and Central St (Gould Rd)	Yes	313.028	365	1.502	0.858

The Andover distribution system is a major contributing source to the Town; therefore, monitoring Andover's drought status and data can be a critical factor for the DMP.

2.4 WATER DEMAND

Historical water usage in North Reading was evaluated to determine past water usage trends and characteristics. An analysis of water use in North Reading from 2002 through 2011 was made and used to forecast future demands. Historical water use data was obtained from the City's Annual Statistical Reports (ASR) which is submitted each year to the MassDEP.

Based on information presented in the ASRs, recently in the years of 2009 and 2010, the population served by the water department increased by 185 people, the residential gallons per capita day (RGPCD) increased by 14 gal/person/day, and the net finished water consumption increased by 13.27 MG, as shown in Table 2-5. On top of that, the water demand in the summer

season tends to be more with a summer consumption increasing by 9.231 MG. However, North Reading's population remained steady in 2011 and net finish water consumption still increased by 36.898 MG which is largely contributed to an increase in summer water usage which saw a 15% increase in use from the previous year. In 2012, the population held steady and demands dropped off from the previous year but the trend over the past four years is an increase in demand on the water supply. On top of the increasing demands, the Town must maintain adequate supplies for fire flows and other critical events.

**TABLE 2-5
DEMAND FROM 2009 TO 2012**

Year	2009	2010	2011	2012
Population (served by the PWS)*	14,221	14,406	14,397	14,397
RGPCD (gal/person/day)	51	65	74	72
Net Finished Water Consumption (MG)	476.151	489.422	526.320	510.235
Summer Consumption, June through August (MG)	142.273	151.504	174.746	158.766

Note: * Census data shows Town population being 500 people higher than the listed population in the Table. It has been estimated by the Town that 500 people are serviced from private wells.

The highest demand in North Reading is from residential population with about 80% to 90% of the total metered finished water volume used, and the second highest demand is from the industrial residents, according to the ASRs. See Table 2-6 for the metered finished water use for each division of town.

TABLE 2-6
2009 THROUGH 2012 METERED FINISHED WATER USE

	2009 Metered Finished Water Use			2010 Metered Finished Water Use			2011 Metered Finished Water Use			2012 Metered Finished Water Use		
	# of Service Connections	Total Volume (mgd)	%	# of Service Connections	Total Volume (mgd)	%	# of Service Connections	Total Volume (mgd)	%	# of Service Connections	Total Volume (mgd)	%
Residential	4562	314.10	80.2	4553	343.45	87.7	4578	392.194	88.9	4577	376.464	89.7
Residential Institutions	14	3.31	0.8	14	3.08	0.8	0	0	0	0	0	0
Commercial/Business	181	27.94	7.1	184	25.47	6.5	169	20.172	4.6	176	24.781	5.9
Agricultural	0	0	0.0	0	0	0.0	2	0.105	0.0	0	0	0
Industrial	45	38.16	9.7	40	28.877	7.4	47	19.469	4.4	48	12.868	3.1
Municipal/Institutional/ Nonprofit	19	8.15	2.1	19	7.05	1.8	34	9.234	2.1	28	5.667	1.3
Other	0	0	0.0	0	0	0.0	0	0	0	0	0	0
TOTAL	4821	391.65		4810	407.885		4830	441.174		4829	419.78	

The highest demand can be linked to summer water use from the residential community, which contributes to the highest population and volume of water use in Town.

Commercial/business and Industrial population has been decreasing and at the same time the residential population has been increasing or holding steady, according to the recent data. Therefore, as noted, the total finished water volume has increased which likely is associated with excess residential outdoor water used in the summer.

2.5 TEMPERATURE

An increase in temperature for a long duration can greatly impact and extend a drought condition. Daytime temperatures can also be higher during a drought because the decrease in moisture in the atmosphere leads to less cloud cover and therefore the sun heats the atmosphere quicker. With a decrease in moisture in the air, the tendency for rainfall is also decreased extending a drought condition. The insufficient soil moisture from the lack of precipitation and increased temperatures leads to stress on vegetation and a tendency to increase outdoor watering to counteract the drying effects. This increase in outdoor watering during the summer leads to a high demand on the water system. Therefore an increase in temperature for a long duration should be tracked by a public water supplier and water conservation measures implemented during such periods, to insure a sustainable water supply for essential water use and fire protection.

Temperature readings can be taken from local accurate gauges or obtained daily from the news. When trending historical temperature data, the Global Historical Climatology Network (GHCN) – Daily was used for this purpose. The GHCN-Daily database provides historical records on temperature, precipitation, and snow records over the globe. Historical temperature data for North Reading was obtained from a National Oceanic and Atmospheric Administration (NOAA) Station (GHCND: USC 00196783) located in neighboring Reading. The historical information obtained from this database can be used to analyze the relationship between increased temperatures and drought conditions in the Town.

2.6 MONITORING PROGRAM

This Section has presented several different means of monitoring drought conditions relative to the North Reading water system. Many of the monitoring points overlap and do not provide adequate resolution to be used as specific indicators. Table 2-7 provides an analysis of potential indicators for a drought and is based upon the specific conditions of the North Reading water supply and system characteristics.

**TABLE 2-7
POTENTIAL DROUGHT INDICATORS**

MONITORING INDICATOR	RATIONALE
Total Water Demand	Indicator of stressed system
Town Storage Tank Elevation	Limits ability of Town to provide water in Emergency
Andover Drought Status	Majority of North Reading water supply / represents a composite of several indices
Andover Water Use*	Manage volumes to less than IBTA Allowances
Ipswich River Flowrate*	Town is a net importer of water into basin
State Drought Watch*	Not as sensitive as other indices
State Precipitation Index*	Not as sensitive as other indices
Sequential Days Over 90 Degrees	Indicator of increase in Outdoor Watering
Palmer Index*	Covered by Andover Drought Status
Town Well Withdrawals	Manage volumes to less than registered volumes

Note: * In cases where these are concerned critical, North Reading should review routine drought indicators to ensure that supplies remain stable and available at current usage rates.

2.6.1 Existing Program

The Town of North Reading has an existing Water Restriction Trigger program in place. Table 2-8 provides a summary of the current water restriction triggers used and monitored by the Town and were obtained from the Water Restriction Triggers and Monitoring Frequency dated August 28, 2012 and Water Restriction Triggers, Internal Procedures dated August 29, 2013.

**TABLE 2-8
EXISTING WATER RESTRICTION TRIGGERS**

TRIGGER	MONITORING INDICATOR	RATIONALE
PRIMARY	Total Water Demand	Indicator of stressed system
	Town Storage Tank Elevation	Limits ability of Town to provide water in Emergency
	Andover Drought Status	Majority of North Reading water supply / represents a composite of several indices
	Sequential Days Over 90 Degrees	Indicator of increase in Outdoor Watering
SECONDARY	Ipswich River Flowrate	Town is an net importer of water into basin
	State Drought Watch	Not as sensitive as other indices
	State Precipitation Index	Not as sensitive as other indices
	Andover Water Use	Manage volumes to less than IBTA Allowances

The existing triggers were reviewed and an analysis of the indicators was performed on the following triggers.

- Pumping records of local sources
- Withdrawals from Andover interconnections
- Storage tank levels
- Historical temperature data furnished by National Oceanic and Atmospheric Administration (NOAA) based on a local temperature station in Reading Massachusetts.

The following figures, Figure 2-3, 2-4, 2-5 and 2-6, show annual historical trending dating from December 1, 2010 to August 31, 2013 of Total Water Demand, Andover Water Use, Town Storage Tank Elevation, and Temperature Data.

Based on that analysis; changes to the Town's current Water Restriction Triggers are recommended.

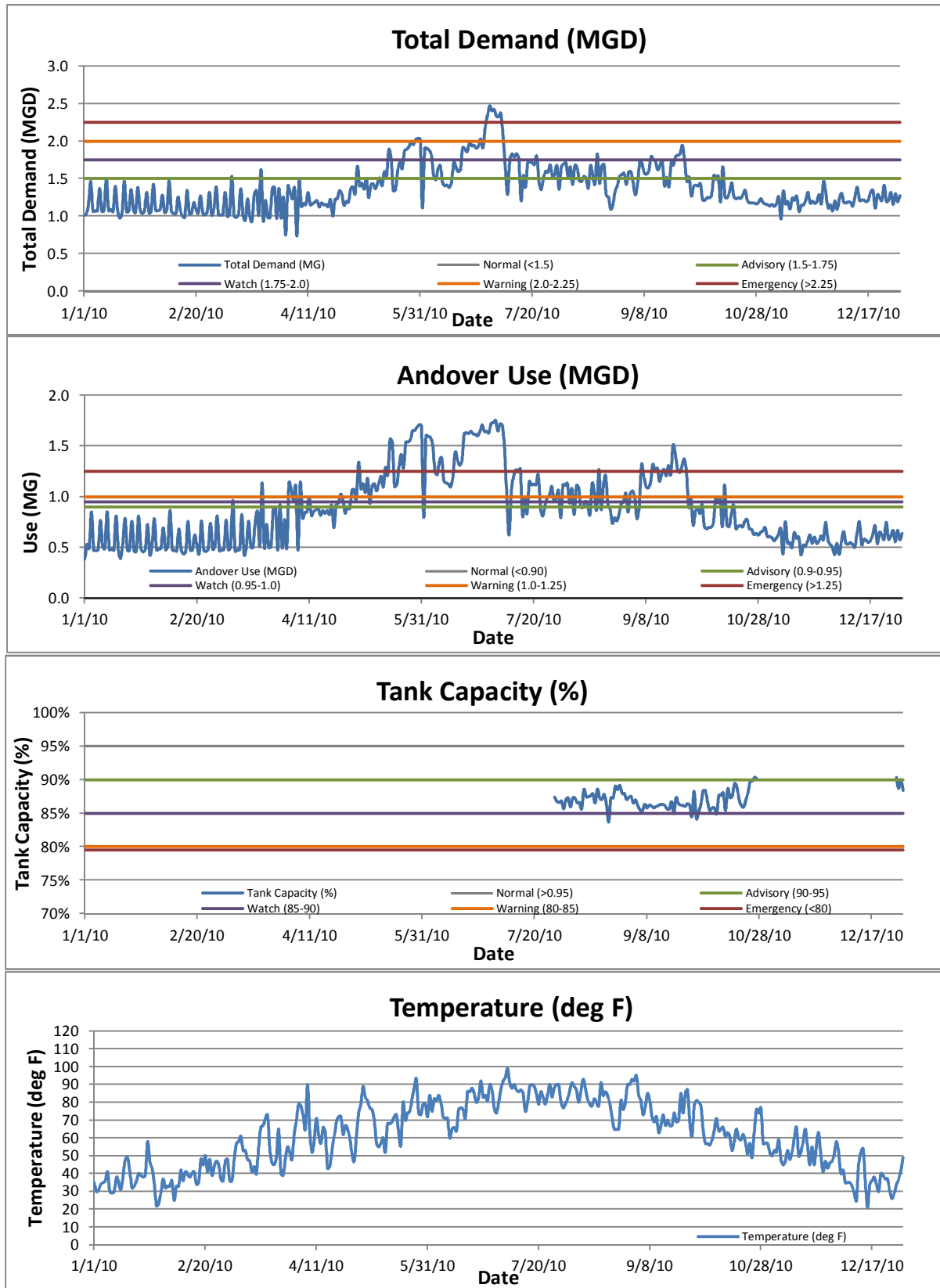
2.6.2 Recommended Changes to Monitoring Program

The total water demand for the Town's system includes essential water use as well as non-essential water use such as outdoor water use during the summer to water lawns and fill swimming pools. The Town currently has a limited supply of water from their local sources and restrictions on their interconnection with Andover through the existing IBTA. Due to limitations on their local water supply due to capacity and water quality issues, the Town relies on the Andover connections to supplement the Town's supplies when demands exceed the capacity of the wells. Therefor we recommend the Andover Water Use be a primary trigger to provide an early indication of water usage trending upwards and to manage its use within the IBTA.

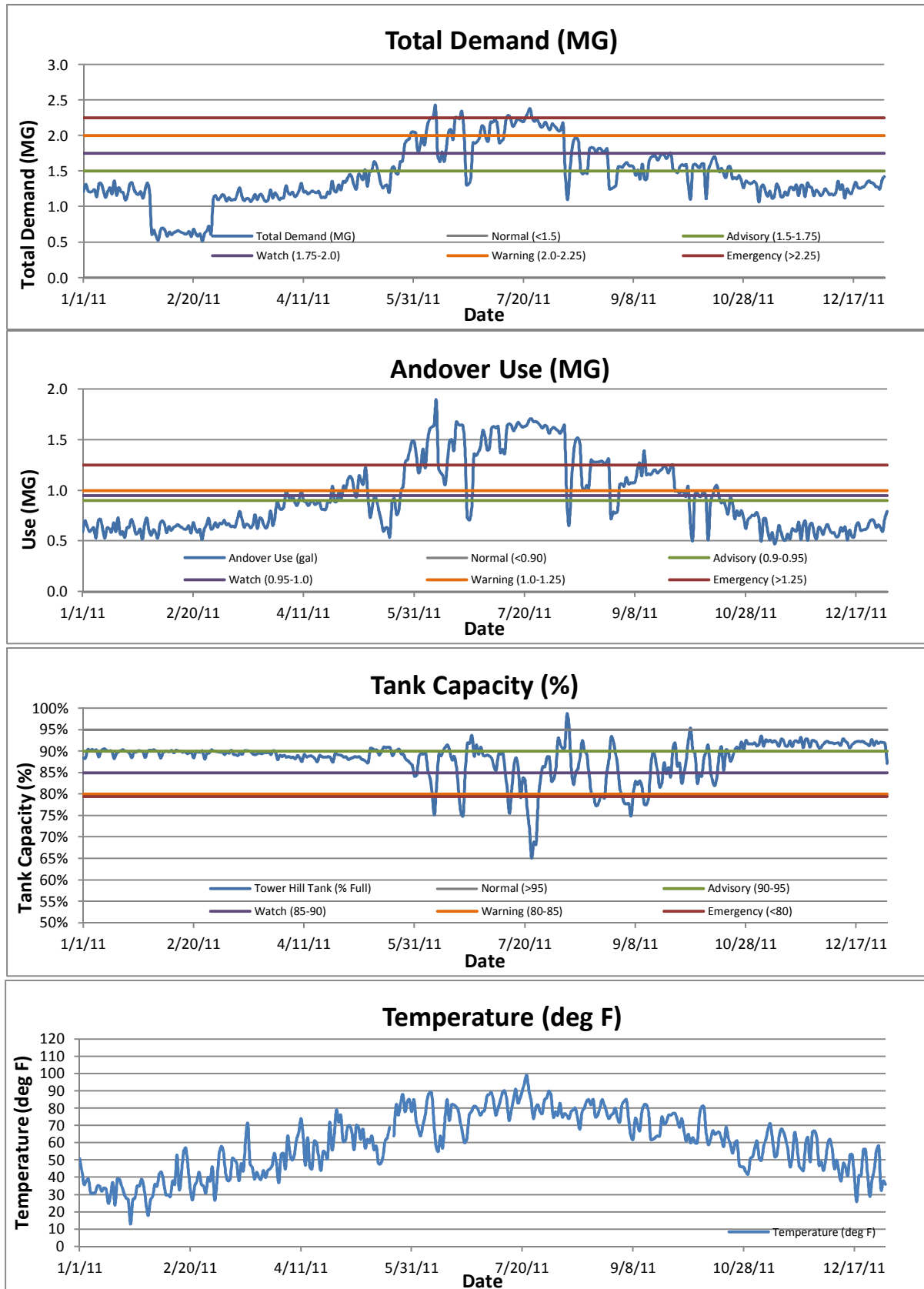
Temperature, especially consecutive days over 90 degrees, is an indication that outdoor water use will increase but it is not so easily and accurately predicted and does not provide ample time for the Town to enforce water conservation measures to maintain a sustainable supply of water within the system for emergency conditions. Also in an effort to have a manageable number of primary triggers, temperature is recommended to be a secondary trigger.

Table 2-9 Recommended Water Restriction Triggers summarizes the recommended changes to the Town's existing triggers. Specifics regarding the thresholds and monitoring frequencies are provided in Section 3.

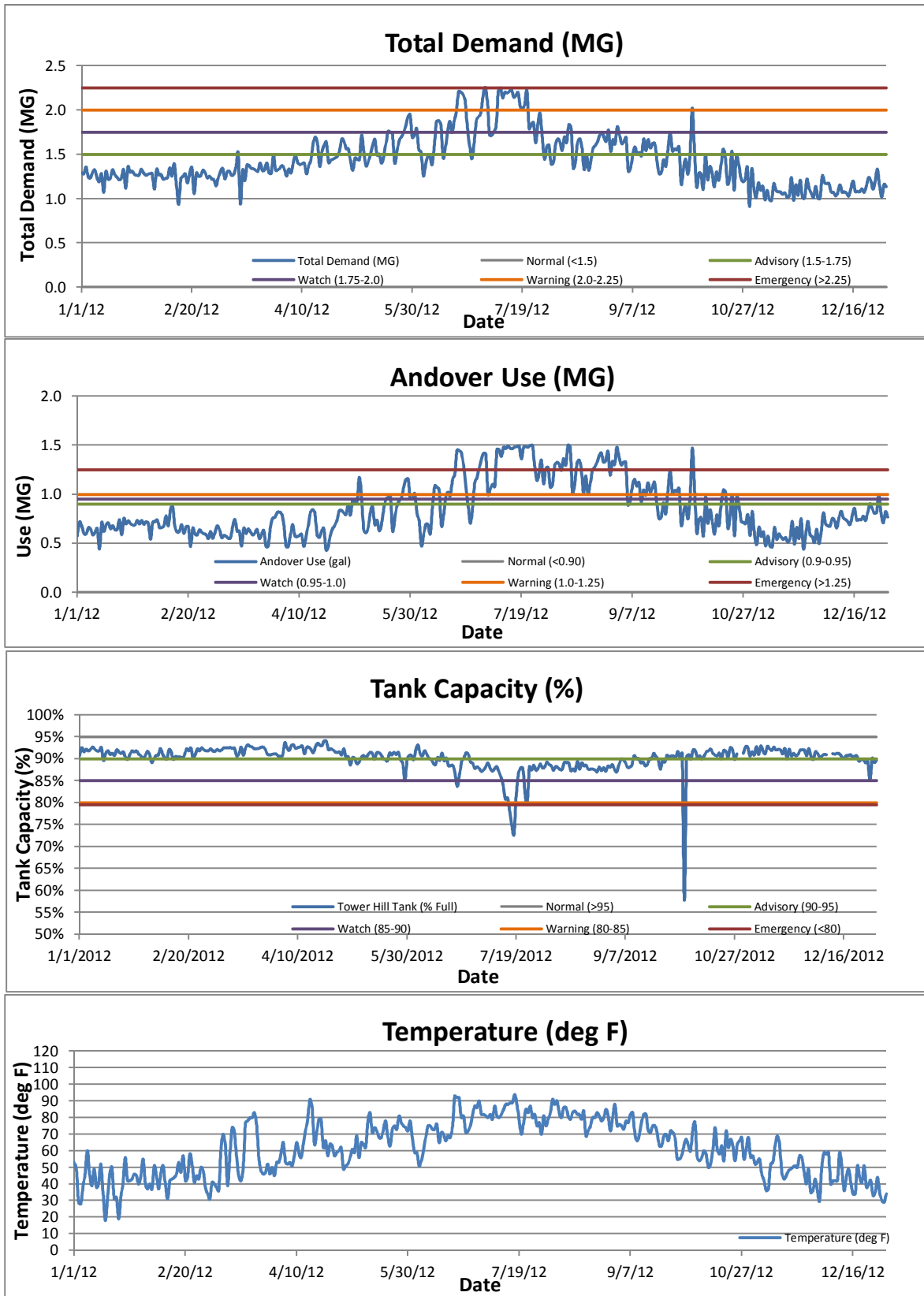
**FIGURE 2-3
2010 HISTORICAL WATER RESTRICTION TRIGGERS**



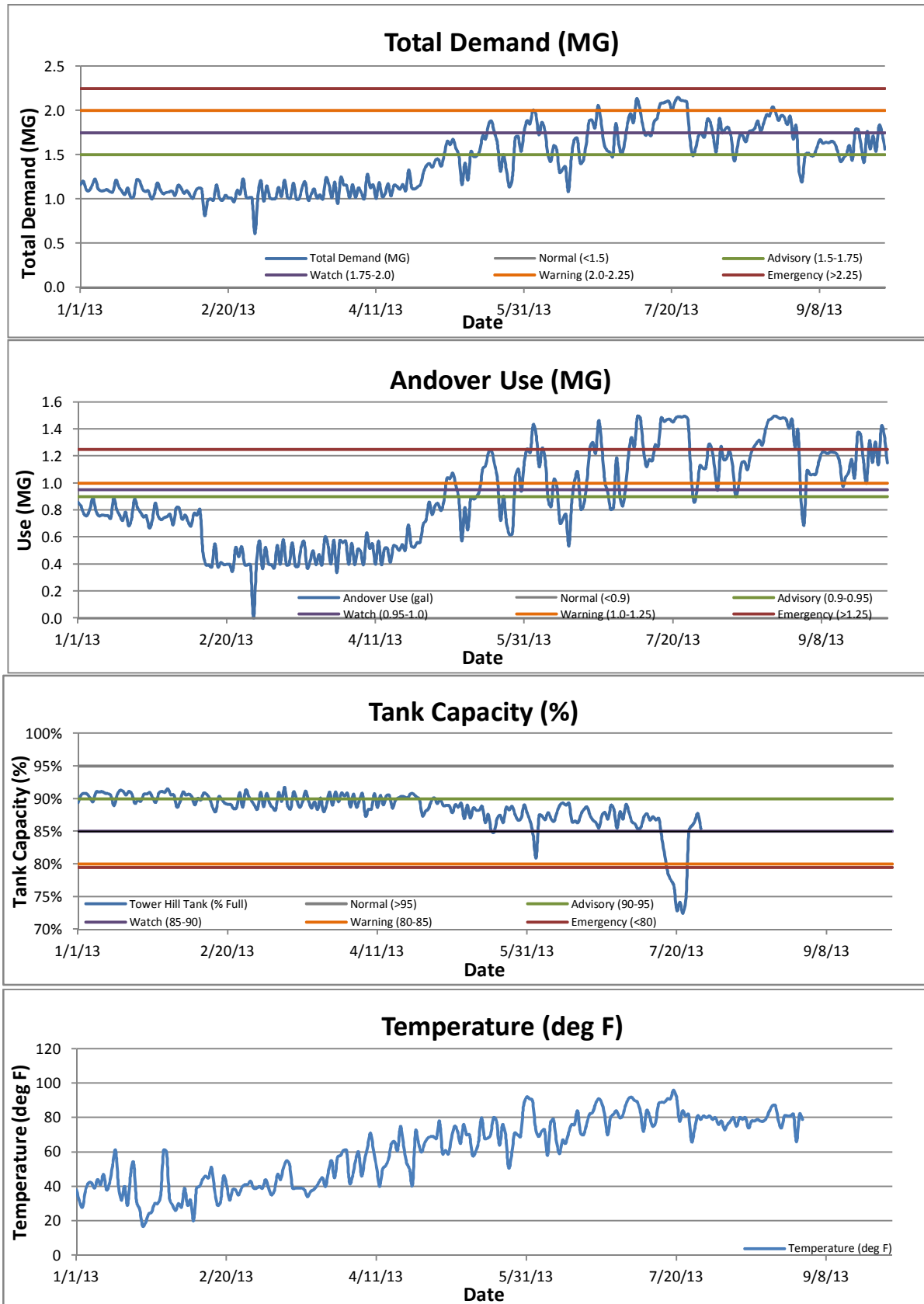
**FIGURE 2-4
2011 HISTORICAL WATER RESTRICTION TRIGGERS**



**FIGURE 2-5
2012 HISTORICAL WATER RESTRICTION TRIGGERS**



**FIGURE 2-6
2013 HISTORICAL WATER RESTRICTION TRIGGERS**



**TABLE 2-9
RECOMMENDED WATER RESTRICTION TRIGGERS**

TRIGGER	MONITORING INDICATOR	RATIONALE
PRIMARY	Total Water Demand	Indicator of stressed system
	Town Storage Tank Elevation	Limits ability of Town to provide water in Emergency
	Andover Drought Status	Majority of North Reading water supply / represents a composite of several indices
	Andover Water Use**	Manage volumes to less than IBTA Allowances
SECONDARY	Ipswich River Flowrate	Town is a net importer of water into basin
	State Drought Watch	Not as sensitive as other indices
	State Precipitation Index	Not as sensitive as other indices
	Sequential Days Over 90 Degrees**	Indicator of increase in Outdoor Watering

Note: ** A recommended change from the current water restriction triggers in place.

Section 3

SECTION 3

DROUGHT RESPONSE PLAN

3.1 DROUGHT INDICATORS

As the water demand increases, the flow rates and the storage tank levels decrease which, in turn, increases the severity of consumption restrictions within the Town. Conservative indicators are set on numerical values for the drought/demand indicator points in order to prevent a failure of the Town water system and limit the need to introduce elevated restrictions. The greatest demand is during the summer when the weather is warmer and when evapo-transpiration is highest resulting in reduced water available for groundwater recharge and runoff to rivers and streams. Simultaneously, excess amount of water is being utilized for outdoor water use such as watering lawns. The water consumption in the summer season generally increases by 30-50% as compared to the winter season. It is mandatory that consumption be limited during this season or any other time of reduced or limited supply such as an instance of severe fire usage or major water break.

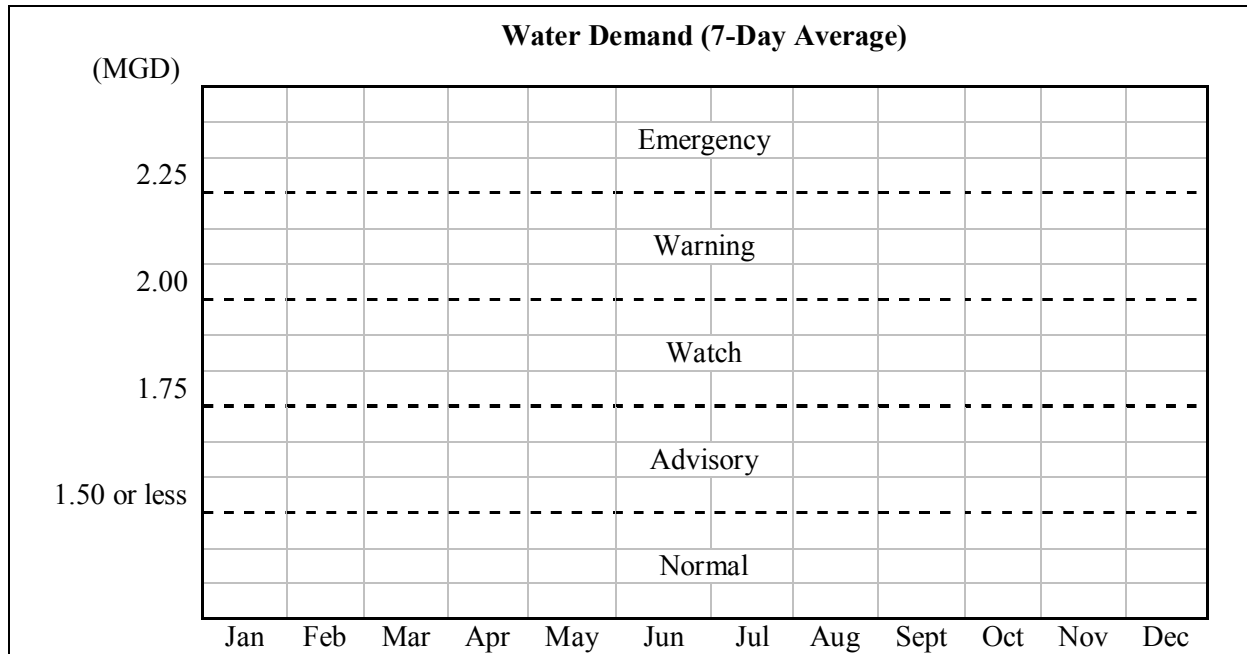
Establishment of the drought indicators is one of the key steps in the DMP. The indicators, discussed in Section 2 are set by guidelines in the form of stages or phases that indicate the severity of the drought. Once an indicator threshold is hit, the new stage goes into immediate action in order for the Town to control water demand to an amount that the Town can reasonably supply during the stressed period. The Primary drought indicators recommended for North Reading are water demand, Andover water use, storage capacity, and Andover Drought Phase. The other indices should be considered especially under circumstances of widespread publicized drought concerns. North Reading should review the key indices for indications of areas of concern under those circumstances.

3.1.1 Water Demand

North Reading's water demand is critical when establishing the DMP.

Figures 3-1 and 3-2 illustrates the water demand for the whole year relative to the Town's two water sources.

**FIGURE 3-1
DROUGHT INDICATOR: TOTAL WATER DEMAND (SEVEN-DAY AVERAGE)**



These measures are in place to sustain the long-term use of the Town well supplies and limit the chance of exceedences of the authorized water use allowed by the Town's Water Registration. These levels will determine the drought stage that would need to go into effect. For example, if the water demand increases above 1.50 MGD, then the Advisory Stage will take immediate effect. What each stage consists of can be found in Section 3.2 Drought Stage Assignment. The goal is to remain in the Normal Stage of 1.50 or less MGD average seven day water demand.

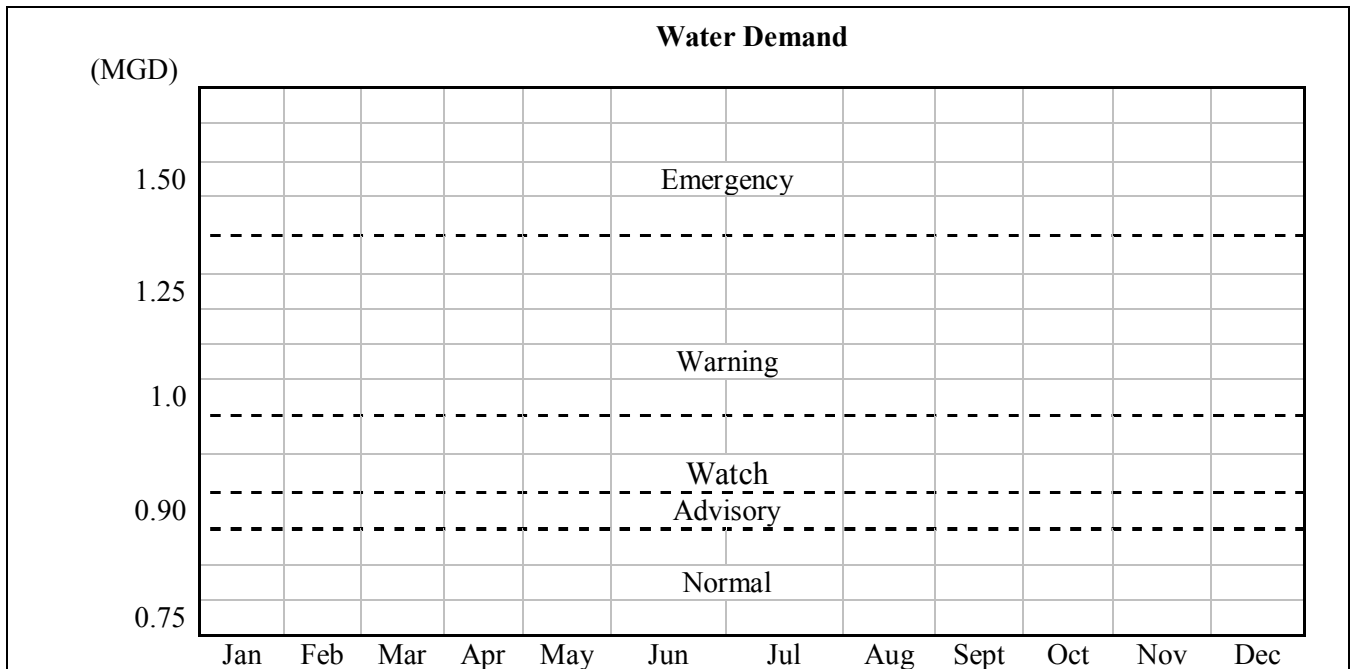
Another recommendation to the existing Drought Management Plan and Secondary Triggers is depicted in the following Table 3-1:

**TABLE 3-1
RECOMMENDED RANGE FOR ANDOVER WATER USE**

TRIGGER	ANDOVER WATER USE (MGD)
Normal	< 0.90
Advisory	0.9 – 0.95
Watch	0.95 – 1.0
Warning	1.0 – 1.25
Emergency	>1.25

By adjusting the ranges of the water purchased from Andover, The Town maintains the amount of water below the existing IBTA permit limit of maximum withdrawal of 1.5 MGD. This would also assist the Town with maximizing the withdrawal from their local sources up to 0.96 MGD. If yield from local sources are not sufficient to accommodate the increasing demands, water restrictions will be enforced earlier to help reduce water usage within permitted limits.

**FIGURE 3-2
DROUGHT INDICATOR: ANDOVER WATER USE**

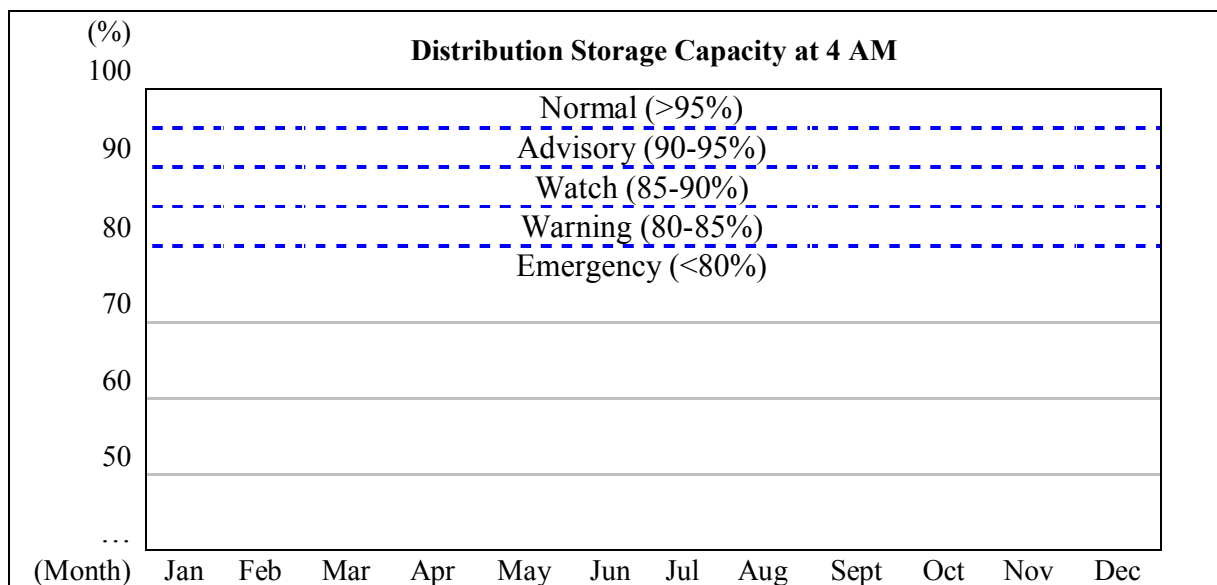


These measures are required to reduce the chance that the IBTA permit is exceeded. These levels will determine the drought stage that would need to go into effect. For example, if the water demand increases above 0.90 MGD, then the Advisory Stage will take immediate effect. What each stage consists of can be found in Section 3.2 Drought Stage Assignment. The goal is to remain in the Normal Stage of 0.90 or less MGD.

3.1.2 Storage Tank Levels

The storage capacity in the water storage tanks is a crucial drought indicator. Figure 3-3 shows the numerical levels to trigger each stage. Once a capacity percentage is hit, the stage will initiate immediately.

**FIGURE 3-3
DROUGHT INDICATOR: DISTRIBUTION STORAGE CAPACITY AT 4 AM**



This capacity analysis is for the whole year with snap shots taken at 4:00 a.m.. The goal is to remain in the Normal Stage at a distribution storage capacity of greater than 95%.

3.1.3 Andover Drought Status

The Town purchases a majority of its water from their neighboring Town of Andover; therefore any drought phases Andover decides to uphold would be adapted to the Town. North Reading is directly impacted by any drought related issues Andover experiences. Andover's designated phases are listed below in Table 3-2. To understand this drought system, the trigger levels are indicated below.

TABLE 3-2
DROUGHT INDICATOR: ANDOVER DROUGHT TRIGGER LEVELS

DROUGHT PHASE	LABEL	RESPONSE ACTION
Phase I	Watch	Voluntary Conservation <i>Target Largest Users</i>
Phase II	Warning	Voluntary Conservation of all users. Mandatory conservation for targeted largest users.
Phase III	Emergency	Mandatory restrictions with by-law in effect.
Phase IV	Critical	Maximum mandatory restriction.

It should be noted that Andover's drought phases differ from Massachusetts and North Reading's drought stages which are consistent. Andover has four drought phases, each indicating a response plan. The first trigger level which is called Phase I "Watch" has the response plan of contacting the system's 25 largest water users and asking those users to conserve their water usage. North Reading is the Andover water system's largest user. The largest water users list is consistently updated every year. Once Phase II is triggered, there is a mandatory restriction on these 25 largest users and all public users are asked to voluntarily conserve water. This may be publicized and communicated to the public through radio, television, newspaper, printed flyers, bill stuffers, and etc. Once Phase III triggers are hit, the Town of Andover Water Use Restriction/Bylaw is put into effect and places limitations on municipal water. Maximum response is mandatory once Phase IV Critical Phase is initiated. Restrictions and measures are at the highest and are enforced on all municipal water use. The emergency public agency actions

begin at this time. North Reading will monitor all drought activities and phases that Andover experiences to guide the Town's own drought plan.

3.1.4 Summary

Table 3-3 below is a summary table for the four primary drought triggers stated earlier that will be monitored by the Town on a predetermined basis in order to determine the drought stage and corresponding conservation measures to be implemented to achieve the water use reduction goals established by the Town. Table 3-4 below is a summary table for the four secondary drought triggers that will also be monitored by the Town.

**TABLE 3-3
PRIMARY DROUGHT INDICATORS FOR EACH DESIGNATED STAGE**

		Total Water Demand (7-Day Average) (MGD)	Tower Hill Storage Tank Capacity at 4 AM	Andover Drought Phase	Andover Water Use*
Stage 0	Normal	< 1.5	> 95%	Normal	< 0.90
Stage I	Advisory	1.5 - 1.75	90 - 95%	Watch	0.90 – 0.95
Stage II	Watch	1.75 - 2.0	85 - 90%	Warning	0.95 – 1.0
Stage III	Warning	2.0 - 2.25	80 - 85%	Emergency	1.0 – 1.25
Stage IV	Emergency	> 2.25	< 80%	Critical	> 1.25

* Recommended Change as discussed in Section 2.

**TABLE 3-4
SECONDARY DROUGHT INDICATORS FOR EACH DESIGNATED STAGE**

		7 Day Ipswich River Flow @ South Middleton (cfs)	MA DCR Drought Status	MA DCR 3 Month Precipitation Deficit (in)	Sequential Days > 90 degrees*
Stage 0	Normal	> 29.8	Normal	< 0.5	na
Stage I	Advisory	29.8	Advisory	0.5 – 1.5	2
Stage II	Watch	18.7 – 29.8	Watch	1.5 – 2.5	3
Stage III	Warning	15.1 – 18.7	Warning	2.5 – 3.0	4
Stage IV	Emergency	< 15.1	Emergency	> 3.0	5

* Recommended Change as discussed in Section 2.

The Town monitors the levels of all their systems, water treatment and storage facilities/tanks/interconnections, on a routine basis which helps initiate triggers for each drought stage. If and when the water falls below a certain level as indicated in this plan, there will be new drought stage with each passing trigger. The severity corresponds to the stage of the drought status.

Various conditions and phases were analyzed to correspond with priority levels. All indicators and triggers were carefully established to provide the most efficient drought plan.

3.2 DROUGHT STAGE ASSIGNMENT

Various conditions and restrictions were analyzed to correspond with each priority level to achieve the most efficient results. The existing assignment for each drought condition stage is shown in Table 3-5.

The five stages (Stage 0 through IV) provide designated mandatory restrictions for the whole Town of North Reading. Each of the drought stages will trigger certain restrictions which range from minimal or extreme. Stage 0 is the normal condition and the most minimal of the stages, whereas Stage IV is the most extreme condition that bans outdoor water use altogether, along with other designated restrictions.

Observation periods vary depending on the month of the year and the drought stage the Town is currently in. The recommended observation frequency increases during the summer months due to the increased likelihood of higher demand that is normally associated with this season, therefore it is important that the data be monitored more frequently. As the Drought Stage changes the frequency of observation also changes. Tables 3-6 and Table 3-7 indicate the frequencies.

TABLE 3-5
NORTH READING EXISTING WATER USE RESTRICTIONS

Town of North Reading Water Use Restrictions		
Drought Condition		Restrictions
Stage 0	Normal	Winter (October 1 - April 30) = No Restrictions.
Stage 0	Normal	▪ Summer (May 1 - September 30) = Voluntary Water Conservation.*
		▪ Outdoor water use on ODD and EVEN days between 7 PM and 7 AM.
		▪ Residents with ODD numbered addresses may water lawns on ODD numbered days.
		▪ Residents with EVEN numbered addresses may water lawns on EVEN numbered days.
Stage I	Advisory	▪ Mandatory Water Conservation.
		▪ Lawn watering restricted to two (2) times per week per Precinct between 7 PM and 7 AM as follows: Precinct 1: Monday & Thursday Precinct 2 & 3: Tuesday & Friday Precinct 4: Wednesday & Saturday
Stage II	Watch	▪ Mandatory Water Conservation.
		▪ Lawn watering restricted to one (1) time per week per Precinct between 7 PM and 10 PM as follows: Precinct 1: Monday Precinct 2 & 3: Wednesday Precinct 4: Friday
Stage III	Warning	▪ Mandatory Water Conservation.
		▪ Outdoor water use restricted to hand held hose or water can with person in attendance between 7 PM and 10 PM for irrigation of shrubs, flowers, and gardens only.
		▪ The following are prohibited: -Lawn watering; swimming pool filling; washing of cars, trucks, boats, buildings; and cleaning of driveways.
Stage IV	Emergency	▪ Mandatory Water Conservation.
		▪ No outdoor water use.
		▪ Water use restricted to normal bathing, cooking, laundry and sanitary use, or to meet the core function of a business or maintenance of livestock.

* Recommended Change as discussed in Section 3.2.1.

**TABLE 3-6
OBSERVATION FREQUENCY THROUGHOUT THE YEAR**

DATE	OBSERVATION FREQUENCY
January - April	Monthly
May- September	Weekly
October - December	Monthly

**TABLE 3-7
OBSERVATION FREQUENCY FOR EACH STAGE**

DROUGHT PHASE	PHASE TITLE	FREQUENCY
Stage 0	Normal	Monthly
Stage I	Advisory	Weekly
Stage II	Watch	Daily
Stage III	Warning	Hourly
Stage IV	Emergency	Hourly

This plan will be able to implement any drought measures already in effect and reduce the occurrences of any water shortages.

3.2.1 Recommendations to the Existing Water Use Restrictions

A review of the existing Water Use Restrictions and the Primary and Secondary triggers was performed. As previously noted in Section 2 and as shown in Tables 3-3 and 3-4, Wright-Pierce recommends changes to the primary and secondary triggers including Andover Water Use becoming a Primary Trigger and Sequential Days Over 90 Degrees becoming a Secondary Trigger. When reviewing the performance of the existing Water Use Restrictions and management of the water system through a drought event (based on historical data and the available water supply from the Town’s local sources and the interconnection with Andover), Wright-Pierce recommends the Town change “Voluntary Water Conservation” in the Summer from May 1 through September 30, during Stage 0 (Normal) Drought Condition to **“Mandatory Water Conservation”** during that said period. This would establish a mind-set with the

residents on how to use water for non-essential uses so they create habit that conforms to the conservation measures needed to manage water use during the summer. This would also help keep the water use demand within the withdrawal permits for its local sources and the existing IBTA for the Andover interconnection.

3.3 DROUGHT PLAN IMPLEMENTATION

Optimization of water use and drought management can be initiated upon being vigilant, controlling consumption, having effective public awareness, and monitoring data consistently. North Reading has established a set a stages to monitor and implement water restrictions to maintain control of the water demand along with a safety factor in order to maintain adequate water for fire protection. Water shortages may vary in degree and duration, and the Town of North Reading must be prepared for the minimum to most extreme conditions. The summer season historically experiences the most extreme water demand and drought conditions within each year. The increased temperature creates dry weather that increases the risk for fire danger and simultaneously the fire supply demand needs to be maintained for protection.

The drought plan consists of keeping a consistent monitoring of important drought indicators, as discussed in Section 3.1, then using those indicators and a set list of restrictions for each, as discussed in Section 3.2. If all steps are taken effectively and efficiently, then water shortages may not occur during drought-like conditions.

In order for the most successful implementation of the DMP, communication to the public is a critical factor along with teaching users to preserve water. For example, North Reading teaches users on their Town website how to efficiently water one's lawn. To learn more about this method and others, visit North Reading's home page at www.northreadingma.gov/Pages/NReadingMA_Water/waterright.

Water conservation techniques can be found at the following resource <http://www.mass.gov/dep/water/resources/watercon.htm#conserve>

Additionally the website <http://www.mass.gov/dcr/watersupply/rainfall/index.htm> contains useful information on monthly precipitation, composite and water conditions, precipitation trends, dry periods, high or low river flow conditions, and groundwater levels.

3.4 ADDITIONAL MEASURES

Once the drought plan is implemented, restrictions must be held otherwise additional measures may need to take place. These additional measures may include:

- Ticketing/Issuing violation notices for unauthorized water use
- House to house verbal/written warnings from police department or DPW department
- Recording water meters to ensure proper water use
- Fines and penalties
- Reverse 911 calls from Town
- Termination of water supply

It is strongly encouraged for all users to adhere to the drought management plan. All restrictions will be enforced.

3.5 COMMUNICATION

The restrictions set for each drought stage, as indicated previously in Section 3.2, need to be effectively communicated within the Town to ensure that an adequate water supply would be available for all residents and businesses. Communication is important in three phases: North Reading's residents, inter-Town, and public awareness/education.

3.5.1 North Reading Communication

Communication within the Town is an essential process. Water storage tank levels must be monitored by operators and reported back to the Water Superintendent if the levels become comparable to the drought plan trigger levels. If a trigger level is reached, the Water Superintendent will contact the DPW Director to notify them of the drought stage. The DPW will need to alert all staff and ensure that the public is informed. North Reading utilizes their homepage website to provide as an additional communication measure.

3.5.2 Inter-Town Communication

The communication between North Reading and Andover includes the Town Administrators, DPW Directors, and Water Superintendents communicating with their counterparts. Once parties are informed, the Town can respond appropriately.

3.5.3 Public Awareness and Education

Communicating and teaching the community is a vital role in the management and planning phases. Having the public aware of the dire circumstances that may occur during drought conditions can help to efficiently conserve and optimize water supply. North Reading uses multiple techniques in order to inform and teach the public such as:

- Online resources
 - Environmental Protection Agency (EPA): <http://www.epa.gov/>
 - U.S. Geological Survey (USGS): <http://ma.water.usgs.gov/drought/>
 - The Official Website of the Massachusetts Department of Environmental Protection (MassDEP): <http://www.mass.gov/dep/>
 - The Official Website of the Commonwealth of Massachusetts: <http://www.mass.gov/portal/>
 - North Reading Home Page: <http://northreadingma.gov/Pages/index>
 - National Drought Mitigation Center: <http://www.drought.unl.edu/>
 - Massachusetts Emergency Management Agency (MEMA): www.mass.gov/mema.
- Written/Digital Communication
 - Newspaper and flyers
 - Public notices and signboards strategically placed
 - Television
 - Telephone (calling and texting) (Reverse 911)
 - Mail
 - Email

Techniques (whether new or old) are always sought after, to efficiently improve the communication and awareness within the Town.

The Town also utilizes CODE RED, a system to keep residents informed in the event of emergency situation or critical community alerts. This system can also be used to notify the residents when water restrictions are in place and enforced. The Town should encourage residents to sign up for notifications through this source.

Section 4

SECTION 4

WATER USE REDUCTION MEASURES

4.1 REDUCTION STRATEGIES

North Reading has a water restriction bylaw, Section 191-6, in place to enforce measures needed to mitigate a drought condition through reduction in water use. Refer to Appendix B for the current Town of North Reading By Law for Restriction on Water Use. The goal of the bylaw is to reduce non-essential water use during a drought condition and maintaining a sufficient water supply for essential uses as well as fire protection. Drought restriction strategies will help reduce the water usage specifically in the summer period, May 1 to September 30, by controlling non-essential water uses and by planning and managing the criteria to determine and control non-essential water use early within a drought condition, gives the Town an opportunity to prolong the use of their sources when they become most critical. The town may also declare water restriction any season if it is deemed necessary to conserve the water supply during an emergency or critical failure of the water system infrastructure. It is important to note that reduction in water use in general, regardless of the drought status, is needed to maintain the water usage below the IBTA with Andover and withdrawal from local sources located within the Ipswich River Watershed within registered permitted volumes.

The strategies currently taken by the Town in regard to water restrictions have been reviewed in addition to new measures to help decrease consumption.

4.1.1 Pricing Rates

Water use during the summer months can double from the average water use for the remaining year and is attributed to outdoor water use. When reviewing goals and tools associated with drought management planning, a reduction in non-essential water use during the summer period is critical. Encouraging residents to reduce water usage during the summer, through education and standards practice is essential for a viable program. However an incentive, such as financial savings, or discouragement, through higher water rates, is needed sometimes to see results that

will mitigate water shortages. One approach to manage a sustainable water system is an increasing block rate structure for water billing. The Town of North Reading currently employs a three-tiered increasing block water rate structure as follows:

**TABLE 4-1
NORTH READING'S CURRENT (FY 14)
INCREASING BLOCK WATER RATE STRUCTURE**

TIER	WATER QUANTITY (GALLONS/QUARTER)	RATE (\$/1,000 GALLONS)
First	< 10,000	\$7.30
Second	10,001 - 22,500	\$10.70
Third	> 22,500	\$14.60

Another way to control non-essential outdoor water usage from doubling during the summer period is to meter all irrigation systems connected to the Town's water distribution system and charge a third tier rate for this non-essential use and/or a flat rate applied annually for a plumbed irrigation system.

4.1.2 Underground Sprinkler Systems

The Town's current bylaws include requirements of outdoor irrigation systems which give the Town knowledge and some control of irrigation systems connected to the public water supply. Some of the measures the Town has in place include the following:

- Registration for all outdoor irrigation systems with the Town of North Reading, DPW
- Installation of a Rain Sensing Device
- Installation of a Backflow Preventer
- Annual Inspections

Some additional measures the Town can take to reduce the usage of nonessential water include the following:

- Metering the irrigation systems separately and applying a higher rate for the use of potable water for a non-essential use.

- Educating and encouraging outdoor watering by hand held hoses between the hours of 4:00 a.m. and 6:00 a.m. when evaporation is the lowest would help mitigate a drought condition and further stress on the public water supply system.
- Banning plumbed outdoor irrigation systems connected to the public water supply.

Ultimately it is up to the Town what water conservation measures to consider, adopt and manage in regards to drought and water management.

4.1.3 Water Reduction Devices

The following are low cost devices that can be installed and retrofitted to existing fixtures that conserve on water during normal essential water uses providing a more sustainable system. The residents can be encouraged to purchase these items or the Town can consider providing them for free, with potential funding through State grants and programs, to help reduce the water demand and manage water use through a drought condition.

- Low flow showerheads (2.0 gpm)
- Faucet aerators (1.5 gpm)

Other considerations include educating the residents to look for and correct leaking fixtures that can be responsible for a large amount of household water use. According to DEP research, 8% or more of all household water use is due to leaks in the piping and fixtures within a home. Some measures for residents to consider include the following:

- Inspecting fixtures and piping (visible) for leakage or signs of leakage such as staining in ceilings and floors.
- Test for leaking toilets by adding dye to the tank and after a few minutes; look for any dye in the bowl.
- Residential water audits (to be discussed further in the following section).

4.1.4 Residential Water Audits

Residential Water Audits free of charge should be offered upon request to all residents and required for the largest 25% users of the system. Reducing water usage to the residential population, which is responsible for the most water usage as discussed in Section 2, should be a priority for the Town.

Through the audit the consumer becomes more aware of the water usage in relation to others, how much they are spending in non-essential water uses such as outdoor water use, detecting leaks within their “system” or house plumbing and appliances, and verifying whether their systems in place are water efficient and how installing “low flow” appliances/fixtures can save them money each year. It also is an opportunity to educate the public how important water conservation especially during a drought condition and how the Water Restriction in place works and enforced in Town.

4.2 PROJECTED WATER USE

Projected water use needs to be evaluated and considered when planning and managing a sustainable water system. The projected water demands are determined by assessing population growth, growth patterns in a community, and historical water-use trends. A Water Master Plan is currently being prepared for the Town of North Reading that will project water demands to year 2033. In summary, the water demands for North Reading are projected to increase based on population growth and non-residential demand even when accounting for increased conservation measures. With an increase in water demands, additional stress is placed on a system if a lack of water supply is available especially during a drought event or emergency situation.

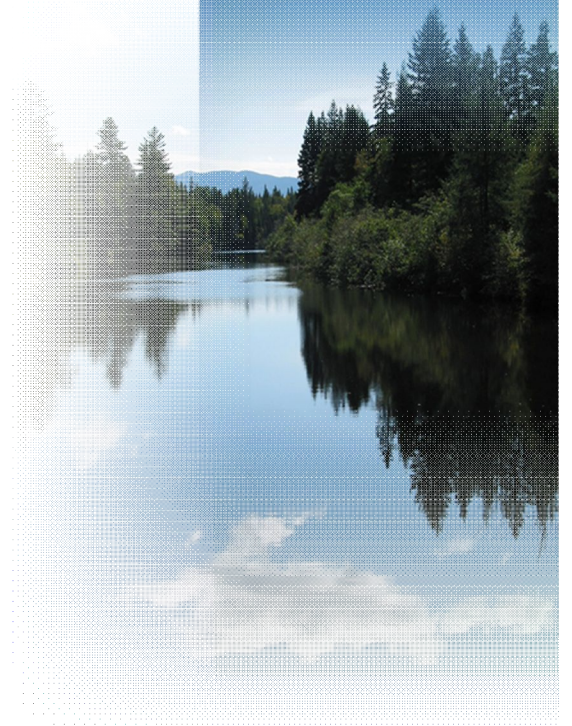
4.2.1 Supplemental Water Sources

To provide a sustainable water system for North Reading, the Town should always be considering redundancy when it comes to supply and meeting water demands of the community. The Town of North Reading currently purchases a significant portion its water supply from the Town of

Andover through two existing interconnections. The Town also maintains two emergency interconnections with the Town of Wilmington. The remaining water supply is produced from a series of Town-owned wells located in the Ipswich River basin.

North Reading is currently considering an alternative supply with the Massachusetts Water Resources Authority (MWRA) water system through an interconnection to the neighboring Town of Reading. The MWRA began developing a plan to address the lack of redundancy to this area and is currently designing a redundant pipeline that will service Reading and North Reading if they choose to pursue this connection.

APPENDIX A



Water Restriction Triggers

Trigger		Water Use Reduction Goal (%)	PRIMARY				SECONDARY			
			Average 7 Day Total Water Demand (MGD)	Tower Hill Storage Tank Capacity @ 4 AM (%)	Andover Drought Stage	Andover Water Use (MGD)	7 Day USGS Ipswich River Flow @South Middleton (CFS)	MA DCR Drought Status	MA DCR 3 Month Precipitation Deficit (In.)	Sequential Days > 90 degrees
Stage										
0	Normal	0	<1.5	>95	Normal	< 0.90	>29.8	Normal	<0.5	NA
I	Advisory	10-15	1.5-1.75	90-95	Watch	0.9-0.95	29.8	Advisory	0.5-1.5	2
II	Watch	15-25	1.75-2.0	85-90	Warning	0.95-1.0	18.7-29.8	Watch	1.5-2.5	3
III	Warning	25-40	2.0-2.25	80-85	Emergency	1.0-1.25	15.1-18.7	Warning	2.5-3.0	4
IV	Emergency	40+	>2.25	<80	Critical	>1.25	<15.1	Emergency	>3.0	5

Primary Trigger Monitoring Frequency

January-April	Monthly
May-September	Weekly
October-December	Monthly

Water Restriction Triggers

Internal Procedures

November 12, 2013

PRIMARY

These triggers have a direct correlation to North Reading Water Use Restrictions. Historically, North Reading has restricted water use days/weeks before Andover. By its water supply contract, North Reading must not have its water restrictions less than the current Andover's Drought Stage.

Average 7 Day Total Water Demand – Manually calculated by Water Superintendent based on totalizer/meter readings at 3 NR locations and the Andover Connections.

Tower Hill Water Storage at 4 AM – Manually calculated by Water Superintendent based on actual water tank level readings.

Andover Drought Stage – As noted on Andover website and/or Andover Water Department notifications to North Reading

Andover Water Use – Manually calculated by Water Superintendent based on Andover meters.

SECONDARY

These triggers are general in nature and provide regional trends.

7 Day USGS Ipswich River Flow at South Middleton Gage – Found on USGS website for this station.

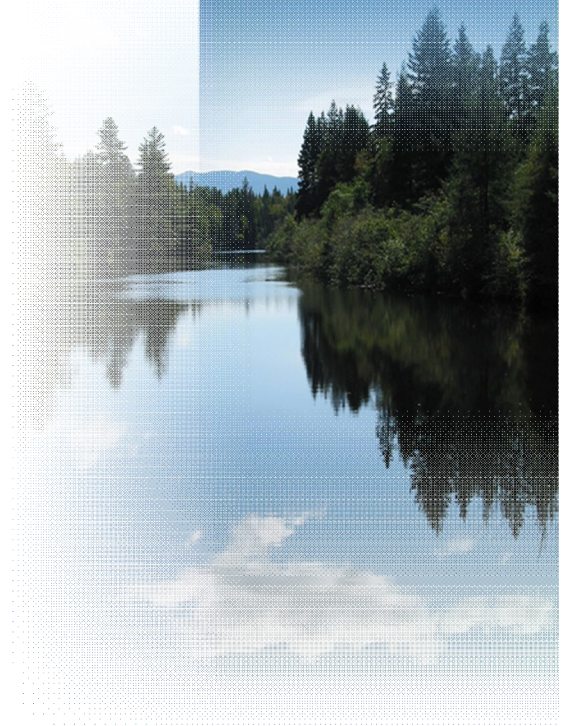
MA DCR Drought Status – Found online at MA DCR website.

MA DCR Precipitation Deficit – Found online at MA DCR website.

Sequential Days > 90 degrees – From a variety of weather reports – TV, internet, weather services, etc.

Town of North Reading Water Use Restrictions		
Drought Condition		Restrictions
Stage 0	Normal	Winter (October 1 - April 30) = No Restrictions.
Stage 0	Normal	▪ Summer (May 1 - September 30) = Mandatory Water Conservation.
		▪ Outdoor water use on ODD and EVEN days between 7 PM and 7 AM.
		▪ Residents with ODD numbered addresses may water lawns on ODD numbered days.
		▪ Residents with EVEN numbered addresses may water lawns on EVEN numbered days.
Stage I	Advisory	▪ Mandatory Water Conservation.
		▪ Lawn watering restricted to two (2) times per week per Precinct between 7 PM and 7 AM as follows: Precinct 1: Monday & Thursday Precinct 2 & 3: Tuesday & Friday Precinct 4: Wednesday & Saturday
Stage II	Watch	▪ Mandatory Water Conservation.
		▪ Lawn watering restricted to one (1) time per week per Precinct between 7 PM and 10 PM as follows: Precinct 1: Monday Precinct 2 & 3: Wednesday Precinct 4: Friday
Stage III	Warning	▪ Mandatory Water Conservation.
		▪ Outdoor water use restricted to hand held hose or water can with person in attendance between 7 PM and 10 PM for irrigation of shrubs, flowers, and gardens only.
		▪ The following are prohibited: -Lawn watering; swimming pool filling; washing of cars, trucks, boats, buildings; and cleaning of driveways.
Stage IV	Emergency	▪ Mandatory Water Conservation.
		▪ No outdoor water use.
		▪ Water use restricted to normal bathing, cooking, laundry and sanitary use, or to meet the core function of a business or maintenance of livestock.

APPENDIX B



By Law Section 191-6: Restrictions on Water Use

A. Authority.

By Law 191-6 Water Use Rules & Regulations authorizes the Board of Selectmen to adopt, and periodically amend, rules and regulations relating to the procedures and administration of Chapter 191, Article II after public notice and a public hearing.

B. Restrictions on Water Use

- (1). A declaration of a State of Water Supply Conservation shall include one or more of the restrictions, conditions, or requirements found in the table titled "Town of North Reading Water Use Restrictions" to limit the use of water as necessary to provide an adequate supply of water for domestic and fire fighting use.
- (2). The Board of Selectmen may require additional water use limitations above those found in B.(1). in case of emergencies such as disasters or critical infrastructure failure.

C. Normal Conditions

- (1). The Normal condition in the table titled "Town of North Reading Water Use Restrictions" shall be in effect year round, unless there is a declaration of a State of Water Supply Conservation.
- (2). During the winter period (October 1 to April 30) there are no water restrictions.
- (3). During the summer period (May 1 to September 30) outdoor water use is on an Odd and Even day schedule from 7 PM to 7 AM. Residents with Odd numbered addresses may water lawns on Odd numbered days. Residents with Even numbered addresses may water lawns on Even numbered days.

D. Outdoor Irrigations Systems

- (1). Outdoor water use is a significant source of consumption for North Reading public water supply system. Lawn irrigation systems are a high percent of this water use. Established lawns only need 1 inch of water per week. Overwatering actually creates a weak grass plant with shallow roots that cannot tolerate drought or pests. The use of rain gauges and/or soil moisture sensors are recommended to assist homeowners to minimize water use.
- (2). In order to prevent excessive outside water use, all outdoor irrigation systems connected to the Town of North Reading public water supply shall be equipped with a rain sensing device, approved by the North Reading Department of Public Works, so that watering will be automatically prevented during rain storms.
- (3). All irrigation systems connected to the public water supply shall also have a backflow prevention device, approved by the Plumbing Inspector, to prevent the introduction of contaminants into the public water supply. Each device shall be installed in accordance with Massachusetts General Law and the manufacturer's instructions. Each device shall be tested upon its installation and annually thereafter in accordance with Massachusetts General Law.

By Law Section 191-6: Restrictions on Water Use

- (4). All outdoor irrigations systems not connected to the Town of North Reading public water supply should also be equipped with a rain sensing device so that watering will be automatically prevented during rain storms. This benefits the customer as it reduces pump energy use & cost; and reduces withdrawals from the Ipswich River basin. A backflow prevention device should also be installed to protect the health and safety of residents using the non public water supply.
- (5). Annually, the owners of all outdoor irrigations systems connected to the public water supply shall inspect their system and make repairs or adjustments as necessary in order to reduce water use. Broken pipes or leaks shall be repaired; damaged or tilted sprinkler heads shall be repaired or adjusted; and any other source of water waste shall be corrected. Rain gauges and backflow prevention devices shall be checked to ensure good working condition. The same annual inspection and repair is recommended for irrigation systems not connected to the public water supply.
- (6). All outdoor irrigations systems, whether connected to the public water supply or not, shall be registered with the Department of Public Works.
- (7) All outdoor irrigations systems not connected to the Town of North Reading public water supply shall have a sign at the property front indicating "private well water". The standard sign shall be the type manufactured for the DPW & will be sold to residents at cost.

E. Exemptions.

Persons seeking an exemption from the requirements of section 191-6 are required to make application to the Town of North Reading Department of Public Works in Town Hall.

