LONG RANGE WATER SUPPLY PLANNING
TOPICS FOR CONSIDERATION II

Planning and Coordination Department
Massachusetts Water Resources Authority
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Long Range Water Supply Planning - Topics for Consideration II

Executive Summary

This briefing paper addresses the environmental, economic, and statutory and admission process considerations involved in the potential expansion of the MWRA water system to new member communities. The paper also addresses questions raised by WSCAC staff related to MWRA's analysis of reservoir "safe yield." Staff's approach to each topic area[1] and key findings are summarized below. A list of sources used in the preparation of this report is attached.

Topic 1, *Environmental Considerations in System Expansion*, focuses on both the receiving basins in which MWRA staff have identified potentially water-short communities and the MWRA donor basins.

Based on a number of considerations, MWRA has identified seventeen potentially water-short communities that are not currently pursuing admission to MWRA and that are in the Ipswich River, Upper Charles River, Boston Harbor, and the SUASCO (Sudbury, Assabet and Concord) River basins. These watersheds abut, and in some cases, overlap the MWRA's water service area. MWRA's study area also included the Nashua and Chicopee River Basins where five additional communities with potential water deficits due to quantity and quality concerns were identified. The identification of these 22 communities, though, in no way means that all these communities have expressed interest in MWRA and would be added to the system.

The United States Geological Survey (USGS) reports that streamflow largely consists of baseflow derived from adjacent aquifers and releases from surface water storage, and that in the summer months, recharge to Massachusetts aquifers is generally limited. Most of the potentially water-short communities in the above noted basins derive part or all of their water supply from ground water sources, where there is often little storage. As a result, naturally occurring seasonal low river flows are exacerbated by summer water supply withdrawals. This condition is contrasted with that existing in the MWRA's water system, in which multi-year reservoirs capture spring flows to support summer withdrawals; the amount of MWRA reservoir storage is also sufficient to dampen year-to-year variations in precipitation that might otherwise strain local resources.

Findings of the Receiving Basin section include:

[1] The paper was principally written by Pamela Heidell, Policy and Planning Manager, with review and assistance from MWRA staff in Planning, Operations, and Finance. MWRA's General Counsel, Steven Remsberg, addressed Topic 3, Legal Considerations.. Topic 5, An Examination of Reservoir Performance During Drought, was prepared by Daniel Nvule and Stephen Estes-Smargiassi. Findings of this report and the earlier staff report were presented in Powerpoint presentations to watershed associations, the Conservation Law Foundation, the Metropolitan Area Planning Council, and at a Pioneer Institute Forum.

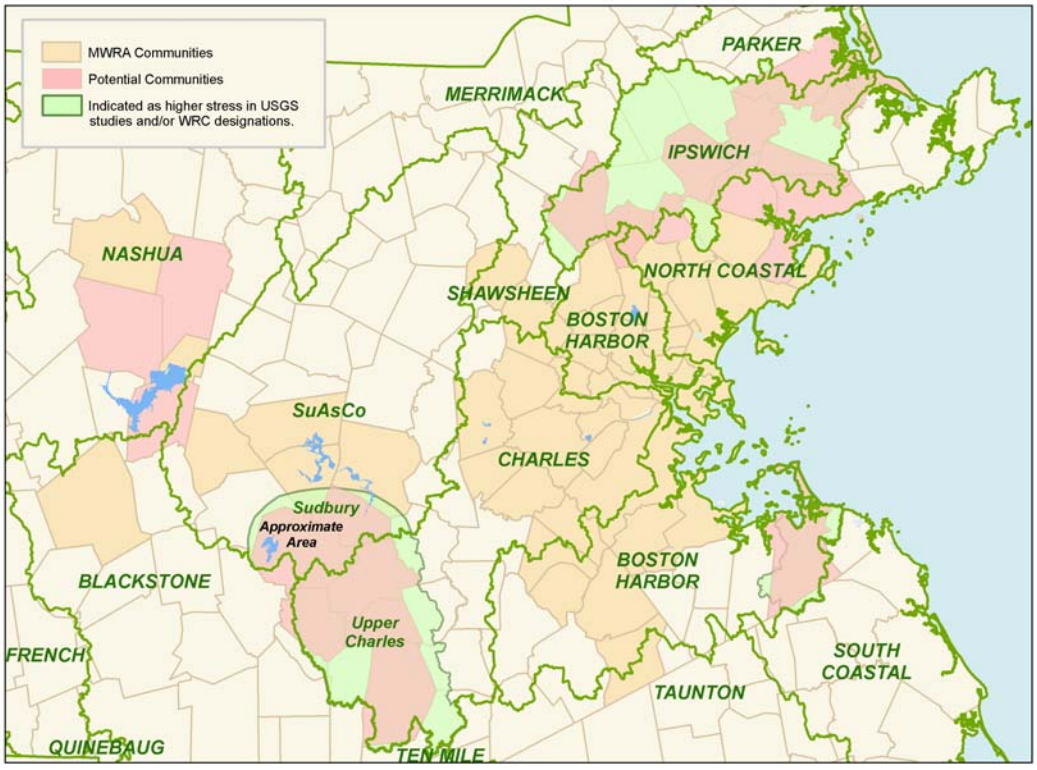
- Detailed water quantity and quality studies conducted by the USGS, Watershed Teams in the Commonwealth's Executive Office of Environmental Affairs (EOEA), and various watershed groups consistently document that withdrawals of groundwater in certain river basins, or portions of river basins, substantially decrease low flows and, in areas such as the Upper Charles and Ipswich River Basins, out-of-basin or downstream transfers of wastewater further decrease natural recharge and contribute to stream flow depletion. In addition, decreased natural recharge from changes in land use also stress water resources.

- Staff's estimate that 10 mgd is the potential demand from MWRA by the 22 communities not currently and actively pursuing admission to MWRA that are within reasonable proximity to the MWRA water service area that have or may face water deficits. This estimate takes into account projected population and employment growth. In identifying communities, MWRA considered river stress, the location of water withdrawals with respect to headwaters and other documented water resource constraints, e.g., current demand close to or exceeding Water Management Act withdrawal limits, identified need for new sources, difficulty in permitting wells, concern with ground water quality, and other considerations. Initially, MWRA staff looked at a larger number of communities but based on further analysis, eliminated some due to factors such as distance and isolation from the MWRA distribution system or source reservoirs, or technical difficulties in providing service.

- Most of the projected water-short communities appear to be already conserving, based on information on conservation indices that the communities reported to DEP. For example, 12 of the 22 communities have a residential gallons per capita per day (rgpcd) of less than 65 rgpcd, DEP's performance standard for Water Management Permits in high stress basins and WRC's performance standard for interbasin transfers. Another 5 communities are very close, with an rgpcd of 70 or less. While there may be room for improvement in conservation practices, reasonable conservation measures alone may not fully address supply shortfalls due to projected growth or other goals to reduce withdrawals from streamside wells

The Receiving Basin section concludes that it is quite possible that given the location of growth and the nature of water withdrawals, concerns over low flow and river stress will persist, even where conservation is practiced. Staff therefore recommend the consideration of regional water management approaches that coordinate the use of surface and groundwater supplies where practical to enable communities to reduce groundwater withdrawals from existing wells near streams in summer or, in the case of surface sources that divert river flow, permit the communities to meet demands that might not otherwise be met due to withdrawal restrictions. Such regional water management approaches might also eliminate the need to construct additional wells in stressed basins. Toward this end, staff recommends that studies being conducted by the USGS for DEP and by the Charles River Association for the EOEA expand the scope of ongoing study efforts to include a timely examination of how MWRA's supply of water to the potential river basins and communities identified might beneficially affect streamflows in the river basins.

The location of the existing MWRA water service area with respect to potential communities for system expansion and with respect to river basins, or portions of river basins, of concern is illustrated in the Figure below.



The Donor Basin section discusses MWRA's controlled discharges from the Quabbin Reservoir to the Swift River and the Wachusett Reservoirs to Nashua Rivers, as well as withdrawals from the Ware River. Discharges include statutorily required minimum releases, additional releases made for flood control and water quality management, and spills over the dams when the reservoirs are full. Varying levels of water demand have not impacted MWRA's controlled discharges to the Swift and Nashua Rivers to meet statutorily and regulatory required releases of approximately 31 mgd.

Key findings of the Donor Basin section include:

- The provision of water to new communities would not adversely affect MWRA's ability to meet its statutorily required minimum releases or its ability to supplement those releases with some incremental volumes.

- Because the primary purpose of the Quabbin and Wachusett Reservoirs is water supply, the river stretches below these impoundments do not reflect natural flow regimes. While the value of the Swift River as a cold water fishery has been documented by EOEA and DEP and has been extolled by area fishermen, the Massachusetts Division of Fisheries and Wildlife is concerned with the current pattern of MWRA discharges to the Swift River, which runs counter to natural flow regimes.

- Adverse Ware River water quality issues that coincide with low streamflow measurements, as well as recreation issues due to fecal coliform counts (even in dry weather), are unrelated to MWRA withdrawals.

- Since 2003, MWRA discharges to the Nashua have well exceeded the minimum requirements, particularly in late spring and summer.

The Massachusetts Division of Fisheries and Wildlife and MWRA have had informal discussions regarding improving flows in the Swift, Ware and Nashua Rivers. At this time, no specific target flows for fish communities have been identified. Future discussions between EOEA, Fisheries and Wildlife, and MWRA to discuss management practices and potential opportunities to enhance resource protections are needed to address this complex issue. Fisheries and Wildlife suggests that further study of the Swift, Nashua and Ware Rivers is required to determine opportunities to enhance resources below the dams.

Topic 2, ***Economic Considerations in System Expansion***, describes the cost implications for a new community of joining the MWRA waterworks systems and the impact on existing member communities. MWRA Operating Policy #10 (OP#10), Admission of New Community to Waterworks System, requires that an applicant must pay all connection costs. In addition, a new community must pay an entrance fee which reflects its proportional share of the waterworks system's asset value at the time of joining, based on the community's average annual daily demand relative to the system's total average daily demand.

Hydraulic analyses are conducted as part of the consideration of a new community's request to join the MWRA system to ensure that the MWRA system can meet the demands of existing user communities, as well as the new community. If a new pipeline and/or facility is needed to provide service to a new community and the assets would also benefit existing users, OP#10 requires that the capital expense of such assets be appropriately apportioned between new and existing users.

In total, the incremental demand due to employment and population growth in the 22 identified communities with potential water deficits is approximately 10 mgd, less that 5 percent of 2005 system demand. Given the current regulatory processes for approval, only a handful of communities at most can be anticipated to join the system in any given year. Moreover, since the demand is spread out over many communities and multiple water service areas (pressure zones), the economic impact analysis is not straightforward. Nonetheless, some conclusions regarding economic effects in FY07 and beyond can be drawn.

- MWRA revenue: Each additional 1 mgd of service to a new community would provide one-time revenue to MWRA of $5.2 million, assuming payment is made in a lump sum. MWRA would use this revenue for capital-related expenditures and/or to pay existing debt.

- MWRA operating costs: Hypothetically speaking, if all 22 communities jointed the system next year, MWRA's annual operating costs would increase by less than $1

million, primarily due to the increased need for MWRA laboratory services, chemicals, and electricity.

- Rate relief benefits to existing members: Fifty existing member water communities would see their annual water assessments lowered next year because the rate base would hypothetically include the additional 22 communities. The impact of lower assessments to current members in FY07 would be a savings of approximately $7 million and would recur annually.

- Service to a new community would not in itself require MWRA to construct new infrastructure.

Topic 3, *Legal Considerations in System Expansion,* describes the statutory basis for MWRA water system expansion.

Key findings of this section include:

- Statutes enacted as early as 1895 that now allow MWRA, as the successor to MDC, to exercise the rights to use the waters of the Swift, Ware and Nashua rivers for water supply (and which also spell out minimum releases to be made to maintain stream flows) were enacted to accommodate service area expansion.

- MWRA's 1984 enabling act expressly provided for the eventuality of "new communities entering the system", dedicating section 8(d) to the subject of expansion.

- Communities eligible for admission may include watershed and non-watershed communities alike. Other than the watershed communities that MWRA already provides water to, or which already withdraw raw water from the reservoir (Clinton), MWRA is under no obligation to "reserve" quantities of water for any specific non-member community whether or not in close proximity to the service area.

- Suggestions by some that the provisions of chapter 575 of the Acts of 1947 mandate that any community that might fairly be regarded as "in and near to the Chicopee River Valley or its tributaries" may have some legislative "reservation" to be admitted to the MWRA system appear to have no legal basis.

The inclusion in MWRA's enabling act of sections 8(c) and 8(d) relative to admission criteria and approvals for expansion of the Authority's water supply and wastewater service areas is irrefutable evidence that the intent of the Legislature that those services areas were not intended to be static and fixed but rather were intended to grow as the need of Massachusetts communities warranted. The fact that one admission criteria regarding water supply deals expressly with the concept of safe yield clearly indicates a legislative intent to protect the water supply needs of the original service areas, to protect the water supplies of the Commonwealth as a natural resource of the state as a whole, and to allow for expansion and use of that natural resource under the conditions set forth in the enabling act. It is believed that The MWRA's expansion policy accommodates both of these intentions.

Topic 4, *Admissions Process Considerations for New Communities,* discusses process and timeframes.

MWRA's Board of Directors can approve admission of a new community or other local body to the MWRA system as long as the community demonstrates that it has satisfied all of the admission prerequisites specified in Section 8(d) of the enabling act, including obtaining the approvals of EOEA regulatory agencies with jurisdiction, the Legislature, the Governor and the MWRA Advisory Board. MWRA's Board must also find that six specific considerations related to system safe yield, local sources, local water management planning, and local demand management and water use, have been met. These requirements are codified in MWRA Operating Policy 10 (OP#10), Admission of New Community to Waterworks System, revised, November 2002. Since its inception, MWRA has approved the admission of Bedford, Stoughton, Reading, and the Dedham-Westwood Water District to the water system.

Key findings of this section include:

- With the exception of one community, Bedford, which took one year, MWRA's portion of the approval process ranged between 1 and 3 months.

- The process of meeting all approval requirements ranged from 14 months for Dedham/Westwood (which did not require Interbasin Transfer Act approval) to 4.5 years for Reading. Wilmington, which is expected to seek MWRA approval once other approvals are in place, is approaching the 5-year anniversary of its MEPA ENF certification.

- MWRA's standards for consideration of a new community are very similar in scope to MEPA and WRC requirements (there is a joint scope for EIR/ITA review).

- The process for admission to MWRA requires that communities adopt and maintain conservation programs. A host of approvals are required prior to application to MWRA, and conditions of these approvals, as well as MWRA's requirements, ensure that conservation, leak detection and repair, public education, and best management practices remain in place.

Topic 5, *Considerations in Water System Management during Drought,* is addressed in Attachment 1. This section includes a description of other measures, in addition to safe yield, of MWRA water system performance during drought.

Six measures – Safe Yield, Supply Shortfall, Severity, Maximum Pool Descent, Resiliency, and Drought Actions - were developed as part of the 1994 Army Corps of Engineers' *National Study of Water Management During Drought*. Over a range of demands up to 300 mgd, increasing demand shows insignificant impacts on all measures except possibly Drought Response Actions. All analyses assume full compliance with all required downstream releases to the Swift, Ware, and Nashua Rivers, and a continuation of current system operating practices.

If a drought as severe as that experienced in the entire eastern seaboard in the 1960s were to occur again, communities and individuals could be expected to take voluntary and mandated efforts to conserve. This could occur at any given demand over current levels. Based on the modeling, no drought response actions could be required for less severe droughts.

Topic 1 - Environmental Considerations in System Expansion

"By properly coordinating the use of surface and groundwater supplies, optimum regional water resource development seems most likely to be assured.[2]"

MWRA concentrated its survey of potentially water short communities in the Ipswich River, Upper Charles River, Boston Harbor Basin, and SUASCO (Assabet, Concord, Sudbury) river basin. These are the primary watersheds that abut, and in some cases, overlap the MWRA's water service area; they are also areas where current and protected water shortages have been identified and are areas where and stressed watersheds and sub-watersheds have been identified through detailed studies. MWRA's study also encompassed areas of the Nashua and Chicopee River Basins.

A few of the communities investigated have surface water withdrawals, but most of them derive their water supply from ground water sources. None have the benefit of large multi-year reservoirs like the MWRA system, where spring flows are captured to support summer withdrawals, and where the amount of storage is sufficient to dampen year- to year variation in precipitation that might otherwise strain water resources.

Between mid-May and early October (growing season for deciduous trees and other plants) recharge to Massachusetts's aquifers is generally limited. Streamflows largely consist of baseflow derived from adjacent aquifers and releases from surface water storage. In basins where available storage is small (e.g., headwaters largely underlain by glacial till) natural streamflows can decline to very low levels by late summers. This naturally occurring seasonal low flow, in conjunction with water supply demands and other effects of urbanization, has created severe shortages of stream flow in some river basins. Source: USGS, Development of A Safe Yield Estimator Application for Massachusetts Basins).

Optimization of MWRA's large surface storage reservoirs is a resource that can be used to meet new demands as well as to help alleviate low flow conditions by reducing summer withdrawals in stressed river basins (see text box above). MWRA water could be supplied without adverse impact to the MWRA system and donor basins, due to decreasing demand in the existing MWRA service area. Both the receiving and donor basins are addressed below.

The Receiving Basins

Detailed studies by USGS, EOEA Watershed Teams, and Watershed Groups have characterized water quantity and quality issues in river basins at the periphery of the MWRA service area. Highlights of these studies are summarized below, with further information on each river basin provided in Attachment 2:

- In the **Ipswich**, the effects of water withdrawals on stream flow were examined for the 1989-93 calibration period by comparing simulations with (1) actual withdraws. (2) no withdrawals, 3) stopping only groundwater withdrawals, (4) stopping only surface withdrawals. Simulation results indicate that the cumulative withdrawals of ground water in the Ipswich River Basin substantially decrease low flows[3]. According to the

[2] Introduction to Hydrology, Warren Viessman

[3] USGS, Effects of Water Withdrawals on Stream flow in the Ipswich River Basin.

hydrologic modeling conducted by USGS, the management options needed to restore natural flow to the river to alleviate summer low flow conditions consistently would require 5-6 million gallons per day (Mgd) of water to be added to the headwater reaches[4].

- In the **Upper Charles River** Basin, water is withdrawn for public water supply from over 30 wells in stratified aquifers in close connection with surface waters, and increased water withdrawals, combined with out-of basin or downstream transfers of wastewater and decreased natural recharge from changes in land use, contribute to stream flow depletion.[5] Stream flow depletion and altered pond levels already are problems in several areas. …In September, withdrawals [for water supply] are 35% of average recharge.[6] Some management approaches to reduce adverse effects of stream flow withdrawals have previously been investigated by USGS; findings suggest that joint management of sources between towns – e.g., reductions in the use of wells nearest the rivers and streams in the summer months, along with increased pumping from wells furthest from streams -- could improve streamflow conditions[7]. Collaborative management of ground water and surface water sources would be an extension on this theme.

- The Boston Harbor South Basin includes Neponset, Weymouth, and Weir Rivers. In the **Weir River Basin**, water withdrawals and development have significantly reduced streamflow in the summer – water resources of the Weir River watershed are taxed in terms of both their capacity to provide a stable public water supply and their ability to maintain adequate habitat for aquatic life.[8] In 2005, the Weir River was classified as a high stress river by the Water Resources Commission. Regarding the Neponset River, studies have noted that water supply, interbasin transfer, and inflow/infiltration have had a significant impact on instream flow levels[9].

- A water balance for the **SUASCO** River basin is currently being developed by the USGS, and based on the findings to date, there is clearly impact from water supply withdrawals in the headwaters of the Sudbury River up gradient of the Central Street dam in Framingham[10]. A low-flow inventory in the watershed has also documented water quantity issues in specific stretches of the Sudbury watershed above the dam, attributing low flows to drought conditions as well as numerous groundwater wells.

In some areas adjacent to the MWRA water service area, higher population densities and higher stress waters converge. And even more growth is projected in some headwater areas where groundwater is the source of water supply. The MetroWest growth corridor around

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[4] Horsley and Witten, Ipswich River Watershed Management Plan
[5] USGS, Simulation of Ground-Water Flow and Evaluation of Water Management Alternatives in the Upper Charles River Basin
[6] USGS, Simulation of Ground-Water Flow and Evaluation of Water Management Alternatives in the Upper Charles River Basin
[7] USGS, Simulation of Ground-Water Flow and Evaluation of Water Management Alternatives in the Upper Charles River Basin
[8] Weir River Water Budget
[9] EOEA and Neponset River Watershed Association, Boston Harbor South Watersheds 2004 Assessment
[10] Personal communication, Steven Garabedian USGS

I-495, a fast growing area of the state, cuts a wide swath through the Concord/Assabet/Sudbury and Charles River Basins. Ashland and Hopkinton lie in the headwaters of the Sudbury River; Holliston and Medway in the Upper Charles. Similarly, Wilmington, in the Ipswich River headwaters, is part of the I-93 growth center that MAPC projects will witness high employment growth. As a result, it is not just the demands of an existing population that must be planned for.

*Massachusetts now ranks third among States in population density, and is presently experiencing high rates of suburban growth in the eastern and central regions (e.g., the I-495 corridor), and in portions of the Connecticut River Valley. Opportunities for development of new surface water reservoirs are limited, and the most favorable sites for new groundwater supplies are generally located in sand and gravel valley aquifers in close hydraulic connection with natural streams, lakes and wetlands. (*Source USGS: USGS, Development of A Safe Yield Estimator Application for Massachusetts Basins).

MWRA identified a number of communities in eastern Massachusetts and a handful elsewhere that may have water deficits now or in the future and that were within reasonable proximity to MWRA infrastructure and that could potentially consider MWRA as an option to supplement their local sources. The following factors were considered (not all the factors, though, apply to any one community identified).

- Communities are approaching, or may have already exceeded their allowed Water Management Act withdrawals;
- Communities have identified a need for additional water supply, and based on available information to MWRA, they are experiencing difficulty in finding, permitting it, or developing it;
- Communities whose ground water sources are in headwaters, where the environmental effects of water supply withdrawals can be significant;
- Communities are located in river basins or sub-basins that are among the higher stressed waters in the state;
- Communities export wastewater out of basin (and not just to MWRA, although some of the communities, such as Hingham Sewer District, Ashland, and Lancaster are already part of the MWRA sewer district); and imported water to balance outflows could reduce the duration of low flow periods; and/or
- Communities may have concerns with ground water quality issues.

Communities In proximity to MWRA that may have water deficits now or in the future ∗

Boston Harbor South
Hingham/Hull
Sharon

Ipswich River Basin
Salem/Beverly
Ipswich
Wenham
Topsfield
Danvers/Middleton
Lynnfield Center W.D.

Upper Charles
Franklin
Holliston
Medway
Milford

SUASCO
Ashland
Hopkinton

Nashua
Boylston
Lancaster
Sterling
West Boylston

Connecticut
South Hadley Fire District #2

∗List does not include communities that are actively pursuing admission to MWRA

For each of the communities, background information is included in Table 1. The table addresses water resource and supply features, and also contains information about projected growth. Among other things, Table 1 documents water resource concerns regarding the communities' current withdrawals, the status of efforts to develop new sources, and additional water needs solely due to projected growth and employment.

Initially, a much larger number of communities were investigated by MWRA; many communities, though, were dismissed due to factors such as distance and isolation from the MWRA distribution system or source reservoirs or obvious technical difficulties in providing service[11]. Also considered highly was the potential for reasonable conservation measures to allow the communities to fully address their shortfalls. As a result, the majority of the communities that remained and that were identified as those that may have deficits now or in the future are already conserving, as shown it Table 2. For these communities, it is quite possible that given the location of growth and the nature of water withdrawals, concerns over low flow and river stress will persist, even where conservation is practiced.

Therefore, consideration of regional water management approaches where practical makes sense. It could enable a community to reduce groundwater withdrawals from existing wells near streams in the summer, or in the case of surface sources that divert river flow, permit the community to meet demands that might not otherwise be met due to withdrawal restrictions. It could also eliminate the need to develop additional sources.

Table 2
Conservation Indices

Community	Conservation Indices	
	Residential Per Capita	Unaccounted For Water
Hingham/Hull*	24	51
Sharon	63	14
Abington/Rockland	64	10
Salem/Beverly	69	8
Ipswich	52	7
Wenham	72	14
Topsfield	53	7
Danvers/Middleton	56	7
Lynnfield Center	67	9
Franklin	64	7
Holliston	72	15
Medway	60	11
Milford	63	21
Ashland	77	37
Hopkinton	75	14
Boylston	49	18
Lancaster	67	21
West Boylston	68	20
Sterling	77	15
South Hadley Fire District 2	63	9

*Data suspect

Source: DEP MADEP Water Management Statistics 2004, provided by Duane LeVangie, DEP

[11]Communities like Barre in the Chicopee Watershed were considered but dismissed due to difficulty of access to MWRA water (e.g., for Barre, tapping into an MWRA shaft is not a practical option).

TABLE 1
Communities Which May Have Water Deficits Now or in the Future (as identified by MWRA)
And That Are Not Currently Pursuing Admission to MWRA

River Basin/ River	Community	Projected Growth 2030 and new water demand[1]	Water Source	WRC Stress Class[2]	Water Resource Features[3]
Boston Harbor South					
Weymouth /Weir	Hingham/ Hull	6705 (population) + 1748 (employment) = .48 - .63 mgd new demand Note: Aquarion is pursuing a new well to meet a higher demand (1.3 mgd)	Wells	High (Weir River Basin)	-2004 water demand was within .06 of their authorized WMA withdrawal. -Need for new sources previously identified. Aquarion Water Co. (supplies Hingham/Hull) has begun MEPA process to permit a new 1.3 mgd well in the Weir River Basin; Hull is exploring desalinization). Outstanding questions regarding these options. -Hingham North Sewer District part of MWRA sewer service area; MWRA water to Hingham would better balance wastewater exported to DITP.
Neponset	Sharon	2208 (population) + 427 (employment) = 0.1 -0.2 mgd new demand	Wells	Medium	-Sharon has made informal inquiry to MWRA re: emergency connection. -Per Sharon's Source Water Assessment Report, existing wells are highly susceptible to contamination. -Sharon is exploring development of additional wells. -2004 withdrawal in Neponset Basin exceeded WMA authorized withdrawal (some additional margin, though, in Taunton River Basin wells)

[1] New demand was calculated as follows. Projections for population and employment growth were obtained by MAPC and Pioneer Valley Planning Council where available. Per capita for each new resident was assumed to be 65 gallons per capita per day; per capita for new employees was assumed to be 34 gallons per capita per day (based on the assumption that the nature of employment growth was a similar mix as that found in the MWRA service area. The average demand forms the lower of the two numbers provided; the higher number represents a small margin for unaccounted for water and peak demand (which is particular relevant in predominantly groundwater supplied systems).
[2] Based on Water Resources Commission's interim report "Stressed Basins in Massachusetts"
[3] Information derived from variety of sources: DEP Water Management Statistics provided by Duane LeVangie, MEPA files, community web sites, CCR reports, personal communications, DEP's list of projects in New Source Approval Stage, provided by Thomas Lamontte; Source Water Assessment Reports, EOEA Water Assets Project..

River Basin/ River	Community	Projected Growth 2030 and new water demand[1]	Water Source	WRC Stress Class[2]	Water Resource Features[3]
Ipswich River Basin					
	Salem/ Beverly	7958 (population) + 1177 (employment) = .56 - .75 mgd new demand	Surface	High	-Based on USGS simulations, DEP restrictions on water withdrawals would result in water shortages in 4 of 35 years under existing demand. - Development of new reservoir has been discussed - DEP already considers Ipswich over-allocated.
	Ipswich	1313 (population) + 416 (employment) = 0.1-0.2 new demand	Wells Surface	High	-Water sources in two basins – Parker and Ipswich; DEP already considers Ipwich over-allocated. -2004 withdrawals exceeded WMA authorized limits in Ipswich (and approached WMA limits in Parker River Basin).
	Wenham	894 (population0 + 233 (employment) = 0.1 mgd new demand	Wells	High	-DEP considers Ipswich over-allocated. -2004 withdrawal approached WMA authorized limit (within .08 mgd)
	Topsfield	606 (population) + 538 (employment) = .1 new demand	Wells		-DEP considers Ipswich over-allocated. -Pump test for new source approval completed in 2000 and is under review by DEP.
	Danvers/ Middleton	Middleton growth highlighted by MAPC. 6812 (population) + 4449 (employment) = .6 -.8 mgd new demand.	Ground/ Surface	High	-A replacement well is in new source approval stage, but has not been approved. -DEP considers Ipswich over-allocated.
	Lynnfield Center	MAPC growth projections may be underestimated, based on number of proposed projects (including 40B)	Wells	High	-DEP considers Ipswich over-allocated. -Town is feeling water pressures and is now denying permits for some new developments unless DEP WMA allowed limits are raised; permit limits have been appealed.

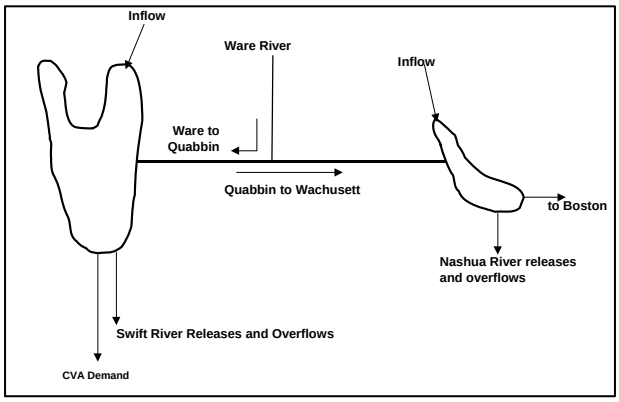
River Basin/ River	Community	Projected Growth 2030 and new water demand[1]	Water Source	WRC Stress Class[2]	Water Resource Features[3]
Upper Charles River Basin					
	Franklin	,6070 (population) + 2,842 (employment) = .5 - .7 mgd new demand	wells	Medium - WRC assessed	-Stratified glacial aquifers along Mine Brook in Franklinare considered stressed by withdrawals from municipal water supplies. - New source approval process for new well in Populatic Ave area was began, but not completed.
	Holliston	2277 (population) – slight decline in employment = .17 – .22 mgd new demand	Wells	Medium – WRC assessed mainstem, though, not headwaters	-New well proposed in headwaters of Charles. Final Report under New Source Approval Process completed in 1996. -2004 withdrawal within .27 mgd of WMA authorized withdrawal.
	Medway	1674(population) + 334 (employment) = .1-.2 mgd new demand	Wells	Medium – WRC assessed mainstem, though, not headwaters	-Town is planning new sources in headwaters of Charles(.43 mgd). Pump Test completed in 2000 and is under review by DEP. -2004 demand approached WMA authorized withdrawal (within .08 mgd of limit).
	Milford	3502 (population) + 227 (employment) = .24-.31 mgd new demand	Surface/ Wells	Medium – WRC assessed mainstem, though, not headwaters	-Recent WMA permit has restrictions that may be problematic. -Milford Water Company has expressed interest in MWRA, indicating efforts with Hopkinton to develop new well have met with limited success
SUASCO:					
Sudbury	Ashland	I-495 Growth Corridor Increase populaton and employment = .37 - .5 mgd new demand Note: Ashland is pursuing a new well to meet a	Wells	Medium	-2004 water demand/withdrawal approached WMA authorized withdrawal limit (within .05) -Town has begun MEPA process to develop new well of .864mgd. Purportedly issues associated with well development, and effects on nearby surface waters. Wells adjacent to Hopkinton Reservoir. -Ashland part of MWRA sewer service area; MWRA water to Ashland would better balance town's wastewater exported to DITP.

River Basin/ River	Community	Projected Growth 2030 and new water demand[1]	Water Source	WRC Stress Class[2]	Water Resource Features[3]
		higher demand			
	Hopkinton	I-495/Metro-West Growth Corridor 2,255 (population) + 2,231(employment) = 0.2 - 0.3 mgd average increase Note: Hopkinton is pursuing a new well to meet a higher demand	Wells	Medium	-Hopkinton is reportedly planning new sources (.77 mgd); its CCR indicates that permit from state has not been issued. - Letter from Milford Water Co. to MWRA indicates efforts with Hopkinton to develop new well have met with limited success. -2004 withdrawal within .12 of WMA authorized withdrawal
Nashua					
	Boylston		Wells	Medium?	2004 withdrawal was at WMA authorized limit.
	Lancaster	1328 (population) + 420 (employment) = .1-.2 mgd new demand	Wells	Medium	-Town planning new sources, but water quality concerns have emerged; new source approval process has not begun in earnest. -2004 withdrawal exceeded WMA authorized limit by .19 mgd.
	Sterling		Wells	Meium	-2004 withdrawal approached WMA authorized limit (was within .04 mgd) -Water Assets study indicates planning new sources,
	West Boylston		Wells	Medium	2004 withdrawal exceeded WMA authorized limit by .10 mgd. -interconnections with Worcester
Connecticut	South Hadley Fire District #2	Fast growing.	Wells	Unassessed-Low	-Some consideration to merging South Hadley Fire District #1 (now MWRA) with Fire District #2 previously studied. -2004 withdrawal within .24 of WMA limit.

When communities join MWRA, they have responsibility to implement and maintain conservation programs. A host of approvals are required prior to application to MWRA, and conditions of these approvals, in addition to MWRA's requirements would ensure that conservation, leak detection programs, and best management practices remain in place – this is addressed in a later section of this report (the process for admission to MWRA). The need for MEPA review, prior to application to MWRA, also means that the environmental impacts, both positive and negative, of additional water to a community and consistency with various state, regional, and local plans are evaluated.

The Donor Basins

The statutes that grant MWRA the rights to use of the waters of the Swift, Ware and Nashua rivers for water supply also spell out minimum releases to be made to maintain stream flows. Controlled discharges from the Quabbin and Wachusett Reservoirs are largely limited to statutorily and permit required minimum releases, except for releases indirectly resulting from transfers for water quality reasons or flood control. Historically, varying levels of water demand has had no impact on MWRA's controlled discharges to the Swift and Nashua Rivers. The additional demand that new communities would exert on the MWRA system is small in relation to the 300 mgd safe yield of the system, and in relation to the decrease in demand that has already occurred (approximately 100 mgd decrease) in the MWRA service area. Providing water to new communities at the magnitude being discussed – approximately 10-15 mgd including communities identified here as well as those that have began the regulatory process for admission to MWRA[12] - would not adversely affect MWRA's ability to meet its statutorily required minimum releases, or its ability to supplement those releases with some incremental volume.



Obviously, the construction of the Quabbin and Wachusett Reservoirs resulted in alteration of the timing and magnitude of flows in the Swift River and Nashua River watersheds. Due to the impoundments' primary purpose as water supply, the river stretches below the impoundments do not reflect natural flow regimes. Spring flows may be lower than flows in colonial times before development or even before Quabbin Reservoir was created, but alternatively, the Swift River 7-day 10-year low flow is never as low as a river with natural flows, due to the continuous releases MWRA makes to the Swift River. For example, recently (March 2006) during a period of low spring precipitation, all of the USGS gages on Massachusetts Rivers recorded at or below normal levels, with the exception of the Swift River below Quabbin Reservoir. Further, other quality environments also now

[12] Communities/local bodies that have begun the regulatory process for admission to MWRA include the South Shore Tri-Town Naval Air Station Redevelopment and Wilmington. Reading, which was admitted to the MWRA in November 2005 to receive MWRA water to supplement their local water sources, is considering the option to obtain all their water from MWRA, but approval of 2/3 of Town Meeting to pursue this option has not occurred and is not certain – a vote is scheduled for mid-June. Together, South Shore Tri-Town, Wilmington, and Reading would have a demand of approximately 4-5 mgd.

flourish at the reservoirs. Vast areas are protected as open space as part of watershed protection efforts, and both the Wachusett and Quabbin Reservoirs provide specialized habitats for a number of rare species. With cold-water discharges from the lower depths of the Quabbin, the Swift River remains an appealing cold-water stream with good fishing. [13]

The EOEA and DEP's Chicopee River Basin 1998 Water Quality Assessment Report included an assessment the Swift below Winsor Dam. Its findings included the following:

- Ninety percent of the river miles in the Swift Sub basin were assessed as supporting the Aquatic Use Life, Primary Contact Recreational Use, Secondary Contact Recreational Use, and Aesthetic Uses. The remaining 10%, a 4.4-mile segment of the Swift River (an area more than six river miles below Winsor Dam and downstream of the Bondsville Dam impoundment), was unassessed. Source: Chicopee River Basin 1998 Water Quality Assessment Report, EOEA and DEP, 1998.

- The Swift River is a valuable freshwater resource. It provides excellent access for recreation, supports a wide variety of wildlife, and is a particularly aesthetic river. Source: Chicopee River Basin 1998 Water Quality Assessment Report.

Massachusetts Fisheries and Wildlife, though, has concerns regarding the Swift River. Fish and Wildlife objects to the current flow regimes, including fluctuations in controlled discharges from 20 mgd to 70 mgd to respond to permit requirements. An additional concern of Fish and Wildlife is occasional spilling of warm water over the Quabbin spillway in the summer months when the reservoir is full – an intake for Fish and Wildlife's hatchery is downstream and cold water, rather than warm water, is essential for the hatchery operations. It is the pattern and timing of releases, rather than the overall quantity, that appears to concern Fisheries and Wildlife the most.

The Ware River was also evaluated in the Chicopee River Basin 1998 Water Quality Study. The report notes adverse conditions coinciding with low streamflow measurements, as well as issues with recreation due to fecal coliform counts (even in dry weather). Neither concern is as a result of MWRA's withdrawals -- MWRA's withdrawals from the Ware are limited to a period when flows exceed 85 mgd and no diversions are allowed between June 15 to October 15, and from June 1- June 15 only with prior permission from DEP. Withdrawals by others occur throughout the year, with peaks in the summer. Similarly, water quality issues in the main stem of the Chicopee are a result of CSO discharges[14] (and not a result of MWRA's occasional withdrawals from the Ware River).

At Wachusett Dam, MWRA discharges a minimum of 1.8 mgd (2.6 cfs) into the South Branch of the Nashua River. The Hydrologic Assessment of the Nashua River Watershed[15] emphasized that the Wachusett watershed defies simple hydrologic stress classifications:

[13] An Atlas of Massachusetts River Systems, Environmental Designs for the Future, Massachusetts Department of Fisheries and Wildlife, 1990.
[14] EOEA, DEP, Nashua River Basin 1998 Water Quality Assessment Report
[15] Study by CDM for DEM Office of Water Resources and EOEA Nashua River Basin Team.

- Because the Wachusett watershed is highly managed for the Worcester and MWRA withdrawals, these withdrawals were not considered in the evaluation of stress in the Wachusett Watershed – a much more detailed analysis would be required to evaluate their uses. These [multi-month] reservoirs are capable of storing large flows in the spring and holding them for use during low flow periods in late summer. Because of the stored volume, the impact of large demands in these systems may not be as great as the stress-classification implies; it is possible that normal low flows are still being released from these reservoirs.

DEP assessed the Nashua River in its 1998 Water Quality Assessment Report. The river segment below Wachusett was assessed as partially supporting aquatic life, primary contact, and secondary contact, and as supporting aesthetics. Recommendations of the DEP's report included that consideration be given to reclassifying the segment as a Cold Water Fishery given that it receives hypolimnetic releases from Wachusett Reservoir during the critical summer months and evaluation of the current minimum release to maximize flow to the river while attempting to maintain natural flow regimes.

In recent years, MWRA discharges to the Nashua have well exceeded the minimum requirements. In the late spring and summer, in particular, discharges to the Nashua are often significantly higher than other times of the year.[16]

For the Swift and Nashua Rivers, Fisheries and Wildlife has suggested that further consideration be given to improving flows for fisheries. At this time, no specific target flows for fish communities or detailed studies on the existing fishery have been identified. Future discussions between EOEA, Fisheries and Wildlife and MWRA to discuss management practices and potential opportunities to enhance resource protection are needed to address this complex issue. That said, any goal to restore these rivers to natural flow regimes appears at odds with water supply needs.

Further Study

Attachment 2 explores water quantity and quality issues in both the receiving basins. Fortunately, more comprehensive and sophisticated study efforts are underway to further quantify and characterize water and water supply throughout the state. Two efforts potentially relevant to MWRA system expansion that are anticipated to be completed in the next few months include the following:

- The Charles River Watershed Association is performing a statewide water budget analysis for EOEA for all communities in Massachusetts. For each

[16]Since Quabbin water has lower concentrations of organic matter than Wachusett water, increasing transfers of Quabbin to Wachusett Reservoir in the spring-summer months has the beneficial impact of improving water quality at the intake of Wachusett. When Wachusett watershed yields are sufficient to maintain reservoir elevations within the normal operating range, and transfers of additional water for water from Quabbin for water quality purposes are made, additional releases from the valves at Wachusett dam are made that exceed the minimum required discharges.

community, it will account for the amount of water than enters or leaves the watershed while quantifying the human impact on streamflow.

- The US Geological Survey is developing a Safe Yield Estimator Application for Massachusetts River Basin, which will integrate estimates of naturally available water, permitted withdrawals and return flows, actual withdrawals and return flows, and interactively specify streamflow requirements for habitat protection. It would be used to allow determination of volume of total yield that is already allocated and the volume that remains for allocation, and instream flow requirements.

MWRA recommends that in the coming months, these study efforts also examine how MWRA's supply of water to the potential river basins and communities identified might beneficially affect streamflows in the river basins; supplementing local sources with varying quantities of MWRA, from 5-15mgd collectively, could be examined. In that fashion, the benefits of import of MWRA water to additional communities can be evaluated as a more holistic approach to water resource management. This amount of MWRA water considered for import to the receiving basins is less than the amount that MWRA water demand has decreased from 2001 to 2006 alone (e.g., running five year average 1996-2000 was 252 mgd; running five year average 2000-2005 is 230 mgd).

In addition, MA Fish and Wildlife have also suggested further study of the Nashua and Ware Rivers to determine opportunities to enhance resources below the dam.

Topic 2 - Economic Considerations in System Expansion

A criterion MWRA uses in considering the admission of a new community is that the expansion shall attempt to achieve economic benefit for existing customer communities.

Upon admission, new communities are required to pay an entrance fee to MWRA, equal to their fair share of the value of the waterworks system based on their proportional share of the waterworks system asset base. For FY07, the entrance fee is projected to be $5.2 million per million gallons a day. New communities must also pay the cost of connection to MWRA, including any required connecting pipeline. They are also required to design and construct the interface between MWRA and the community pursuant to MWRA specifications[17]. Operating Policy #10, Admission of New Community to the Waterworks System, is quite explicit regarding who bears the cost of connection. It states the following:

> "The applicant community must pay all the costs of connection. The MWRA will charge the costs to the new user as they are incurred, as well as expenditures by MWRA for outsider services necessary to make the connection. These costs may include, but are not limited to, costs of preliminary and final design, land acquisition, environmental review, pumping and storage facilities, and actual construction including construction services and resident inspection. The new user shall pay only the connection cost incurred to serve its own needs. If other existing users will benefit from the new pipelines and facilities, the MWRA will assume an appropriate portion of the connection cost that will be added to the overall capital costs for water."

Much of MWRA's costs are fixed costs. Unlike many community systems which may have multiple wells and treatment facilities that serve a given area, with varying costs of operation, or like the electric industry where the power sources to meet peak demand may be more expensive to operate than the baseload plants, MWRA's operating costs do not vary much by each additional volume of water treated, as addressed below. MWRA's source waters are an interconnected system, where water flows from the Quabbin to the Wachusett, or from the Ware to the Quabbin by gravity.

In FY06, the cost per million gallons of water supplied to metropolitan Boston communities is $2,168. Of this amount, approximately 55% or $1,170 is for debt service. Direct and indirect expenses account for approximately 45% or $998.

[17] As an example, MWRA's contract with Reading reads: Reading agrees to pay the full cost of any required upgrades to the connection from the MWRA distribution system to Reading's water system at meter 240 at the Reading/Woburn line. The interconnection between Reading's distribution system and the MWRA Northern Intermediate High system was constructed in 1993 to provide a source of emergency supply. The existing connection requires the use of a manually operated valve. The replacement of that valve is contemplated for use of the connection as a permanent supply to Reading. Any upgrades will be constructed by Reading according to MWRA specifications and will be owned and maintained by Reading.

The incremental demand due to employment and population growth in the 22 identified communities with potential water deficits is approximately 10 mgd, less that 5 percent of 2005 system demand. Given the current approval process, only a handful of communities at most can be anticipated to join the system in any given year. Moreover, since the demand is spread out over many communities and multiple water service areas (pressure zones), the economic impact analysis is not straightforward. Staff have therefore focused on the cost centers where the impact is most obvious and readily quantifiable.

If all 22 communities joined the system next year and their additional demand that was met by MWRA was 10 mgd, MWRA's annual operating costs are likely to increase by no more than $1 million. The largest drivers of increased operating costs are:

- laboratory and testing requirements. The incremental cost for 22 new communities is $275,000, assuming 500 tests per community per year at $25 per test (all direct expenses included).

- water treatment chemicals. The incremental cost for 10 mgd is $197,000 ($54 per million gallons x 10mg x 365 days).[18]

- electricity for transmission and treatment ($96,000, based on a cost of $26.20 per million gallons per day), and distribution ($85,000, assuming 2 mgd of the total 10 mgd will require pumping at a cost of $116 per million gallons pumped).

Certain costs that appear fixed in the short to medium term may vary somewhat over time. These include maintenance on machinery such as pumps or motors. It is harder to quantify such costs; staff estimate that the incremental cost of maintenance for less than 5% increase in demand is negligible. There are other incremental and variable costs as well. For example, there would be more MWRA meters to service for each new community. Each meter would be serviced by a three-person crew four times per year, for a total labor cost of approximately $1,150/meter per year.

Similarly, MWRA provides technical assistance to its member communities in addressing distribution system issues that arise, as well as emergency assistance when a community is

[18] New communities might exert more demand on MWRA in the summer months, rather than the winter months, if their demands are associated with objectives to reduce withdrawals during periods when streamflows and the groundwater table are lowest. Treatment costs per gallon of water treated, though, should not vary seasonally. Many of the chemicals used by MWRA for treatment are added at the same dose rate regardless of the season; some are not. Prior to operation of the John J. Carroll water treatment plant, MWRA found a need to add sodium hypochlorite at a higher dose rate in summer than in winter to achieve primary disinfection. Chemical addition for secondary disinfection (sodium hypochlorite and ammonia) is increased slightly in summer in order to maintain disinfectant residuals in MWRA's communities' distribution systems. Last summer, however, the John J. Carroll water treatment plant utilized lower ozone doses for primary disinfection than it needed compared to this winter to meet the same level of pathogen inactivation. Also, due to the lower ozone decay rate in cold water, an additional ozone quenching chemical (sodium bisulfite) was required in winter which is not necessary in the summer. Although there is limited operating experience with the John J. Carroll water treatment plant, the net result of these chemical additions and subtractions between summer and winter appears to be a wash in terms of the treatment cost per million gallons.

confronted with issues such as pipe breaks and assistance in other day-to day operational practices to improve system operation. MWRA also provides conservation materials to its member communities and has a Task Order contract for leak detection services that provides an economy of scale the communities might not otherwise derive if they procured the services on their own. (communities use the task order contract, and repay the costs in the next year's water assessment). These costs are small, however, and the annual assessments to member communities, existing and new, cover the costs. On the other hand, these are benefits that go beyond the proportionate share of water new communities may receive from MWRA.

If all 22 communities joined the system next year, the fifty existing member water communities would see their annual water assessments lowered next year because the customer community rate "base" over which MWRA's costs are apportioned would be larger. Savings to current members in FY07 would be approximately $7 million and would recur annually.

Some communities with existing or potential water supply deficits are at the periphery of MWRA's Southern, or Northern High gravity fed pressure zones; there are no pumping costs associated with MWRA service to communities in these pressure zones. MWRA's metro west communities are served by community pumping stations, not MWRA. Should a new community have a higher hydraulic grade line than MWRA, the cost of a pump station would be borne by the community[19]. Alternatively, MWRA pumps the water it delivers to its Southern Extra High, Northern Intermediate High, and Northern Extra High service zone communities; new communities added to these service areas would incur MWRA pumping costs. However, in either instance, with or without pumping requirements, the cost impact is small. The Table that follows provides further information on infrastructure requirements.

In addition, service to a new community would not in itself require MWRA to construct infrastructure as the historic demand for the system as a whole, as well as each MWRA service area, with a few exceptions, is higher than current demand. A review of historical demand data from 1987 to 2005 by pressure zone shows a consistent decline in demand in all zones except in the case of the Northern Intermediate High (For further detail, see figures in Attachment 3)[20]. Because several non-MWRA coastal communities adjacent to

[19] Dedham Westwood's contract with MWRA illustrates this. It reads: DWWD agrees to pay the full cost of a new connection to the MWRA transmission system in Westwood, consisting of a new underground meter vault and an above ground booster station. The connection will be constructed by DWWD according to MWRA specifications and standards for permanent connections, and the design will be submitted to MWRA for review and comment prior to construction. MWRA's comments will be reflected in final design and construction. The connection will consist of a new underground meter vault to be owned and maintained by MWRA, and a new booster pumping station to be owned and maintained by DWWD.

[20] In the late 1980's the Northern Intermediate High service area included only two communities: Woburn and Stoneham, which had an average yearly demand of approximately 5.5 mgd. By 1990, the town of Wakefield started withdrawing approximately 2 mgd of water to supply its northwestern corner of town and also, with the use of a pressure-reducing valve supply its main system. Another cause for the increasing demand was that the town of Winchester began withdrawing water from this pressure zone in 1994. Previously, the eastern side of Winchester was supplied directly from Spot Pond, this changed by 1994 when

Infrastructure Cost Considerations		
Service Area	**Non-MWRA Communities W/ deficits In Proximity to Service Area**	**Infrastructure Needs**
Southern High	Hingham/Hull	-Service area fed by gravity. -Communities would exert additional demand on emergency storage
Southern Extra High	Sharon	-Sharon could partner with Stoughton, as Stoughton recently constructed pipeline to MWRA. Additional demand from Sharon could improve pipeline operation. -Existing MWRA system could benefit from additional storage and improved redundancy. If MWRA sites storage further south, southern system can be extended.
(Northern) High Service Area	Ipswich Salem/Beverly Wenham Topsfield Danvers/ Middleton Lynnfield Center W.D.	-Non-MWRA coastal communities are at lower elevation than existing service area communities, so MWRA can deliver water up to MWRA existing service grade line. -To determine the hydraulic impacts on the MWRA system resulting from an additional 10 mgd in the Northern High system, MWRA hydraulic model was used, and run under maximum day demands (June 1999) for three consecutive days, a conservative operating regimen. The maximum drop in grade line occurred at the Peabody and Marblehead meters with a drop of approximately 20 to 25 ft (8.65 to 10.8 psi) during peak periods. The grade line at the Peabody meter dropped to 220 ft BCB with a drop of 215 ft BCB at the Marblehead meter. These grade lines are above what was seen in the late 1990's and also are above what is needed to provide adequate service to these communities. Recent projects have increased the capacity to this area significantly, now typical summer days remain above 240 ft BCB. -MWRA has a current project to remedy existing hydraulic deficiencies (under peak flow conditions) for the Lynnfield Water District. This pipeline may also be used in the future to improve redundancy to the adjacent Northern Intermediate High System.
Northern Intermediate High	Reading Wilmington	-With or without the addition of new communities in this service area, more storage and pipeline redundancy is desirable
Western Intermediate High (community pumping)	Ashland Hopkinton Holliston Medway Milford Franklin	-MWRA system strong -New communities would not impact system hydraulics -new pipeline to serve multiple communities required to be constructed – a community cost, not MWRA -existing MWRA pipeline right-of-way extends from MWRA's Sudbury Reservoir south to Framingham Reservoir #1 (old MDC supply source) in Ashland
Wachusett Reservoir	Boylston Lancaster Sterling West Boylston	-Communities in vicinity of Wachusett Reservoir would require their own raw water intakes and would be responsible for treatment (as are MWRA emergency communities of Leominster and Worcester). -An existing Leominster pipeline from Wachusett Reservoir to Leominster traverses Lancaster
Quabbin/CVA	South Hadley Fire District #2	CVA has sufficient capacity

water became available via a new pipeline to this area. More recent fluctuations are due to Woburn varying their withdrawals based on the status of their local sources.

the Northern High pressure zone have deficiencies/limitations on their local sources, an analysis was conducted to determine the impacts on the MWRA system resulting in these communities withdrawing additional water. An additional 10 mgd was assumed. These communities would benefit from recent projects that have increased the carrying capacity to this area. Communities like Marblehead and Swampscott previously required pumping downstream of their meters to adequately service higher elevations; however, for several years now pumping has not been required even during peak summer days. Additionally, as shown in the Figures in Attachment 2, demand has declined since 1987, therefore an additional withdrawal of 10 mgd in the Northern High Service area should not significantly impact the MWRA system.

At the same time certain improvements are desirable, with or without the addition of new communities. For example, MWRA is presently assessing the long-term needs of its Northern Intermediate High system, including alternative ways to provide pipeline redundancy and increased distribution storage. The proposed FY07 CIP has approximately $6 million allocated to design and construction of NIH improvements. A similar study of redundancy and storage in the Southern Extra High system is recommended for a future CIP. The addition of new communities to these systems would likely result in some incremental addition to pre-existing storage need and costs.

Hydraulic analyses are conducted as part of the consideration of a new community's request to ensure that the MWRA system can meet the demands of existing user communities, as well as the new community. The analysis done for Stoughton, Dedham/Westwood, and for Wilmington and Reading demonstrated that the addition of these communities had an insignificant impact on existing user communities[21]. The analysis did, though, point to the fact noted above; that is, with or without Reading, and Wilmington if Wilmington is admitted to MWRA, improved pipeline redundancy and more emergency storage is desired. The addition of new communities may present opportunities to address MWRA storage needs. The contract between MWRA and Reading contained a provision that " Reading agrees to cooperate with MWRA in any investigations to locate MWRA distribution storage facilities in the Northern Intermediate High Service Area to improve system operability and reliability." Similar opportunities to mutually strengthen both MWRA and community systems may also exist.

[21] For example, assuming the cumulative demand of Wilmington and Reading, including maximum emergency demands by Reading (3.8 mgd, the Town's maximum day demand), modeling indicated that target hydraulic gradeline are met for all Northern Intermediate High communities except for Stoneham. For Stoneham, modeling shows two of the three meters to remain above the target gradeline. For the third meter, MWRA's modeling indicated a potential for the meter to be slightly below the minimum target for brief periods during peak days - this occurs with or without the addition of Reading. MWRA's model does not include community piping, though. In reality, the modeled effect is unlikely to be experienced as Stoneham's three meters are hydraulically connected within the community distribution system, causing the flows at the other two Stoneham meters to adjust and maintain adequate pressures. Insignificant impacts were also modeled for the addition of Dedham-Westwood: under non-emergency maximum day demand of 2.0 mgd, there would be a drop in the grade-line downstream of the DWWD connection, but all meters still remain above their target gradeline throughout the day.

MWRA acknowledges that new communities at the periphery of the MWRA system would in many instances not be served by the same level of redundancy that exists elsewhere in the MWRA system. For example one pipeline, rather than multiple MWRA pipelines, might serve the new communities. In most cases, though, MWRA would not be the community's sole source of supply, and other supply redundancies would exist.

In terms of cost efficiency, if MWRA were adding only one community, then the appropriate design would be different than if there were a consortium of communities that jointly construct a pipeline. The Southern High Service Extension Study, conducted a number of years ago at the direction of the Legislature, and with funding from the state, studied extension of the MWRA service area to seven south shore communities and considered pipeline alignments that could simultaneously serve multiple communities.

Topic 3 - Legal Considerations in System Expansion

The Statutory Basis For System Expansion

MWRA's authority to expand the service area within which it may furnish water is not subject to dispute. Section 8(d) of the MWRA enabling act allows new communities or other local bodies to join the system assuming that they first satisfy all of the statutory prerequisites to admission, including approvals by the Advisory Board, by the MWRA Board of Directors, by EOEA regulatory agencies having jurisdiction, by the Legislature and by the Governor. MWRA must make six specific findings including that: (i) the safe yield of the watershed system is sufficient to meet all projected demand, (ii) no existing or potential local water supply source of the municipality seeking admission has been abandoned, (iii) a water management plan has been adopted following WRC approval, (iv) effective local demand management measures (leak detection/conservation) are in place, (v) no local source which has the potential for development for water supply purposes has been identified by the community or by DEP, and (vi) a water use survey has been completed which identifies all users of water in the community in amounts greater than 20 million gallons per year.

Date when Communities Joined the System

Community	Date
Belmont	1895
Boston	1895
Chelsea	1895
Everett	1895
Malden	1895
Medford	1895
Melrose	1895
Newton	1895
Revere	1895
Somerville	1895
Watertown	1895
Winthrop	1895
Quincy	1897
Nahant	1898
Arlington	1899
Stonehan	1901
Lexington	1903
Milton	1903
Swampscott	1909
Framingham	1912
Clinton (raw water)	Authorized in 1923
Brookline	1925
Southborough	1930 from Sudbury Res
	1941 from Hultman
Saugus	1946
Winchester	1946
Chicopee	1947
Wilbraham	1948
Cambridge	1949
Waltham	1949
Marblehead	1951
South Hadley F. D. #1	1951
Needham	1954
Northborough	1954
Norwood	1954
Lynnfield Water District	1956
Marlborough	1957
Peabody	1957
Wakefield	1957
Weston	1963
Leominster	1964
Canton	1967
Worcester	1971
Woburn	1972
Wellesley	1974
Lynn Water & Sewer	1982
Bedford	1993
Stoughton	2002
Reading	2005
Dedham-Westwood W.D.	2005

Expansion of the service area to increase use of the metropolitan water supply, upon demonstration of need and upon agreed to terms and conditions, is consistent with historical practice. Chapter 488 of the Acts of 1895 established the original metropolitan water district and also authorized approximately 25 additional communities within ten miles of the statehouse to be eligible for membership. Successive acts of the Legislature authorized further expansion. (See Table) Early legislation limited extension of the service area to within 10 miles of the statehouse, then later to 15 miles (St. 1945, c. 587). Chapter 575 of the Acts of 1947 ended the 15 mile

radius rule, and specifically authorized the current three CVA communities, as well as other neighboring communities, that "may make agreements with the MDC", to join.

MWRA's 1984 enabling act (St. 1984, c. 372), which expressly provided for the eventuality of "new communities entering the system", dedicated section 8(d) to the subject of expansion. Rules of statutory construction would strongly suggest that the most recent, most comprehensive and most specific statute concerning the subject of expansion (the 1984 enabling act) should control that topic over the provisions of older and more general statutes that refer to expansion.

However, even these earlier statutes that now allow MWRA, as the successor to MDC, to exercise the rights to use the waters of the Swift, Ware, and Nashua rivers for water supply (and which also spell out minimum releases to be made to maintain stream flows) were enacted to accommodate service area expansion. For example, Chapter 375 of the Acts of 1926 established a special metropolitan district water supply commission. That legislation authorized the commission (a predecessor to the MWRA) "to divert into the Wachusett reservoir . . . the flood waters . . . of the Ware River . . . for the purpose of extending and increasing the water supply of the metropolitan water system, and of such cities and towns not members of the metropolitan water district as may hereafter require water from said system . . .". One year later, the legislature, in section 1 of Chapter 321 of the Acts of 1927, authorized the same commission to construct such tunnel, aqueduct and diversion dam structures as would create a storage reservoir in the Swift River valley (now the Quabbin Reservoir) "for the purpose of adding to, extending and further developing the additional sources of water supply of the metropolitan water system". Section 2 of the same legislation provided further general authority to the commission to build such other future structures to become part of the metropolitan water system that in the commission's opinion "may be necessary for the additions, extensions and developments authorized by this act."

Limitations on Who MWRA May Supply

Communities eligible for admission may include watershed and non-watershed communities alike. Other than the communities in the watersheds that MWRA already provides water to, or which already withdraw raw water from the reservoir (Clinton), MWRA is under no obligation to "reserve" quantities of water for any specific non-member community whether or not in close proximity to the service area.

Reservation of Capacity

It has been suggested by some that the provisions of chapter 575 of the Acts of 1947 mandate that any community that might fairly be regarded as "in and near to the Chicopee River Valley or its tributaries" may have some legislative "reservation" to be admitted to the MWRA system. However, that statute merely authorized the MDC to "construct a pressure aqueduct system from the Winsor dam outlet works . . . to a suitable point or points of delivery to such towns "as may make agreements" with the MDC for the purchase of water." Only three communities (Chicopee, Wilbraham and the South Hadley Fire District No. 1) have made and entered into such agreements with MWRA or its predecessors to be served from the Chicopee Valley Aqueduct ("CVA"). There is nothing in that statute that indicates or implies that any municipality specifically mentioned in the

statute or within the Chicopee River Valley has gained or been grandfathered a prior claim or future reservation to take water from the MWRA waterworks system.

It has also been suggested that section 60 of the MWRA enabling act, which lists several pre-1984 special acts "which shall continue to govern certain water supply arrangements" identified one special law of particular note -- St. 1947, c. 575. The argument suggests that since the legislature went to the trouble of "preserving" the provisions of that special law regarding the CVA, that its provisions have some special meaning – e.g., that all the communities within the Chicopee River Valley and its tributaries have a "pre-approval" from the legislature to enter the MWRA water service area whenever they wish without the need to comply with section 8(d). There are at least two problems with that argument. First, by placing section 60 within the enabling act, courts would require all of its provisions to be read in a manner consistent with the enabling act as a whole and by which none of them is rendered meaningless. Absent a provision in St. 1947, c. 575 which expressly exempts those potential CVA communities from compliance with section 8(d), the proper reading of the special act is that all new communities must observe the provisions of 8(d). Second, a close review of section 60 of the enabling act reveals that there is actually no reference there to St. 1947, c. 575. There is, however, a reference to St. 1947, c. 557. The reference to that special act is preceded by the language "with respect to the Sudbury river, ..." In fact, chapter 557 does relate to the Sudbury river, but chapter 575 does not. Arguments that the legislature inadvertently transposed the numbers (from 575 to 557) in that 1947 special law reference are not well founded.

Topic 4 - Admission Process Consideration for New Communities

The Timeframe For Approval

Admission of new communities to the waterworks system is governed by MWRA Operating Policy 10, Admission of New Community to Waterworks System, revised, November 2002. The Enabling Act forms the foundation of OP#10, and requires that prior to application to MWRA, the Community must obtain approval of the Advisory Board, the Governor and the legislature. Also required are MEPA and Interbasin Transfer Act (ITA) reviews.

With the exception of Bedford, the time required to obtain MWRA's approval, after all other approvals required had been obtained, is short (1-3 months), whereas the time that is required to proceed through the prerequisite regulatory reviews can be extensive (See Table below). The regulatory approval process for Reading was upwards of four years; Wilmington's process is still ongoing as its process for admission to MWRA is integrally linked to its Comprehensive Water Resources Management Plan addressing wastewater and drinking water supply needs. Dedham/Westwood Water District did not require review by the Water Resources Commission under the Interbasin Transfer Act (Dedham was already listed as an MWRA community in the Enabling Act), and contributed to a shortened time frame for approval.

Review Milestone	**Community**				
	Bedford	Stoughton	Reading	Dedham/ Westwood	Wilmington
MEPA ENF Certificate	10/90	2/01	6/01	10/04	07/01∗
MEPA EIR Certificate	3/92	12/01	10/03	9/05	
Legislature/Governor	1990	11/01	08/05	5/04	
WRC ITA Approval	6/92	5/02	6/05	NA	
Advisory Board	7/92	5/02	10/05	11/05	
MWRA Board	6/93	6/02	11/05	12/05	
Total time	3 years	18 months	4.5 years	14 months	
∗ Secretary's Certificate was for a Notice of Project Change to expand scope of MEPA documents to include water. An ENF related to wastewater was filed in 1991.					

Overlap between MWRA and Other Regulatory Reviews

There is a joint scope for EIR Review/ITA review for communities seeking admission to MWRA. The scope was developed by WRC. By the time an application is submitted to MWRA, MWRA concerns have largely been addressed as OP#10's requirements and standards for consideration of system expansion proposals overlap with the MEPA scope/Water Resources Commission's requirements to a significant extent. (See Table below).

KEY CRITERIA FOR ADMISSION TO MWRA	
ITA Approval	**MWRA Requirements for New Communities**
An environmental review inclusive of MEPA has been completed	Applicant has met all legal requirements for admission
All reasonable efforts have been made to identify and develop viable sources in receiving area	No existing water source has been abandoned without DEP approval; feasible local source have not been identified
All practical measures to conserve water have been taken, including a specific list	Evidence that effective demand management measures have been developed, including a specific list.
Submission of a Local Water Resources Management Plan	A Water Management Plan approved by WRC has been adopted.
Watershed Management - a comprehensive forestry management program has been implemented	Submission of measures designed to protect local sources of supply
Reasonable instream flow is maintained in river from which flow diverted	The Safe Yield of the watershed system is sufficient. Admission of new communities shall strive for no negative impact on the interests of the existing MWRA communities, water quality, and the watershed communities.

DEP, other agencies, and watershed associations actively participate in the EIR/ITA reviews. Ultimately, the WRC's approval includes conditions that respond to many of the concerns raised during the MEPA and ITA reviews. For example, Reading was required to limit its Ipswich River Basin sources to 1 mgd from May-October and to implement mandatory conservation restrictions on outdoor use linked to streamflow. There are also various reports and notifications required.

In turn, the Advisory Board's approvals incorporate a condition that the community shall abide by all applicable conditions as stipulated within the WRC's approval. The water supply contracts entered into between MWRA and the communities also contain this condition. Conservation requirements and protection of local supplies are also reinforced by MWRA's typical requirements with contract communities that include, but are not limited to, the community's continued implementation of local demand management programs, compliance with MWRA's leak detection and repair regulations, and protection of local sources. Water supply contracts with new communities also explicitly state that any increase beyond the annual average basis and maximum daily basis will require a contract revision and revision to the entrance fee. The annual average limit is the same as those contained in regulatory approvals.

In short, MWRA's requirements as they relate to environmental protection and conservation mirror, though typically do not exceed those of the DEP and WRC.

Opportunities to Revise Process

As noted above, the Enabling Act requires that regulatory approvals be obtained prior to admission to MWRA. Much review takes place prior to the Board's consideration of the request, and MEPA and ITA regulations, policies and precedent dictate much of the process for admission to MWRA.

On prior occasions, MWRA staff have suggested that perhaps there are opportunities to pursue greater flexibility for MWRA system expansion within the existing construct of the ITA if enlargement of MWRA's receiving area does not increase transfer of water out of the donor basin and if enlargement is accompanied by reductions in water use in the existing receiving area. A principal concern of the WRC under the ITA is whether a proposed increase in inter-basin transfers to serve an additional member community would have an adverse impact upon the existing in-stream flow within the donor basin. MWRA has taken the position in the past that so long as the admission of a new member community is: (i) consistent with the legislative limits imposed upon releases of waters from the Swift River to insure minimum levels of streamflow downstream of the Quabbin, (ii) does not exceed our WMA registration, (iii) complies with permit conditions of the War Department permit, and (iv) allows a margin for future drought conditions, the objectives of IBTA are satisfied and should allow new communities to be admitted to the service area.

As a result, abbreviated review by regulatory agencies was suggested by MWRA staff. EOEA legal staff did not agree.

ATTACHMENT 1
EXAMINATION OF PERFORMANCE MEASURES

ATTACHMENT 1

Examination of Performance Measures

The following section provides information regarding MWRA's reservoir performance measures. This information was derived from a joint MWRA, Army Corps of Engineers, WSCAC and MAPC effort in the early 1990's. A detailed description of the work was previously provided to the MWRA Board of Directors in May 2002 in the Supply and Demand Report. The text below provides a brief overview of those measures and what they indicate about system capacity and the operation of the water supply reservoirs (Quabbin and Wachusett).

Rather than looking at a single measure (safe yield) of how the system behaves at varying levels of demand, the work done as part of the Trigger Planning portion of the *National Study of Water Management During Drought* (October 1994) looked at a total of 6 measures. Together they provide a full picture of how the reservoirs would respond during a drought. As part of the study effort, the study team recommended the threshold values shown below. They were reviewed independently by Dr. Richard Palmer of the University of Washington at Seattle.

Performance Measure[22]	**Definition**	**Recommended threshold**
Safe Yield	Quantity of water that can be supplied on a continuous basis during a critical drought	300 mgd
Supply Shortfall	Number of months with a shortfall in supply	0 months
Severity	the maximum number of consecutive months that Quabbin Reservoir spends below a specific target pool	18 months
Maximum Pool Descent	Maximum deviation of the water level at Quabbin Reservoir below a specific target pool level at a specific water demand	470 ft
Resiliency	ability of the water supply system to recover from an unsatisfactory condition	98%
Drought Actions	Number of months that Quabbin levels remain in each of the stages in the MWRA Drought Status Control Program[23]	24 combined months of Stages 1 to 3

[22] For each measure, the modeling of reservoir operations was conducted over the entire hydrologic record from when Quabbin was created with a monthly time step. The required regulatory and permit mandated streamflow releases were calculated and made to the Swift and Nashua Rivers. Transfers from the Ware River to Quabbin were made in accordance with permit conditions and current operating procedures. After minimum mandated releases were made from each reservoir, water system demands were withdrawn from the reservoir, the reservoir elevations were noted, and the cycle restarted for the next time step. The model was run for trial withdrawals of 220 mgd through 320 mgd, and the effects on each measure calculated as shown in discussion below, and in the attached May 2002 report on Supply and Demand.

[23] The 2002 Supply and Demand Report contains details of this program.

As discussed at earlier meetings, over a range of demands up to 300 mgd, increasing demand shows insignificant impacts on all measures except possibly Drought Actions as discussed below. All analyses assume full compliance with all required downstream releases to the Swift, Ware and Nashua Rivers, and a continuation of current system operating practices. The impacts on each measure are discussed below.

Safe Yield:
No impact. Safe yield a reference demand and is only impacted by the hydrology, operating procedures and physical characteristics of the water supply system. The safe yield of the system is approximately 300 mgd.

Supply Shortfall:
No impact. With drought management in place, the supply system can meet demands up to 300 MGD without a single month of supply shortfall.

Severity:
Stays well below the threshold of 18 months for demands up to 300 mgd with a maximum of 9 months at 300 mgd.

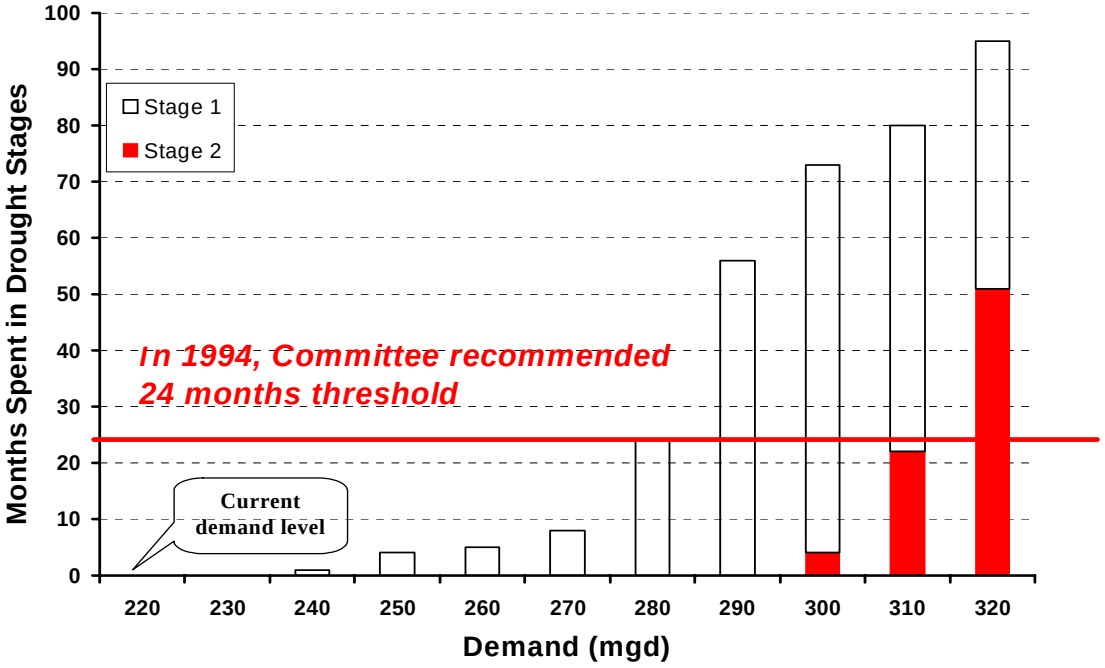
Maximum Pool Descent:
During a drought as severe as the 1960s Quabbin drops to about 486 ft at a demand of 300 mgd. This drop does not reach the threshold of 470 ft.

Resiliency:
No impact. 100% Resiliency was defined as Quabbin spending 18 or less consecutive months below 490'. Quabbin's resiliency is 100% for all demands up to 300 mgd.

Drought Actions:
As demand increases, for a given severity drought, the reservoir would fluctuate over a wider range. For all but the most severe recorded droughts, the modeling indicates that there would be no call for drought actions for demands up to and including 300 mgd. Only under the most severe drought, would there be any call for drought response.

During a drought as severe as that of the 1960s, the number of months with Stage 1 drought response action increases as demand increases, as shown in the chart below. During Stage 1 of the Drought Response Plan, relatively minor actions such as outdoor water use restrictions, are called for which would reduce demand by about 10%. None of the more severe Stage 2 drought actions are called for until levels of 300 mgd. No Stage 3 actions are required until well above 300 mgd.

DROUGHT ACTIONS



The study team recommended the 24-month threshold for this measure in the 1994 report. Since the publication of that report, some have argued that this should be the limiting constraint for defining the reservoirs capacity, while other have argued that a moderate number of months of reasonable drought actions during a very severe drought is common sense and good public policy. The critical issue in that discussion is just how severe the drought of the 1960's is If it would be expected to occur frequently, then a more conservative approach might have some merit. However, if it is a rare event, then limited use to well below 300 mgd would be unnecessarily overly conservative. The next section reviews the data 1960's drought data.

How severe was the drought of the 60s?

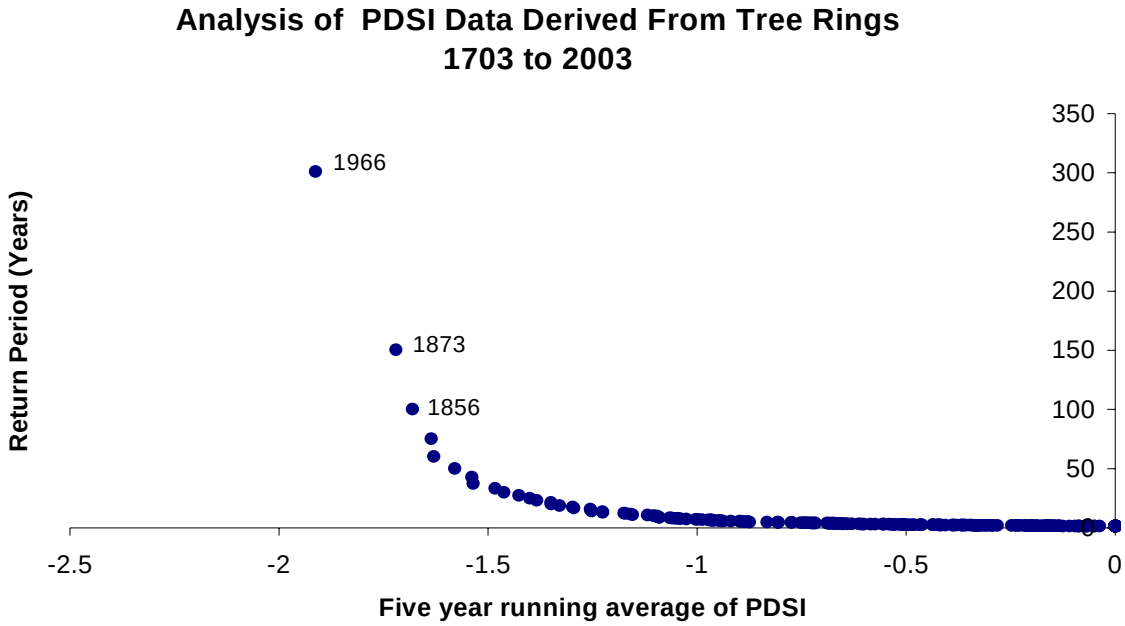
This is a key question in the system expansion discussion and it goes to the very heart of assessing the degree to which the system was conservatively built and operated. Many water supplies are planned and designed around a 20 to 50 year recurrence drought, with the expectation that some type of drought restrictions would be required periodically (2 to 5% probability in a given year). A more conservative approach is one that uses a 100-year drought or the drought of record for planning purposes. Again, the assumption is that periodically drought restrictions will be necessary, but the probability in any given year is lower.

DEP's adopted policy for permit and permit amendment applications and 5-year reviews recommends evaluating safe yield using a period in which the probable driest period or period of greatest water deficiency is likely to occur. The return period that the DEP typically uses for systems without a drought management plan is 100 years. For example,

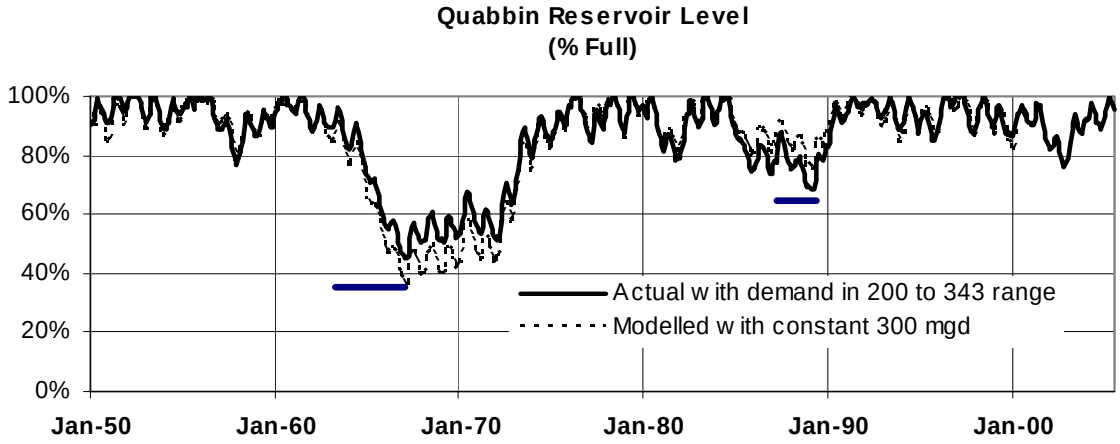
DEP determined the safe yield of the Town of Weymouth's two sources, the Great Pond Reservoir and the Mill River basin, to be 4.51 mgd based on a 100-year drought (see http://www.weymouth.ma.us/dpw/index.asp?id=1179).

MWRA's practice has been to conservatively use the 1960's drought for all analytical purposes. The 1960's drought was notable for both the severity of the shortfall in precipitation, and its duration. Quabbin Reservoir levels dropped precipitously from a high of 90.5% full in May 1964 to a record low of 45% full in March 1967. Short severe drought often affect smaller local water supply systems which depend on spring runoff each year to top off their reservoirs; the Quabbin and Wachusett systems are large multi-year systems, designed to ride through months or even a few years of below average precipitation. The severity or recurrence frequency of a drought can be determined by reviewing regional climatological historical data.

The longest climate record in the region is the Amherst record that dates from 1836. From that record, it is clear that the 1960's drought is the most severe by far in 170 years of climatological data. In 2004, scientists at the Lamont-Doherty Earth Observatory Tree Ring Lab completed their North American Drought Atlas work and published tree ring data for the entire country. For Massachusetts these data go as far back as 481AD. Tree ring data can be used as a surrogate for climatic conditions in that the width of an annual ring is reasonably well correlated to the wetness or dryness of the growing season. However, for water supply purposes, particularly for large "multi-year" reservoirs system such as MWRA's, they cannot capture the amount of precipitation that occurs during the winter months. However, they do extend the understanding of long-term climate variability, and so are used cautiously to analyze the more distant past. Based on these data, the 1960s drought appears to be the severest in the last 300 years as shown in the accompanying graph using the Palmer Drought Severity Index (PDSI).



Another view of the relative severity of the 1960's drought compared to a more typical 20 year recurrence drought such as the 1989 drought can be seen in the chart below showing the modeled performance of the system if demand had been 300 mgd during both droughts. An interesting contrast is the actual performance of the system, showing a similar pattern, despite the rise and then decrease in water use over time.



The 1960s drought was therefore an extremely rare event whose return period far exceeds that used by the water supply professionals in planning water supplies or the DEP in reviewing permit applications.

Does the modeling of drought-induced demand represent reality?

A question has been raised on how the reservoir modeling handled the fact that during drought periods some partially supplied communities would reach the limit of their local sources and turn to the MWRA to supply the deficit. This effect has been included in the updated version of the Reservoir Model and is sometimes referred to as pop-up demand. The amount of increased demand which would be incurred was based on records of demand during prior drought periods. It is modeled based on the drought stage level in Quabbin reservoir as shown in the following table.

Quabbin Reservoir Drought Stage Level	**Pop-Up Demand (mgd)**
Drought Warning	6.5
Drought Emergency – Stage 1	12
Drought Emergency – Stage 2	25
Drought Emergency – Stage 3	Not used as Quabbin never gets to this stage for demands up to 300 mgd

These assumptions have been reviewed using two different methods to determine if they are reasonable and conservative. Using actual supply data for the partially supplied communities, MWRA staff have been able to derive historical pop-up demands and compared them to those computed using the above methodology. The reservoir stage-based approach slightly overestimates annual pop-up demand in the long-term by about 0.45 mgd on average. The approach is therefore conservative.

An alternate methodology has been developed whereby this pop-up demand would be approximated using drought indices published by the National Climatic Data Center. Initial reviews indicate that it would result in a similar affect.

How significant are demands for emergency supplies?

Another factor to consider is how emergency users were accounted for in the supply and demand modeling. While individual emergency uses might seem significant, that over the modeling horizon of 60 plus years, they would likely average to a very small number. Typical emergency uses are for a few hundred thousand gallons per day for weeks or a few months. Occasionally amounts will be longer or use periods longer. Staff has analyzed MWRA historical data on emergency connections from non-user communities for the past decade. For the last ten years, MWRA has supplied an average of less than 0.1 mgd to emergency users.

The demand estimates separately account for the possibility that MWRA partial users may require MWRA water if there were operational or contamination problems with their sources. This type of use could consist of uses such as Cambridge's or other community's use of MWRA water during construction or upgrading of their water treatment plant. This might occur due to changes in treatment standards or due to changes in water quality at their sources or due to local sources use restrictions during low flow periods. MWRA has assumed very conservatively that up to one quarter of the local supplies might be unavailable on average over the planning horizon. This is substantially higher than past experience.

ATTACHMENT 2
CHARACTERISTICS OF RECEIVING RIVER BASINS

Ipswich River

Wilmington, like Reading, is located in the headwaters of the Ipswich River, and for some time has been pursuing admission to MWRA. Additional communities in the Ipswich River basin also have water issues, among them, the Salem/Beverly Water District, Ipswich, Wenham, Topsfield, Danvers/Middleton and Lynnfield Center Water District. These communities are within reasonable proximity to the MWRA service area, and there is the potential for existing demand coupled with future employment and population growth to exceed currently allowed withdrawals or alternatively, to exacerbate stress in already stressed rivers.

DEP's annual water supply withdrawal statistics show that the communities noted above as potential MWRA communities withdrew a total of 15.7 mgd in 2004. The total amount of water withdrawn is about 2 mgd less than the amount allowed under current Water Management Registrations and Permits.

Community	2004 Withdrawal (mgd)	Authorized Registered Withdrawal (mgd)
Salem/Beverly	11.87	12.44
Ipswich	.2	.26
Wenham	.32	.48
Topsfield	.40	.69
Danvers/Middleton	2.64	3.95
Lynnfield Center	.29	
Wilmington*	2.22	3.71
Total registered and permitted withdrawal	15.72	17.82
*Wilmington has well contamination concerns and is in process of admission to MWRA.		

The Water Resources Commission's study of *Stressed Basins in Massachusetts* rated Ipswich as the most stressed river basin in the state. Similarly, the Ipswich River Watershed Association notes that the Ipswich River had been declared to be one of the 10 most endangered rivers in the entire country. A number of studies have illuminated the low flow conditions further.

The USGS has conducted several studies of the Ipswich River:

- The effects of water withdrawals on stream flow were examined for the 1989-93 calibration period by comparing simulations with (1) actual withdraws. (2) no withdrawals, 3) stopping only groundwater withdrawals, (4) stopping only surface withdrawals. Simulation results indicate that the cumulative withdrawals of ground

water in the Ipswich River Basin substantially decrease low flows. Source, USGS, Effects of Water Withdrawals on Stream flow in the Ipswich River Basin).

Many findings of their studies were incorporated into the Ipswich River Watershed Management Plan, prepared by Horsley and Witten. That study noted:

- According to the hydrologic modeling conducted by USGS, the management options needed to restore natural flow to the river to alleviate summer low flow conditions consistently would require 5-6 million gallons per day (mgd) of water to be added to the headwater reaches.

- Water withdrawals from the Ipswich River, especially "streamside" groundwater wells, are a major factor causing the low-flow problems of the river. Replacing these sources of water with less damaging supplies is essential to restore the river to health. The first priority is to reduce or eliminate the use of the most damaging wells during low-flow periods. USGS's recent modeling of alternatives shows that reducing the use of the Reading and Wilmington wells is a very important component of the plan.

USGS findings were also used as one basis for the DEP's Water Management Permits for the Ipswich River.

- …the Department has determined that there is documented evidence that water withdrawals, and to a lesser extent an increase in impervious area and development, along with the export of wastewater to other basins substantially contribute to low flow in the Ipswich River. (DEP letter to various WMA permittees in the Ipswich River Basin).

- The Department has further determined that unless and until conditions in the Ipswich River significantly improve, it is unlikely that permittees in the Ipswich River Basin will be approved to increase their authorized withdrawal. (DEP letter to various WMA permittees in the Ipswich River Basin)

More findings related to specific communities water withdrawals include the following:

- Changes in withdrawal rates (relative to 1989-93 withdrawals) were mostly simulated in the model reaches where the towns of Wilmington and Reading have supply wells…Simulations of 50% reduced seasonal withdrawals, combined with 2.6 mgd wastewater-return flow, increased low flows in the model reach 8 (near Reading town well field) above the values simulated under no withdrawals. Simulation of alternative water-supply withdrawals and wastewater- return flows indicated that different rates of return flow and reduced withdrawals could maintain streamflow in model reach 8 to a level similar to the flow expected under no withdrawals. (USGS, Effects of Water Management Alternatives on Stream flow in the Ipswich River Basin).

- Systems that obtain water from the Ipswich River Basin are affected by seasonal restrictions placed on stream withdrawals to maintain aquatic habitat and by the capacity to pump water from the river. ... The Salem-Beverly system has three primary supply reservoirs that are supplied by the Salem-Beverly canal, which draws water

from the Ipswich primarily between November and May when river flow is above a minimum threshold… Simulated results under the 2003 permitted withdrawal [thresholds] and average 1998-2000 demands (10.1 mgd) indicated that reservoir storage was depleted in 4 of 35 years and the average storage was about 72% of capacity. (USGS, Effects of Permitted Withdrawals and Water Management Alternatives on Reservoir Storage and Safe Yield)

- Based on USGS findings, there is concern that newly activated wells in Danvers will deplete stream flow if pumped during low flow periods. (Source: Horsley and Witten, Ipswich River Watershed Management Plan).

- The use of wells in Reading and Wilmington, and potentially in Danvers and other communities must be curtailed during low-flow periods or flow and no-flow deficits will continue. There is a need for alternative sources to meet demand during low flow periods. (Source: Horsley and Witten, Ipswich River Watershed Management Plan).

The USGS's investigations also included the reservoir systems of Peabody and Lynn, MWRA partially supplied communities. Based on their 2003 permitted withdrawals and demands equal to their 1998-2000 demands, USGS found that these reservoir systems would also have difficulty delivering their stated yield. Additional growth in these communities could be met by purchase of MWRA water, not local sources.

Boston Harbor Basin – South

The Boston Harbor Basin includes the Weir, Weymouth (Fore and Back Rivers), and Neponset Rivers in the south.

The Weir River Basin

The Weir Watershed includes Hingham and Hull. DEP's annual water supply withdrawal statistics show that the Aquarian Water Company, which serves Hingham and Hull, withdrew 3.45 mgd in 2004. Their five-year average daily withdrawal was 3.57 mgd. They have in the past exceeded their WMA registered and permitted withdrawal of 3.51 mgd. Their wells are located in the Weir River Basin. Other local water supply options are being investigated, but are far from certain. Aquarian is investigating development of a well in the already high stressed Weir River Basin and Hull is investigating desalinization.

GZA did a water balance study for the Weir River Basin. Findings from that study were as follows:

- The water resources of the Weir River watershed are taxed in terms of capacity to provide a stable water supply and ability to maintain adequate habitat for aquatic life.

- Under current conditions, the water balance model predicts that baseflow in a typical summer is completely eliminated from Accord Brook and is reduced by up to 62% in the Weir River.

- The net outflow from the basin is 2.98 mgd, which exceeds the estimated August median flow and also exceeds the 7Q10 flow by an order of magnitude.

- Aquarian Water Company's withdrawal represented 85% of water withdrawals in the Watershed.

In 2005, the Water Resources Commission classified the Weir River as Highly Stressed.

Neponset River Basin

Much of the Neponset River watershed is served by MWRA. With the exception of Walpole and Sharon, and very small parts of Foxborough, Medfield, Dover, and Randolph, communities are in both the MWRA water and sewer service area. The Dedham-Westwood Water District, which obtains its water supplies from wells in both the Neponset and Charles River basins, was recently admitted to the MWRA water service area as a partial water supplied community. Stoughton, also a partially supplied community, was admitted to MWRA in 2002; most of their water supply is still derived from local sources. Sharon is identified as a potential community for consideration for admission to MWRA, as there has been an inquiry regarding emergency supply of water , and their 2004

withdrawal from the Neponset River Basin exceeded their allowed withdrawal by .05 mgd (Sharon also has a withdrawal in the Taunton Basin).

The Boston Harbor South 2004 Assessment[24] notes that in the Neponset River watershed:

- Water supply, interbasin transfer, or inflow and infiltration have a significant impact on instream flow levels;

- Twenty-one percent of the water pumped is returned to the Neponset River watershed as septic system influent, while sixty-five percent of wastewater is transferred tout of basin by sewers;

- Even when one considers the substantial amount of water imported to the Neponset Valley via the MWRA water supply system, the Neponset incurs a net loss of more than 9 billion gallons of water per year that is equivalent to almost 25% of the Neponset River's annual discharge. This net loss is increasing…municipalities are developing new Neponset water supply sources as a substitute for imported MWRA water whose cost is rising ….; and

- The Upper Neponset (from Hawes Brook and upstream) is listed as moderately stressed, while the East Branch of the Neponset is listed as low stress.

[24] Boston Harbor South Watershed 2004 Assessment, EOEA

The Upper Charles River Basin

MWRA identified Franklin, Holliston, Milford and Medway as communities which are in reasonable proximity to MWRA and where there is the potential for existing demand plus future growth to exceed currently allowed withdrawals, or alternatively, to exacerbate low flow concerns in the headwaters. All are located in the Upper Charles. Milford Water Company, which serves Milford, Hopedale and Mendon is also listed, as they have expressed interest in MWRA. Bellingham, Norfolk, Millis and Wrentham were not, at this time, listed as communities that might have deficits.[25]

DEP's annual water supply withdrawal statistics (below) show that communities in the Upper Charles withdrew a total of 11.35 mgd in 2004. The total amount of water withdrawn is about 5 mgd less than the amount allowed under registered and permitted withdrawals under the Water Management Act, raising the possibility that to the extent low flow conditions in the Upper Charles are attributable to water supply withdrawals, low flows may be exacerbated if the full amounts allowed under the WMA registrations were withdrawn.

Community	2004 withdrawal (mgd)	Authorized Withdrawal (Mgd)
Franklin	2.93	4.1
Holliston	1.14	1.41
Medway	.93	1.01
Milford	3.2 mgd*	5.32
Millis	.74	2.09
Bellingham**	1.33	1.36
Norfolk	.46	.65
Wrentham	.62	.92
Total Upper Charles	**11.35**	**16.86**

* Milford Water Co serves Milford, and also exports water to Hopedale and Mendon

** Bellingham also has registered and permitted withdrawals in the Blackstone Basin with an additional margin between withdrawal limit and current withdrawals.

[25] Based on information available to MWRA, there is the potential for water conservation to reduce demand is some communities in the Upper Charles(Norfolk), and for others, the projections are for only limited growth (Millis). Wrentham and Bellingham, which have some margins between current demand and WMA allowed withdrawals also have sources in another river basin.

Using numerical modeling techniques, the USGS evaluated the effects of various withdrawals on groundwater levels, pond levels, and stream base flows in the Upper Charles. Findings and conclusions from their study, *Simulation of Ground-Water Flow and Evaluation of Water-Management Alternatives in the Upper Charles River Basin, Eastern Massachusetts*, are included below, and inform current considerations regarding the use of MWRA water to supplement local sources.

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- Water is withdrawn for public water supply in the Upper Charles from 33 wells in stratified glacial aquifers and two locations on Charles River. (USGS). Stratified glacial aquifers in the basin are in close hydraulic connection with streams, ponds, and wetlands.

- Increased water withdrawals, combined with out-of-basin or downstream transfers of wastewater and decreased natural recharge from changes in land use, have stressed water resources by contributing to streamflow depletion and lowering water levels in ponds and wetlands.[2627] In the Upper Charles River Basin, streamflow depletion and altered pond levels already are problems in several areas.

- Total annual water use is 9% of recharge, calculated on basis of 89-98 average withdrawals. On a monthly basis, portion can be much higher. In September, withdrawals are 35% of average recharge. (In 2004, water withdrawals were slightly higher than 1998 withdrawals (11.35 mgd vs. 10.1 mgd, and so the conclusions of USGS evaluation would be generally the same)

Estimated average annual water balance for the Upper Charles River Basin 1989-98	
Water Balance Component	Rate of Flow (MGD)
Inflow	
Recharge from precipitation	100-130*
Septic tank return flow	3.1
Wastewater discharge to streams	7.5
Total Inflow	111-141
Outflow	
Groundwater discharge to streams (stream baseflow at Upper Charles boundary)	104 (80-137)*
Water supply withdrawals	10.1
Groundwater evapotranspiration in wetlands	5
Total Outflow	119
*Values correspond to recharge rates of 20-26 inches a year Source: USGS, Simulation of Ground-Water Flow and Evaluation of Water-Management Alternatives in the Upper Charles River Basin	

[26] Small transfers for water supply and wastewater discharge in and out of the study area balance each other.

- Model calculated effects of increased withdrawals of 5 mgd in the Charles River Basin [difference between actual withdrawals and currently allowed withdrawals] included reductions in stream base flow ranged from less than 5% to more than 60% of simulated base flow during low flow periods on the Charles and its major tributaries (USGS, 2002).

- In general, the effects of increased withdrawals were largest where supply wells are located in headwaters areas or near small streams such as Miscoe Brook, Stall Brook, Bellingham (late summer flow reductions of more than 60%) and Miller Brook, Franklin (late summer flow reductions of more than 80%).

USGS also writes that wastewater discharges also affect the water balance in the Upper Charles. In the Charles River, flow depletions from increased withdrawals were balanced by flow augmentations from wastewater discharges from two treatment facilities in Milford and Medway. These changes also have implications for water quality in the Charles River. Wastewater from Medway, Franklin, Millis, and Bellingham is treated and discharged into the Charles River Pollution Control District Facility in Medway…. Finally, increased withdrawals and transfer to treatment facilities potentially increased the effects of these discharges on water quality in the river by increasing the wastewater component of streamflow during low periods. (USGS, Testing Ground Water Management Alternatives Upper Charles River Basin, Eastern Massachusetts).

The USGS evaluated various management approaches to reduce adverse effects of stream flow withdrawals, including collaborative management of sources between towns, and use of wells nearest the rivers and streams were reduced in the summer months, along with increased pumping from wells furthest from streams. For Norfolk and Franklin, they assumed that water supply systems for these towns were connected and their supplies shared. The results found that August stream base flow in the Charles River headwaters could be increased 14% if there was collaborative management of water resources by towns (Franklin decreased pumping from wells adjacent to the summer, and Norfolk increased pumping at a well further from the Charles River in the summer). USGS suggested that this approach could be useful elsewhere as well.

SUASCO (Sudbury, Assabet, Concord) River Basin

The Sudbury and Assabet River join to become the Concord River. The headwaters of the Sudbury are the primary concern for the purposes of MWRA's study. Alternatively, the Assabet River is less of a concern for the purposes of identifying communities that may have water supply deficits, as the concerns in the Assabet appear more water quality related, as addressed further below.

Sudbury River Basin

Hopkinton and Ashland are in the Sudbury River Basin. For these communities, there is the potential for existing demand coupled with future employment and population growth to exceed currently allowed water withdrawals or alternatively, to exacerbate water quantity and quality issues in already stressed rivers. They are located in proximity to the existing MWRA service area.

DEP's annual water supply withdrawal statistics show that the communities noted above withdrew a total of 2.49mgd in 2004. The total amount withdrawn is 0.15 mgd less than the amount allowed under their current Water Management Act registrations and permits.

Community	2004 Withdrawal (mgd)	Authorized Withdrawal (mgd)
Hopkinton	.86	.98
Ashland	1.63	1.68
Total	2.49	2.65

A hydrological assessment of the Sudbury is now underway by USGS. Based on the preliminary modeling conducted, the results show that there is no question that water supply withdrawals in the headwaters impact river flow.[28]

Previous low-flow concerns attributed to water supply withdrawals are noted in the SUASCO River Watershed Assessment Report, prepared for the Executive Office of Environmental Affairs by Ambient Engineering and the SUASCO Watershed Community Council:

- The Massachusetts Department of Fish and Wildlife Riverways Program Lowflow Inventory has documented a number of water quantity issues along the Watershed. The Sudbury River ran dry for about 200 feet near Fruit Street in Hopkinton during August and September of 1999 for a period of about 15 days. The no flow event on the Sudbury River near Fruit Street in Hopkinton may have been due to a combination of 1999 drought conditions and numerous groundwater wells nearby.

[28] Personal communication, Steve Garabedian USGS with Pam Heidell

All of the Town of Hopkinton's wells plus the wells for a golf course are located in the Whitehall area near the Fruit Street section of the Sudbury River.

Assabet River Basin

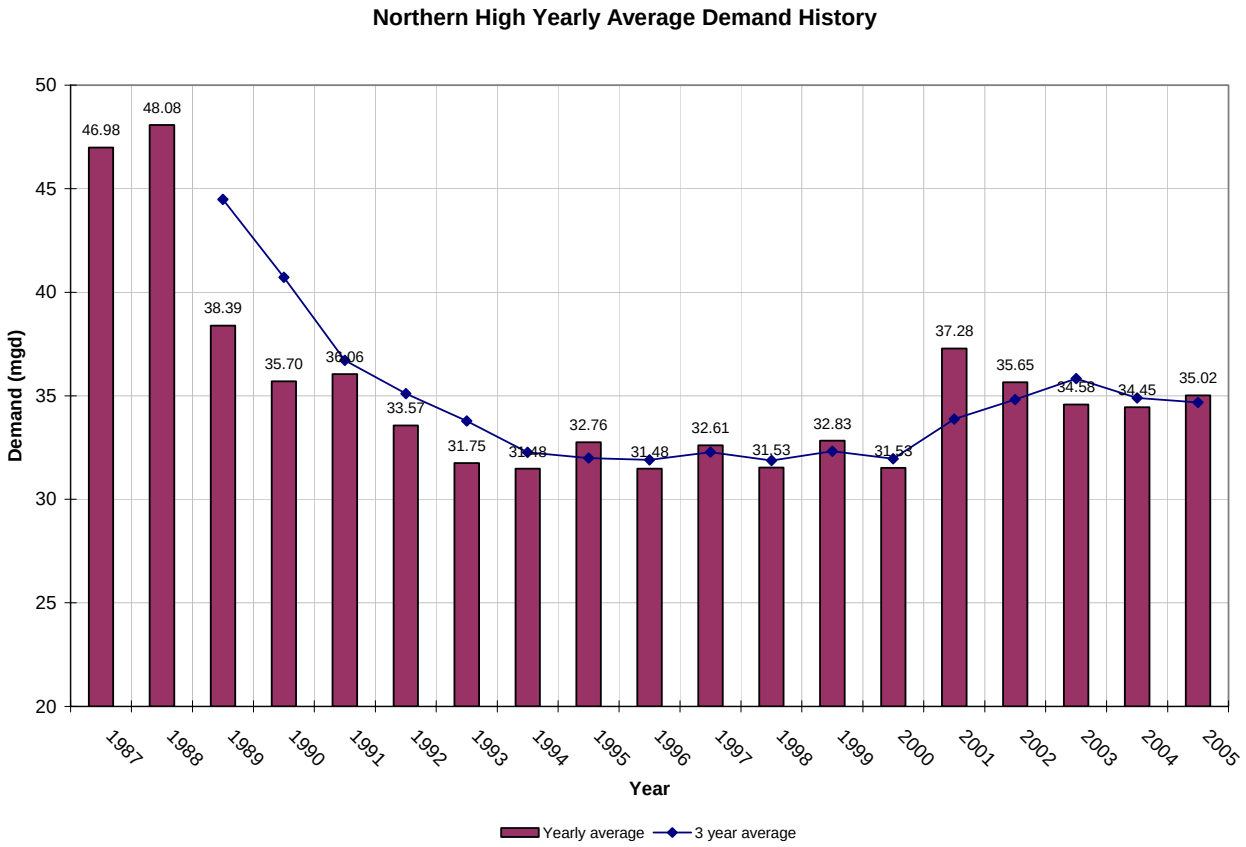
The USGS's 2004 study, *Simulation of Ground-Water Flow and Evaluation of Water Management Alternatives in the Assabet River Basin, Eastern Massachusetts*, presents the results of model simulations undertaken to better understand the effects of water withdrawals and discharges and water management alternatives in the Assabet River. The study was undertaken in cooperation with DCR. Their findings included the following:

- Overall, water use and management in the Assabet River Basin result in a net import of water, primarily as wastewater.

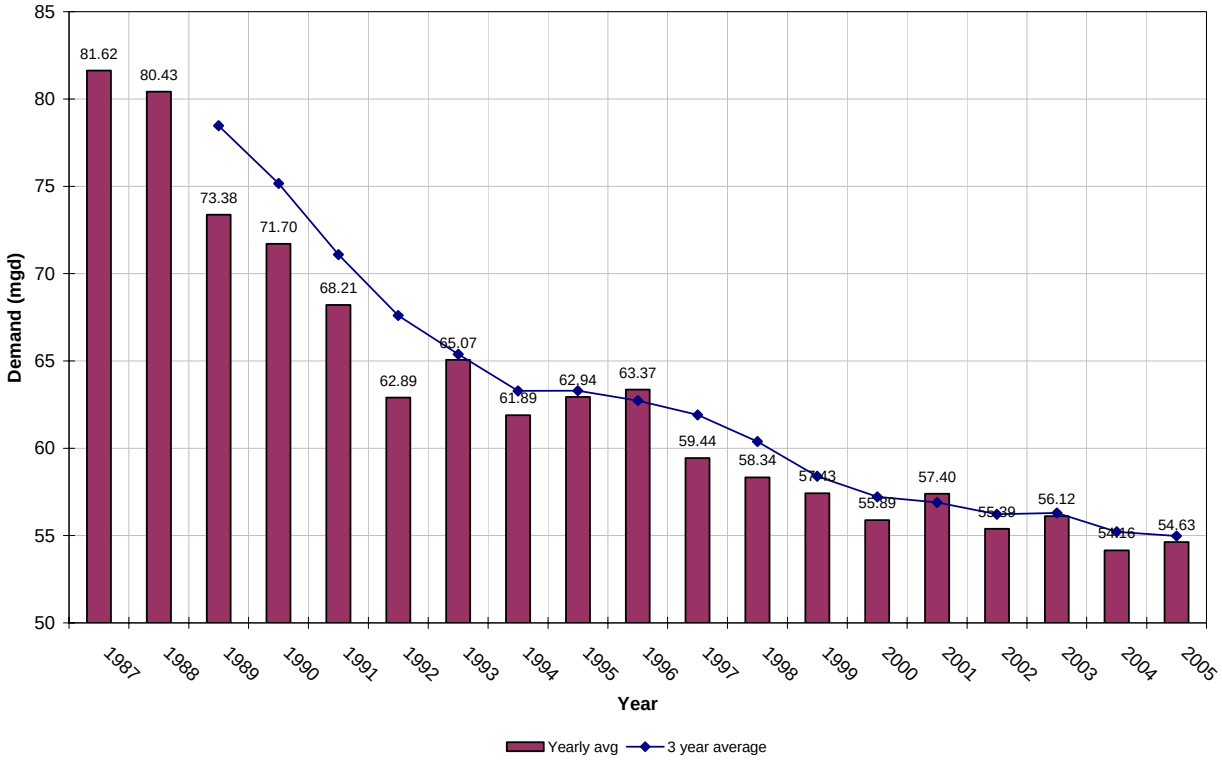
- Currently, the Assabet River is eutrophic during the summer and fails to meet most applicable water quality standards (DEP, 2003, as quoted by USGS). These conditions result form discharges from four municipal wastewater treatment facilities along the river, and other sources. Natural groundwater discharges to streams provides high quality base flow that dilutes wastewater discharge. Reduced ground water discharge to streams resulting from withdrawals for water supply my exacerbate the poor water quality conditions common during low flow periods (USGS)

Two communities in the basin with public water supply are already served by MWRA (Northborough and Marlborough); others are generally some distance from MWRA (e.g. Acton, where water quantity concerns have been previously identified) or have water withdrawals significantly below their allowed limits with relatively low growth projected.

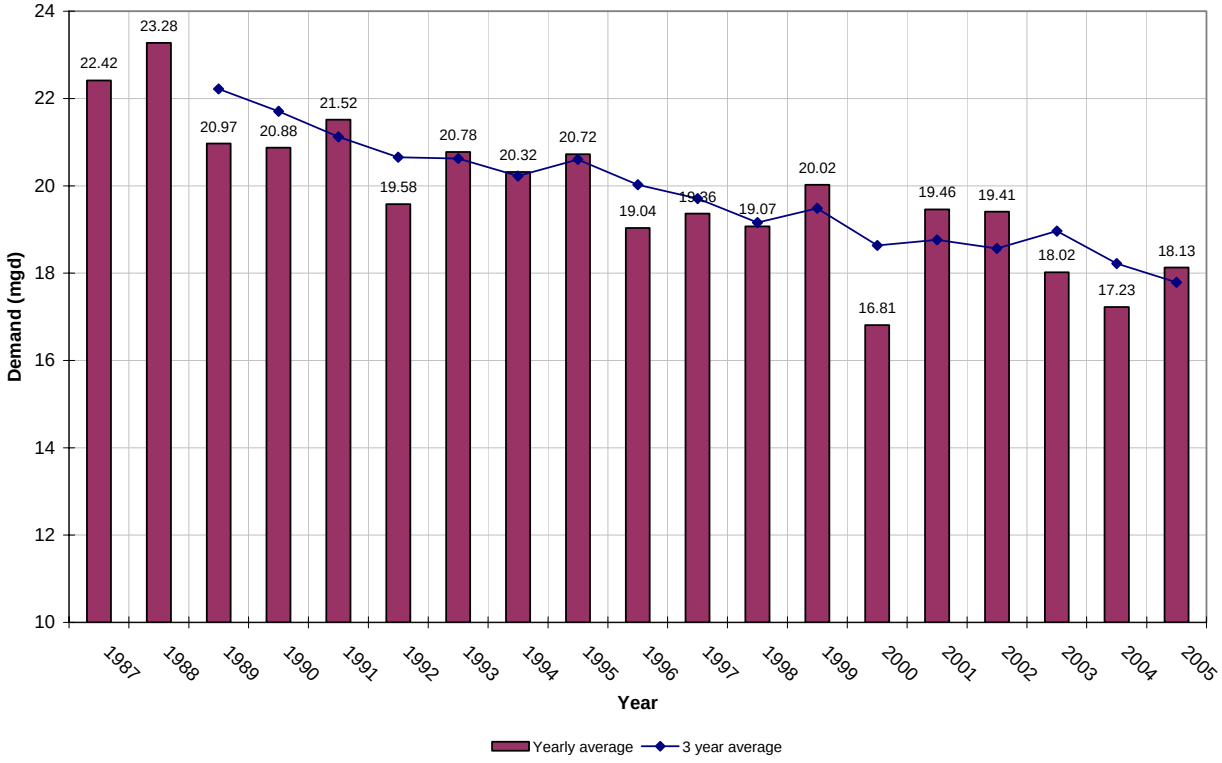
ATTACHMENT 3
HISTORICAL DEMAND IN MWRA WATER SERVICE AREAS

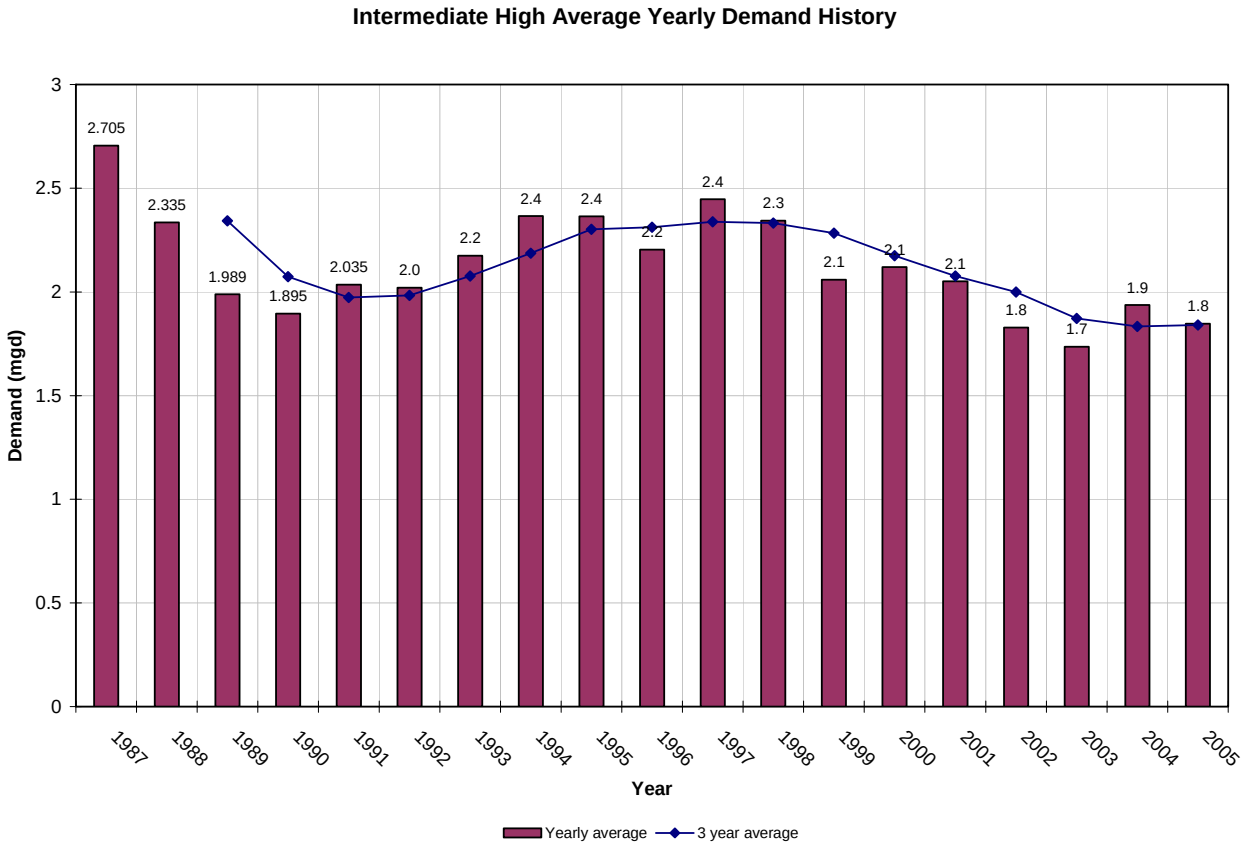

Northern High Yearly Average Demand History
Demand (mgd)
50
45
40
35
30
25
20
46.98
48.08
38.39
35.70
36.06
33.57
31.75
31.48
32.76
31.48
32.61
31.53
32.83
31.53
37.28
35.65
34.58
34.45
35.02
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year
Yearly average
3 year average

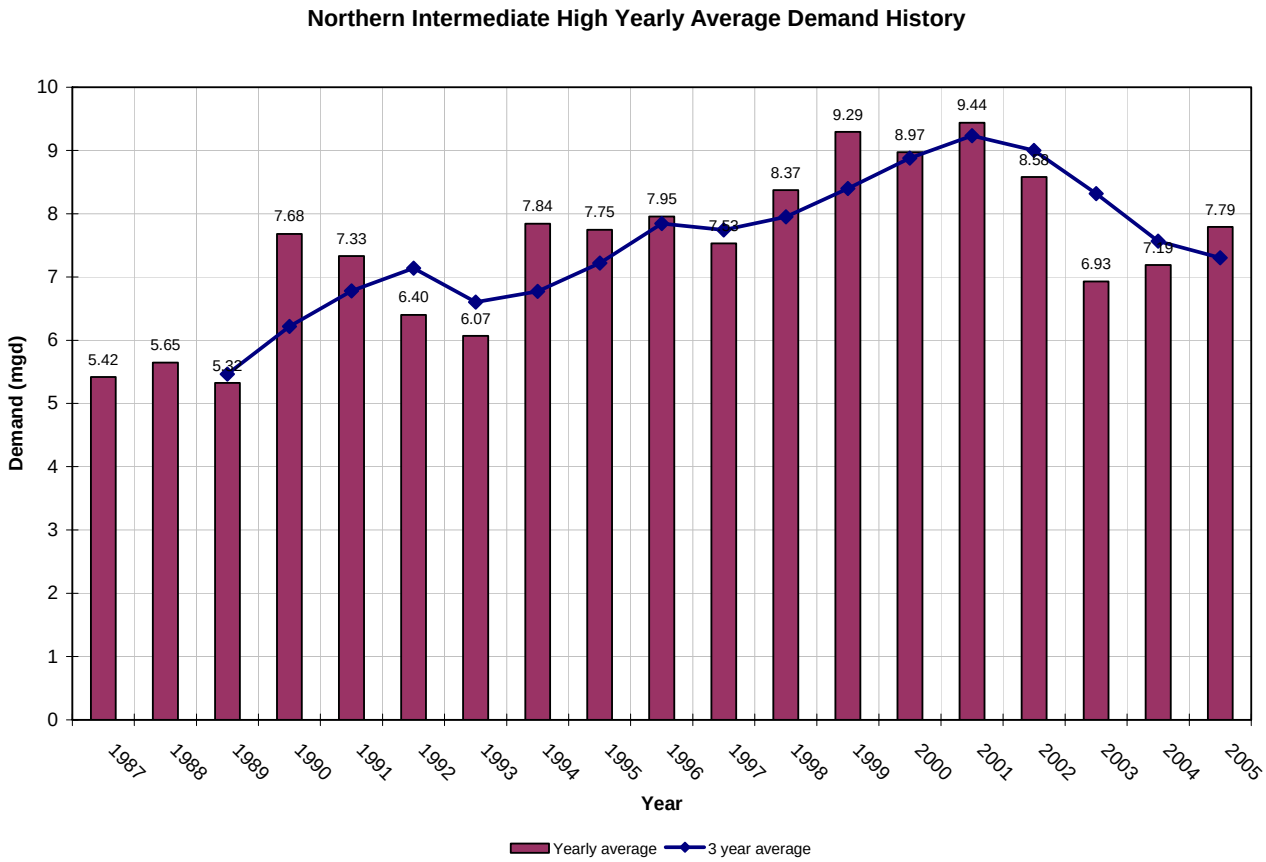
Southern High Yearly Average Demand History



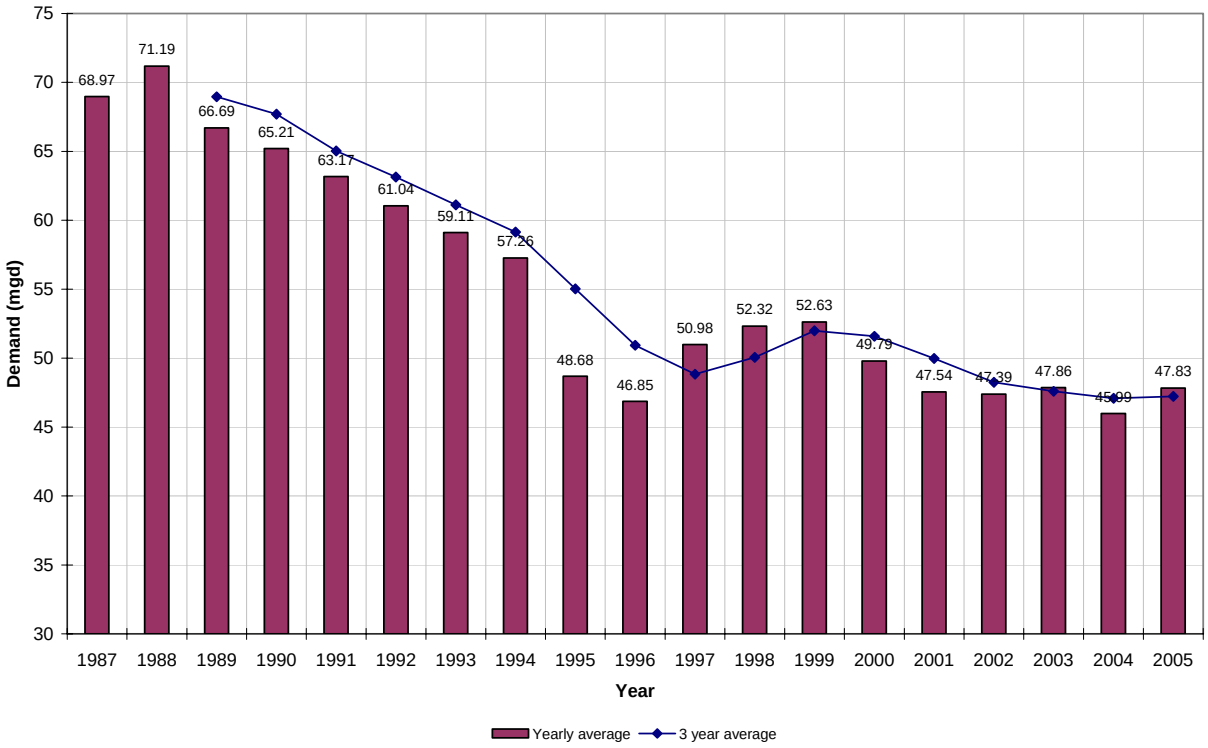
Norumbega Supply Line Average Yearly Demand History



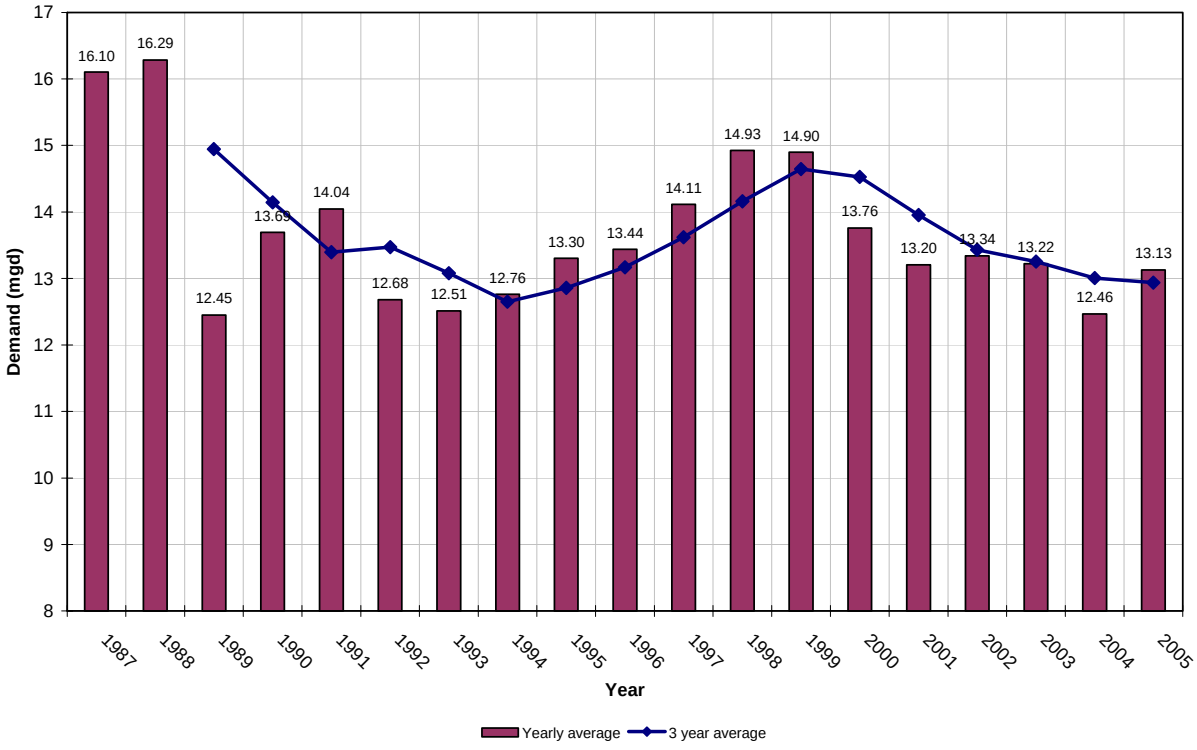

Intermediate High Average Yearly Demand History
Demand (mgd)
Year
Yearly average
3 year average
2.705
2.335
1.989
1.895
2.035
2.0
2.2
2.4
2.4
2.2
2.4
2.3
2.1
2.1
2.1
1.8
1.7
1.9
1.8

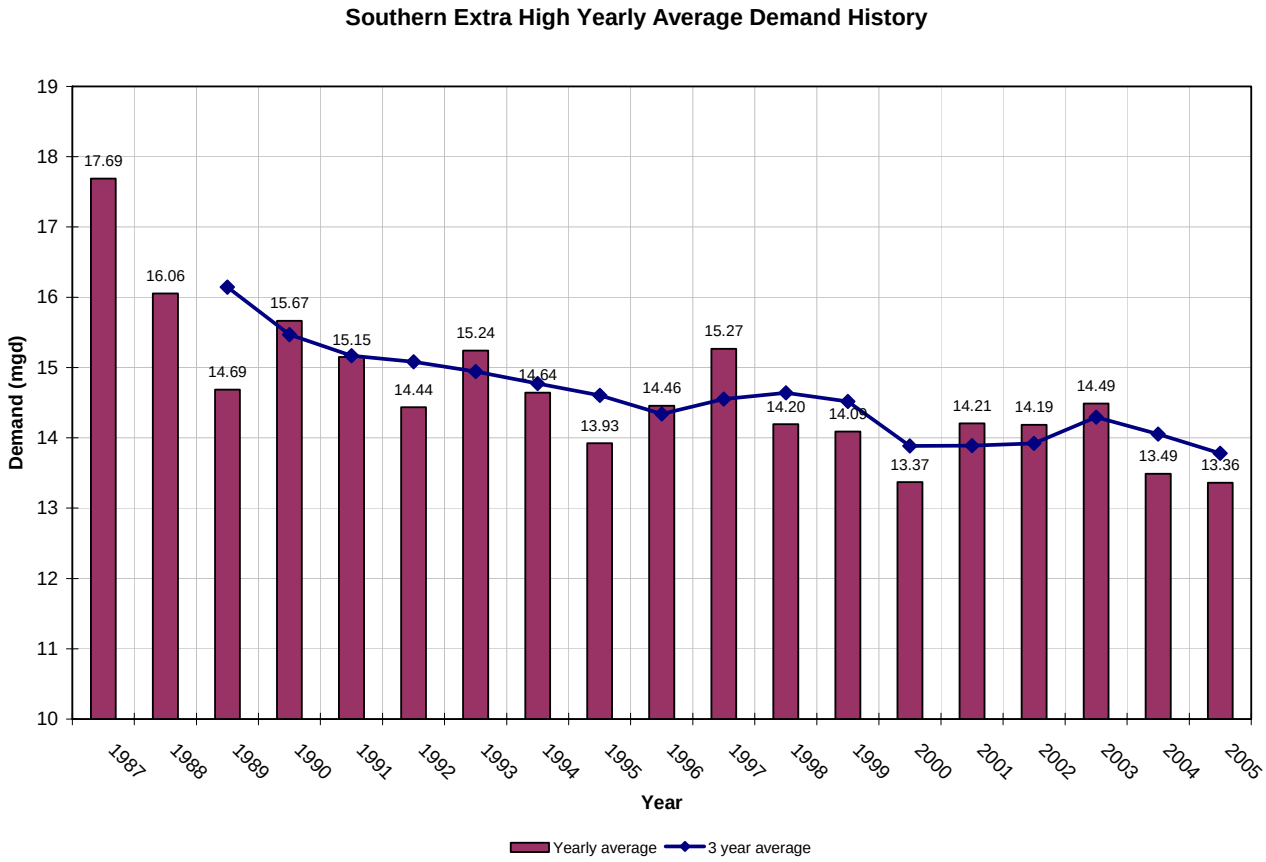

Northern Intermediate High Yearly Average Demand History
Demand (mgd)
Year
Yearly average
3 year average
5.42
5.65
7.68
7.33
6.40
6.07
7.84
7.75
7.95
8.37
9.29
8.97
9.44
8.58
6.93
7.19
7.79

Low System Yearly Average Demand History



Northern Extra High Yearly Average Demand History




Southern Extra High Yearly Average Demand History
Demand (mgd)
19
18
17
16
15
14
13
12
11
10
17.69
16.06
14.69
15.67
15.15
14.44
15.24
14.64
13.93
14.46
15.27
14.20
14.09
13.37
14.21
14.19
14.49
13.49
13.36
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year
Yearly average
3 year average

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SOURCES CONSULTED

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