Action Plan 10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies

Problem[135]

As growth in the region has increased in recent decades, both the quantity and quality of Buzzards Bay public water supplies have been threatened. In some cases, both public and private water withdrawals are cumulatively affecting wetlands, anadromous fish runs, and other wildlife habitat, particularly during droughts. Buzzards Bay's growing population is creating a need for additional water supplies, but available land to develop future water supplies is disappearing because of the intensity of land use and the loss of open space.

Goals

Goal 10.1. Protect and preserve groundwater and surface water supplies in order to ensure a sustainable supply of high quality drinking water.

Goal 10.2. Protect and restore the natural flows of rivers and the natural waters of ponds, lakes, and wetlands and the habitat that depend on them.

Goal 10.3. Maintain natural hydrology.

Goal 10.4. Protect and preserve estuarine and brackish surface water habitats in river mixing zones.

Objectives

Objective 10.1. Encourage water use conservation and increase utilization efficiency to minimize water withdrawals, system losses, and associated impacts.

Objective 10.2. Encourage water reuse for irrigation, industrial process water, and other non-potable uses within public health constraints.

Objective 10.3. Update state regulations to reduce the potential of affecting wetlands, surface waters, and other public water supplies.

Objective 10.4. Encourage LID techniques for enhanced stormwater recharge to maximize groundwater recharge.

Objective 10.5. Manage water withdrawals and wastewater discharges from existing and new development to help maintain recharge to the aquifers.

Objective 10.6. Manage equally both public and private water withdrawals in a subwatershed, including the adoption of water use rates that encourage conservation.

Objective 10.7. Limit non-essential water use during droughts.

Objective 10.8. Develop new water supplies and improve infrastructure to improve distribution and reduce redundancy to avoid over utilization of existing wells.

Objective 10.9. Identify and protect open space for future water supplies, when needed, located as far from significant surface water resources as possible to minimize potential impacts on natural water resources.

Objective 10.10. Incorporate new information, when available, from ongoing or planned state studies on water budgets and sustainable yields into local water resources planning and regulation.

Objective 10.11. Encourage accurate tracking of water use by agricultural users and promote agricultural BMP practices for water conservation.

Objective 10.12. If and when desalinization occupies a water supply role in the watershed, encourage control technologies and operational measures that minimize entrainment and impingement impacts at intakes and preserve the natural salinity structure of receiving water bodies at outlets.

Objective 10.13. Collect and maintain water use data in support of this action plan and for tracking success.

Approaches

Managing water withdrawals to minimize environmental impacts is complicated and politically challenging and will require the implementation of long-term strategies. The objectives articulated above provide a clear road map for the approach needed. Some of the strategies require adoption of new state or local regulations to meet one of the listed objectives, and DEP must prevent new withdrawals from subwatersheds with flow stressed rivers.

Costs and Financing

The costs of these solutions and the mechanisms to finance will vary with each community, and financing options will be dependent on the strategy chosen.

Measuring Success

Tracking stream flow in stressed stream watersheds, together with tracking municipal water withdrawals and agricultural withdrawals in those stressed stream recharge areas will be the principal environmental measures that need to be tracked for this action plan. Regulatory action and outreach efforts can be used to track programmatic actions.

[135] This action plan was not in the 1991 CCMP.

Background

Among the 17 Massachusetts communities and a small portion of Rhode Island that comprise the Buzzards Bay watershed, there are eight major river subwatersheds on its western shore (the Westport River, Paskamanset River, Acushnet River, Mattapoisett River, Sippican River, Weweantic River, Wankinco River, and Agawam River). This contrasts with the eastern shores on Cape Cod (Bourne and Falmouth), and the Elizabeth Islands, where there are no significant riverine flows (Figure 81). These surface and groundwater flows are an important natural resource to the area (USGS, 1990; DEM 1995)

The total volume of water available within the Buzzards Bay watershed is dependent on the hydrologic cycle (Figure 82). All water in the watershed originates as precipitation that falls upon the surface of the land and ponds and begins its journey back to the ocean. Some of that rain and snowmelt infiltrates into the ground where it replenishes groundwater aquifers and travels slowly through the aquifers before discharging to rivers, streams, or coastal waters. A large amount of this precipitation, perhaps 50% on an average annual basis, evaporates or transpires from vegetation back to the atmosphere as water vapor. Some of this precipitation runs off the land surface as stormwater runoff, or into stormwater drainage systems, quickly entering streams or manmade channels, or discharging directly to the ocean.

The relative amounts of groundwater recharge, evapotranspiration, and stormwater runoff are dependent upon climatic factors, geology, and the amount and characteristics of impervious manmade surfaces and stormwater conveyances. In addition, water withdrawals from wells or reservoirs and disposal of wastewater effluent affect the amount, distribution, and residence time of water within the watershed.

Humans can alter the natural hydrology of watersheds through the cumulative water withdrawals for drinking water, irrigation, industrial processes, or other uses. These withdrawals, together with water diversions undertaken for agriculture, or transported from impervious surfaces via stormwater drainage networks, can reduce the quantity of water available within watersheds or subwatersheds. These actions can also change the transport and residence time of water within these systems.

The effect of stormwater drainage systems on subwatershed hydrology can be important. The impervious surface area within a watershed, and the manner in which stormwater runoff from those surfaces is managed, significantly influences a watershed's hydrology, the quantity of water available to support natural water resources, and the residence time of water within the watershed before it discharges to the ocean.

Figure 81. Principal rivers and subbasins of the Buzzards Bay watershed.

Traditional stormwater management has emphasized quickly conveying stormwater away from its point of origin to ultimately discharge in wetlands or the ocean, as if stormwater was an undesirable waste product. New stormwater treatment requirements and low impact development (LID) practices that towns are now adopting are reversing this trend. These new stormwater practices minimize stormwater runoff, retaining stormwater near its point of origin, and infiltrate it to recharge groundwater supplies and increase the hydrologic residence time of water within the watershed or subwatershed. These practices increase the amount of water available within a watershed to support water resources, and can offset impacts of water supply withdrawals on groundwater. We address these principles with recommendations in this action plan and in recommendations in Action Plan 3 Managing Stormwater Runoff and Promoting LID.

The relative importance of water withdrawal impacts versus stormwater management impacts on the natural hydrology of a watershed is variable and dependent upon specific characteristics of the watershed or subwatershed. In urbanized watersheds that have few if any significant water withdrawals (water is imported from outside of the basin), stormwater management practices will be the dominant anthropogenic influence on watershed hydrology. In contrast, in predominantly rural watersheds that have significant water supply sources (perhaps supplying a nearby urbanized watershed), groundwater withdrawals are a dominant anthropogenic influence on watershed

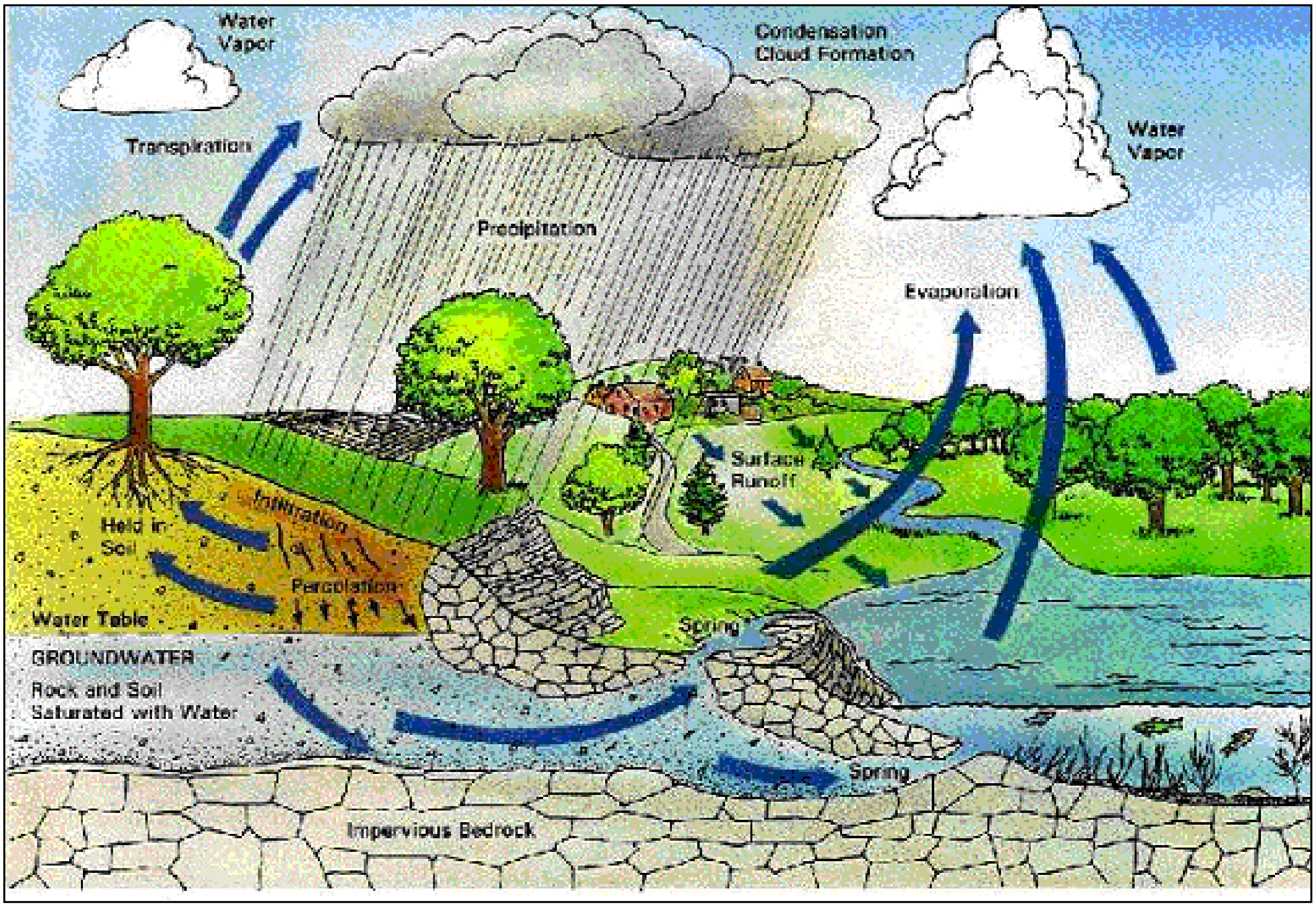


Figure 82. Illustration of the water cycle.

hydrology. Most watersheds will fall somewhere between these two extremes.

Many of the withdrawals discussed here are subject to the Water Management Act (MGL Chapter 21G), which became effective 1986. The Act authorizes the Massachusetts Department of Environmental Protection (DEP) to regulate the quantity of water withdrawn from both surface and groundwater supplies to ensure adequate water supplies for current and future water. The supporting regulations are 310 CMR 36.00.

Key components of the law are a registration program and a permit program. Since 1988, water withdrawals from ground or surface sources in excess of an annual average of 100,000 gallons per day or 9 million gallons in any three-month period must apply for a Water Management Act Permit. Within the Buzzards Bay watershed, cranberry bogs, public water suppliers, 18-hole golf courses, and sand and gravel facilities are the common uses required to obtain a permit.

Buzzards Bay Water Supplies

Of the 15 communities principally located within the Buzzards Bay watershed, eight have public water supplies located within the watershed (Dartmouth, Fairhaven, Mattapoisett, Carver, Marion, Wareham, Westport, and Bourne); two communities receive water from outside the watershed (New Bedford and Acushnet); and several communities that straddle the watershed have water supply sources both inside and outside the watershed (Falmouth, Plymouth, and Fall River). Two communities have no municipally owned water supplies, and are served either by individual onsite private wells or by small private water supply companies (Rochester and Westport).

Wells drawing groundwater account for the majority of these municipal water supplies, but surface water ponds serve large population areas including Fall River, New Bedford, Acushnet, and portions of Falmouth. The sources of all these water supplies and some of their characteristics are summarized in Table 36.

Private water supply wells serve large portions of the less developed portions of the Buzzards Bay watershed. In these areas, small-volume private wells serve individual homes, and larger volume private wells service campgrounds, restaurants, hotels, golf courses, and other private facilities that cater to the public. In a few areas, private water supply companies may serve a small portion of a community.

Figure 83 shows all of the major public drinking water wells and surface water reservoirs contained in the

Buzzards Bay watershed. This map includes some smaller volume, non-community water supplies for restaurants, campgrounds, and similar public places. The figure does not show the location of agriculture and other private irrigation wells. Figure 84 shows the service areas of these public water supply wells.

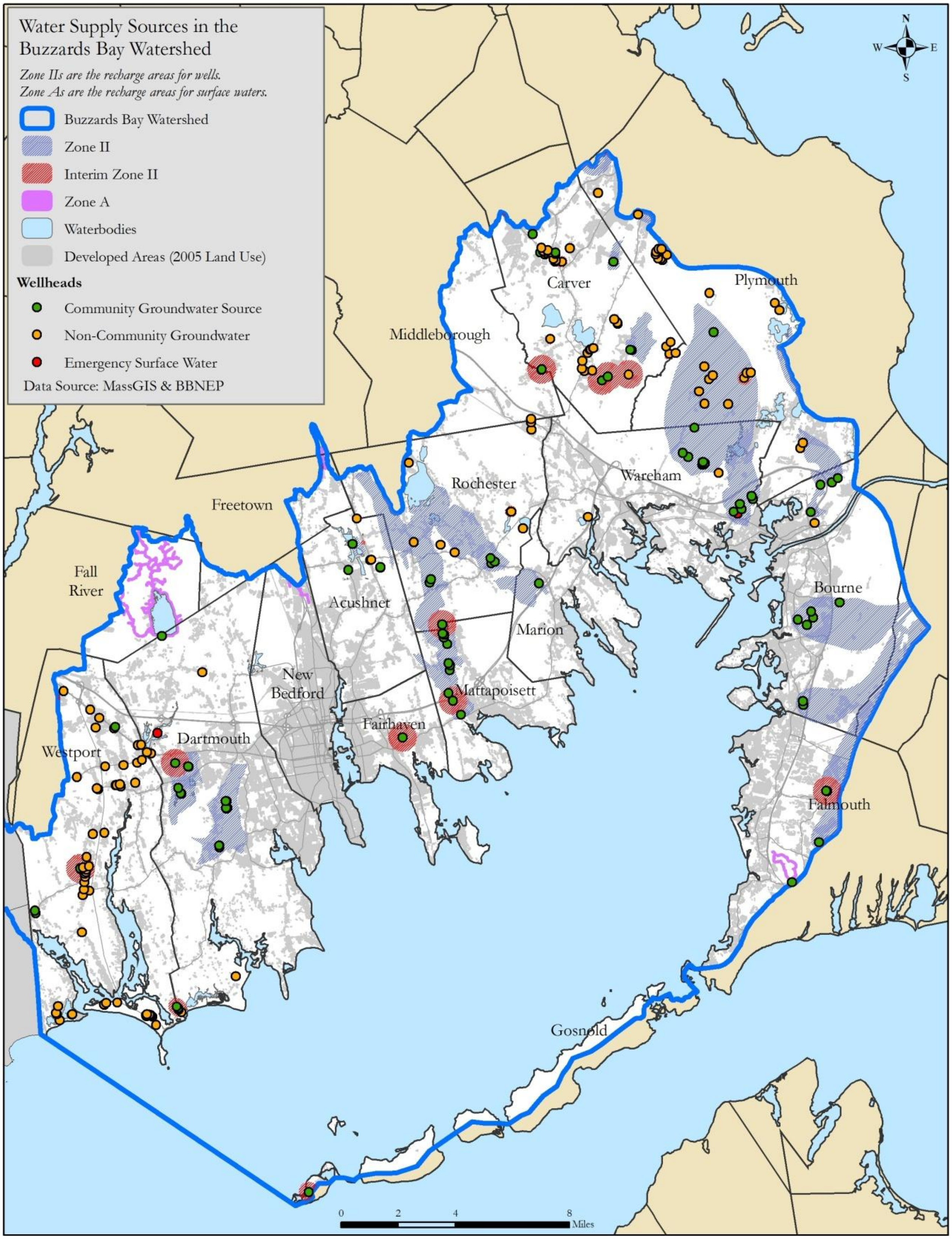


Figure 83. Water supplies in the Buzzards Bay watershed.

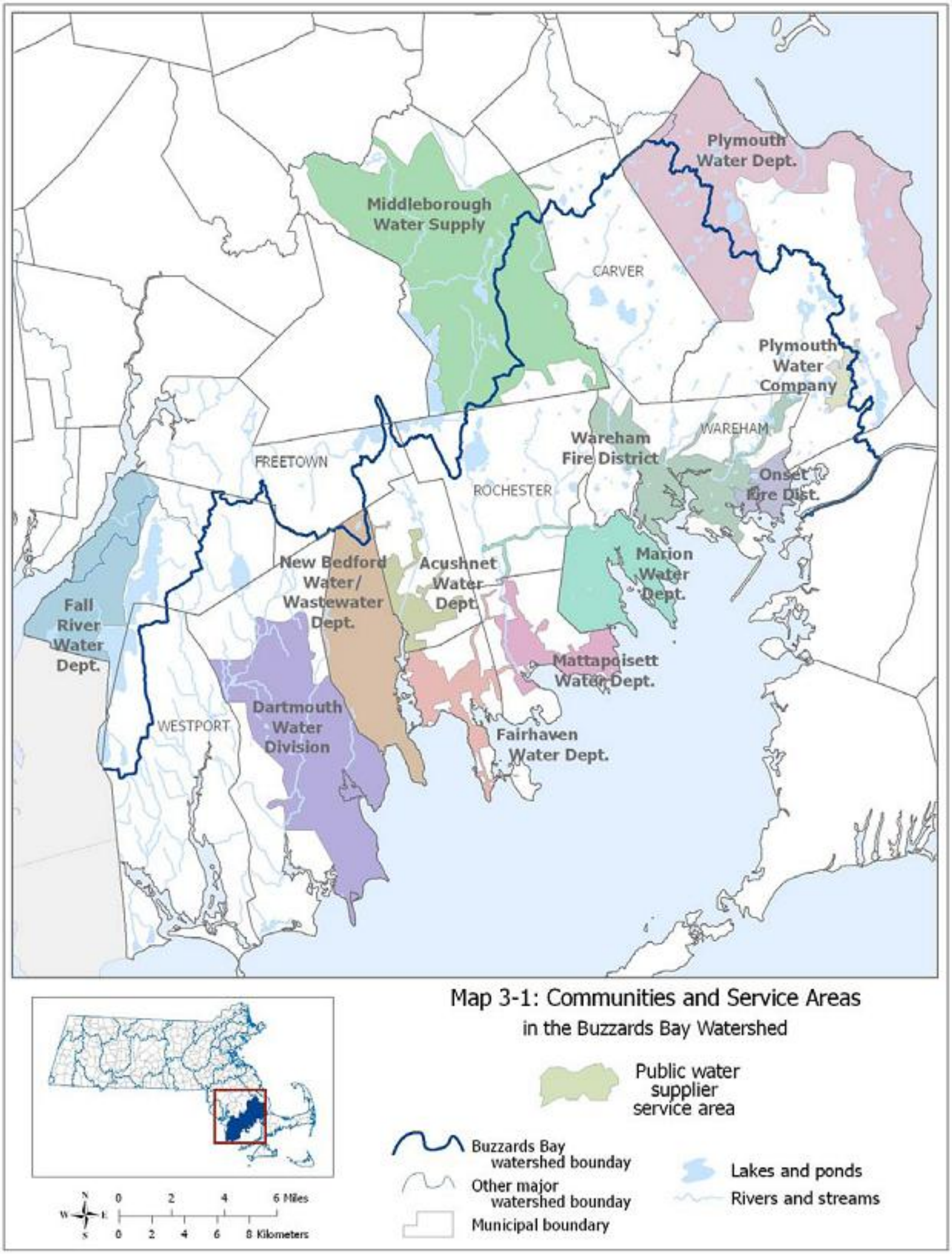


Figure 84. Public water supply service areas of the Buzzards Bay watershed.

Not shown are service areas of Bourne and Falmouth, although most areas of these towns are served by public wells. Source: EOEA (2006) Water Assets Study: Regional Summary Report.

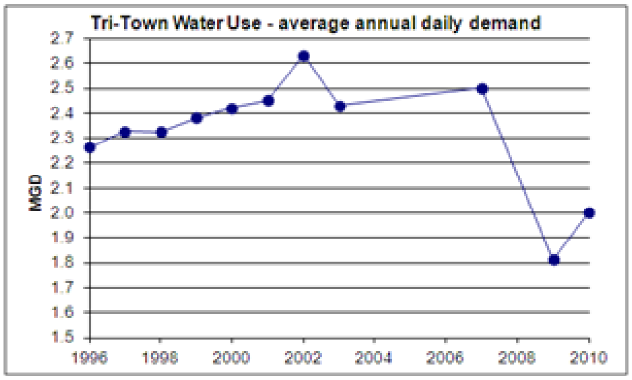


Figure 85. Combined water use in the towns of Marion, Mattapoisett, and Fairhaven.

Average water use declined with implementation of water conservation measures, but peak summer use during drought years remains high.

As noted above, the City of New Bedford obtains its water from outside of the Buzzards Bay watershed (Long and Quittacas Pond). The City's water supply system supplies water to most of the City, as well as large areas of Acushnet, Dartmouth, and Freetown. Large amounts of this drinking water, particularly from New Bedford, Acushnet, and parts of Dartmouth, are collected by the New Bedford sewer system, which discharges, into Buzzards Bay off Clarks Point. Some of the New Bedford water supply is discharged to septic systems in the greater New Bedford area, creating a net gain of water recharge into the Buzzards Bay watershed.

In other parts of the Buzzards Bay watershed, there are net transfers out of the basin. Most notably, Fall River, whose population is virtually entirely located out of the Buzzards Bay watershed, obtains some of its water from the Copicut Reservoir in Westport.[136]

Important subbasin transfers also occur, and these are not regulated by the state. For example, wells in the Mattapoisett River subwatershed supply water to the towns of Fairhaven and Marion that are in other Buzzards Bay subwatersheds (Figure 81). In fact, pumping to these two towns alone account for a transfer of 65% of the water outside the Mattapoisett River subwatershed. Similarly, Dartmouth pumps water from the Paskamanset River subwatershed, which discharges to septic systems in other subwatersheds, or discharges directly to Buzzards Bay via the town's wastewater facility. Groundwater withdrawals are highest in the Paskamanset and Mattapoisett Rivers subwatersheds, and both rivers have been identified as stressed because of municipal and agricultural water withdrawals. According to the USGS, in 1992, well withdrawals from those two subwatersheds accounted for 57% of all the groundwater used in the Buzzards Bay watershed (Bent, 1995).

All water withdrawals within the Buzzards Bay watershed, whether from large volume wells or numerous small volume wells, affect the overall water budget of the watershed. Likewise, all withdrawals within river basin subwatersheds affect the water budgets of those subwatersheds. The consumptive portion of water withdrawals (that which is evaporated, transpired by irrigated vegetation, conveyed as stormwater runoff, or transport-

Table 36. Average residential per capita water use for Buzzards Bay public water supplies as reported in 2007.

(Data from DEP from http://www.buzzardsbay.org/download/rgpcd07.pdf as downloaded 6/27/08.)

PWSID	PWS Name	Town/ City	DEP-Accepted RGPCD (gal/person/day)	DEP-Accepted Unaccounted for Water (%)
4003000	Acushnet Water Department	Acushnet	68	22
4036000	Bourne Water District	Bourne	69	9
4036001	Buzzards Bay Water District	Bourne	54	9
4036002	North Sagamore Water District	Bourne	79	8
4052001	South Meadow Village	Carver	NS	NS
4072000	Dartmouth Water Department	Dartmouth	72	10
4094000	Fairhaven Water Department	Fairhaven	63	9
4095000	Fall River Water Department	Fall River	65	22
4096000	Falmouth Water Department	Falmouth	79	20
4169000	Marion Water Department	Marion	81	11
4173000	Mattapoisett Water & Sewer Dept	Mattapoisett	55	6
4182000	Middleborough Water Supply	Middleborough	69	9
4201000	New Bedford Water Department	New Bedford	59	14
4239000	Plymouth DPW Water Division	Plymouth	83	14
4239045	Plymouth Water Co.	Plymouth	167	6
4239055	Pine hills LLC	Plymouth	65	3
4310000	Wareham Fire District	Wareham	60	13
4310003	Onset Fire District	Wareham	45	17

[136] Fall River Water Department is authorized to withdraw a combined volume of 14.59 MGD from a linked reservoir system that is located within two basins: the Copicut in the Buzzards Bay watershed and the North and South Watuppa Ponds located in the Mt. Hope watershed. A single source meter is located at the point at which the water from the Copicut enters the North Watuppa Pond. (DEP 2000 Buzzards Bay Water Quality Assessment Report.

Photo courtesy of the MAFWS Riverways Program.

Figure 86. More than 1000 feet of the Mattapoisett River ran dry in October 2007.

ed out of basin and not returned through wastewater discharges or infiltration of excess irrigation water) represents a cumulative loss of the overall water available within the watershed or subwatershed to sustain water resources and their associated flora and fauna. Whether these withdrawals and transfers have impacts that must be addressed by management, action depends on a number of factors.

Local officials and residents often under appreciate the environmental impacts of municipal water withdrawals because of misconceptions about the sources of their water supplies, or a lack of appreciation that surface water supplies and groundwater supplies are fundamentally connected. Confusion arises also when groundwater withdrawals are taken below impervious sediment layers (confining areas) which prevent a "cone of depression" forming in the water table around the wellhead. Even in those situations, sufficiently high water withdrawals will cause a lowering of the water table over a broad area around the wells, which can lower pond levels and dry out wetlands.

In general, larger water withdrawals located closer to surface freshwaters and wetlands will potentially have a more immediate and noticeable impact on those water resources, especially during drought years. A well that is located 100 feet from a river will intercept groundwater that would have previously traveled to that river in a period of weeks to months whereas a well that is located miles from that river represents years of groundwater travel time away from the river. Therefore, withdrawals from a nearby well that occur during natural low flow periods contribute quickly and directly to reduced and noticeable low flows. In contrast, withdrawals located years of travel time away from a water resource may affect that resource at a time of higher natural flows or affect that resource over a longer period, resulting in a less noticeable change.

If water withdrawals are also exported out of a watershed or subwatershed, the potential impacts can be exacerbated because there is no groundwater return flow from septic system discharge or lawn watering. While the return flow from septic systems is usually a small percentage of most subwatershed budgets, it may be locally significant in a few stressed watersheds. This coupled with past practices to direct stormwater flow into surface waters, instead of recharging to groundwater, can exacerbate the problems related to low river flows.

Impacts to the Mattapoisett River

Water withdrawals appear to have already affected the Mattapoisett River, and unmanaged future water withdrawals from either Snipatuit Pond or from wells in the Mattapoisett River Valley will likely threaten the flow and biological integrity of the Mattapoisett River. These withdrawals include both public and private water supply servers, agricultural withdrawals, and private wells. The largest of these withdrawals are the municipal public wells serving the towns of Mattapoisett, Fairhaven, and Marion, which are close to the river (see Figure 83).

The first assessment of groundwater in the River Valley was conducted by Metcalf and Eddy (1980). A 1984 U.S. Geological Survey study (Olimpio and de Lima, 1984) of stream flow and groundwater found that groundwater withdrawals on the Mattapoisett River depleted stream flows as compared to upstream sections or other similar nearby streams. An earlier study by the Department of Environmental Management's Office of Water Resources also found that water withdrawals from the Mattapoisett River 1980-1981 equaled 87% of estimated base flow. Furthermore, the USGS study concluded that an estimated 78% percent of the Mattapoisett River basin well water is discharged outside of the river subbasin where it serves populations in Marion and Fairhaven. These studies estimated that with the current wells in place along the river, peak water withdrawals exceeding 4.0 MGD during a summer drought period would result in the river running dry.

In September 1999, the Mattapoisett River ran dry for the first time. This occurred during drought conditions, and peak water withdrawals exceeding 4.0 MGD. The river ran dry again 2007 (see Figure 86 and Data from USGS 2008 Water Data Report for station 0110591). The Massachusetts Department of Fish and Game Riverways Program maintain an online "Low Flow Inventory" website[137] that notes that the Mattapoisett River has already experienced low flow problems. They wrote "In September of 1999, a freshwater mussel surveyor for the Massachusetts Natural Heritage and Endangered Species Program found a series of deep pools with little flow between them on the Mattapoisett River at the Route 6 crossing in Mattapoisett. Further upstream just

[137] www.rifls.org/. Last accessed October 13, 2013.

north of Route 195 in Mattapoisett [in the vicinity of public wells], the river was "bone dry," and local kids were riding their ATVs up and down the stream banks." This report further notes these low flows may be caused by groundwater withdrawals.

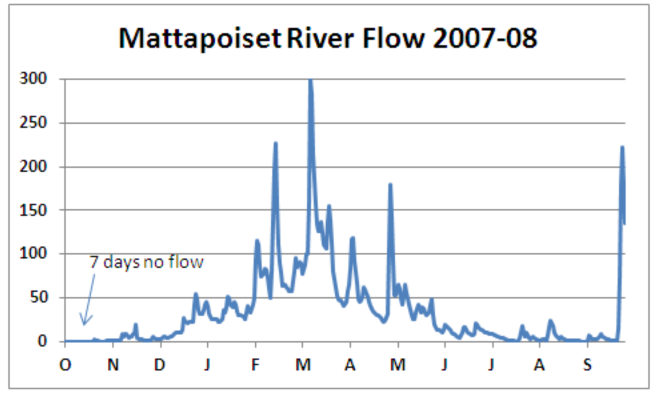
The source of the increased water demands within the watershed is clear. Between 1990 and 2000, the population in the Mattapoisett River watershed increased 10.8%, or roughly 1% per year. The population served by these municipal wells is now around 29,000 during the summer, has increased at about the same rate. Between 1996 and 2003, average water use has been increasing at a faster rate of 1.5% per year. While there is considerable variability on water use from year to year (compare 2002, a drought year to 2003 a wet year), municipal data shows that not only is water demand increasing with population, but average annual per capita usage is increasing as well.

Increased water use by cranberry bogs also contributes to this demand. In the early 1990s, there were 275 acres of cranberry bogs in the watershed, mostly around Snipatuit Pond. A decade later, at least 100 additional acres were added, also mostly around Snipatuit Pond.

In 1997, the state legislature passed a law creating the Mattapoisett River Valley Water Supply Protection Advisory Commission (henceforth the "River Valley Commission"). This River Valley Commission has been collecting roughly $80,000 in fees annually from its water customers. To date, these funds have been used principally to help buy land and protect open space in the aquifer or to fund various water use and withdrawal studies.

Water use regulations may not always be optimally effective at protecting water resources or uniformly applied between different communities. The Interbasin Transfer Act applies only to transfers between major basins (e.g. in and out of the Buzzards Bay watershed) and not between specific subwatersheds (e.g. in and out of the Mattapoisett River watershed. This Act, as well as the Water Management Act which regulates all significant water withdrawals in the Commonwealth, includes registered or grandfathered water withdrawals that were in place before the Acts were implemented.

A compilation of permit information for all of the Buzzards Bay watershed communities has not been performed for this action plan. However, in general, different communities may have different permit conditions dependent upon the specifics of their individual withdrawals, and how long ago those withdrawals were either registered or permitted. Water use restrictions in individual communities are sometimes tied to DEP permit requirements so those restrictions may vary from community to community. In addition, communities may impose restrictions based upon other independent factors. The result is that water restrictions may not be uniform between individual communities within the watershed



Data from USGS 2008 Water Data Report for station 0110591
. Figure 87. Mattapoisett River gauged river flow.

and may not be transparently tied to observable climatic and or hydrologic communities.

The Commonwealth has also developed a set of water conservation standards for use throughout the state. However, these standards are not concretely tied to regulatory acts to encourage or require their adherence. Some towns may elect to use these standards as guidance, but there is no requirement at this time to follow them.

Agricultural Withdrawals

Another important water use in the Buzzards Bay watershed relates to the cultivation of thousands of acres of cranberry bogs. The majority of Massachusetts' approximately 13,000 acres of cranberry bogs[138] are located in the Buzzards Bay watershed. Cranberry farming is a water intensive agricultural activity, with large amounts of water used for frost protection, irrigation, cooling, and harvesting (Bent, 1995). In some systems like the Weweantic River, bog operations have appreciably manipulated stream flow (Masterson et al., 2009, p. 77). Bogs require irrigation through the growing season while flooding is undertaken for the fall harvest and winter frost protection. Hansen and Lapham (1992, p. 9) estimated that 84 percent of the water supplied for use on cranberry bogs is from ponds and reservoirs. Much of the water used in cranberry farming is eventually returned to the watershed when the flooded bogs are drained back to tributary streams or ponds, with some floodwater infiltrating into groundwater, and some flood and irrigation water lost through evapotranspiration.

The recharge to groundwater from precipitation and floodwaters on cranberry bogs has been considered in two USGS studies in the Buzzards Bay watershed. In the first hydrologic investigation of the Plymouth-Carver Aquifer, Hansen and Lapham (1992) estimated that cranberry bogs constitute a negative 17 inches per year loss of aquifer recharge per unit surface area. Masterson et al. (2009, p. 9) affirmed this estimate and concluded

[138] USDA, NASS New England Field Office Massachusetts Statistics for 2012.

Table 37. Drought restrictions enacted by Buzzards Bay watershed municipalities.
(Information collected by the Buzzards Bay NEP from Buzzards Bay municipalities in 2008.)

Municipality	Mandatory Restrictions	Odd-Even Watering	Other	Fines	Percent On town water	Private Well Restrictions
Acushnet	NB applies to Acushnet					No
Bourne	Yes	Yes	No auto sprinkler	$50 first, $100 thereafter		Yes
Carver	No PWS				No PWS	No
Dartmouth	No				90	No
Fairhaven	Yes				90	No
Fall River	No. Notices put in paper					No
Falmouth	Yes	Yes	Pistol grip required, no washing sidewalks, restaurant water on request	$50, $100, shut-off on 3rd offense		No
Gosnold						No
Marion	Yes	Yes	6:00 a.m.-8:00 a.m. 6:00 p.m.-8:00 p.m.	$50 first, $100 thereafter	98	No
Mattapoisett	Yes	Yes	no pools, auto-sprinklers, or outdoor watering. Can water only during hours specified	$50 first, $100 thereafter	84	No
Middleborough	Yes	Yes	6:00 a.m. - 9:00 a.m. 6:00 p.m. - 9:00 p.m.	$50 first, $100 thereafter		No
New Bedford	Yes				>95	No
Plymouth	Yes	No	5:00 a.m-7:00 a.m. only			No
Rochester	No PWS				No PWS	No
Westport	Comes from Fall River				0	No
Wareham	Yes	Yes	does not apply to water use by hand held hose		48	No

whereas rainfall recharge to the aquifer as a whole was 27 inches per year, recharge in bogs was 10 inches per year. This amount was actually 2 inches higher than natural vegetated wetlands and was based on the assumption that flooded bogs acted more like ponds (which contribute 20 inches of recharge per year) during those periods when cranberry bogs are flooded. It is worth stressing these values are based on annual budgets, and during the summer, bogs become net sinks when surface evaporation and plant transpiration exceed precipitation Masterson et al. (2009, p. 77).

Whether cranberry bog water use recharges to groundwater or is discharged to streams is less important than the potential reduction or cessation of stream flows that may occur during periods when streams are diverted to flood bogs, or when high volumes of groundwater or pond water is withdrawn. Because large water withdrawals (whether for agriculture or municipal water supplies) have a potential to affect the wetlands and aquatic habitat, they are subject to the aforementioned Water Management Act.

Cranberry growers with less than 4.66 unregistered acres of "old style bogs" in production do not require a WMA permit[139]. Best management practices for "new style bogs" not requiring a permit for a 9.33 acre threshold include bog construction laser leveled (or equivalent) to 6 inches, implementation of a tail water recovery system, and irrigation systems and water control structures (dikes and flumes) that meet USDA National Resources Conservation Services (NRCS) standards. The total cumulative magnitude of cranberry bog consumptive water use in the watershed relative to other water withdrawals is unknown.

As noted in Action Plan 8 Restoring Migratory Fish Passage, MA DMF has noted that large numbers of juvenile herring have been killed in the past due to cranberry bog operations. Reback et al. (2004) suggest that growers employ a simple, inexpensive screening system that has been developed that will prevent most of these losses. They recommended that appropriate screening of

[139] According to a 2004 Cape Cod Cranberry Growers' Association grower advisory on the WMA, "the difficulties in metering water usage in cranberry bogs led the Department to agree to issue registrations base on acreage. In 1987, taking into account water used for harvest or trash flow, for initial winter flood, and for fall frost protection this acreage was calculated to be 4.66 acres."

Table 38. Rates and customers of Buzzards Bay water providers.

Municipality or District	Basic Rate	Volume included with base rate and/or rate for additional volume	Average Annual Cost (b)	Primary Water Source Type (a)	Estimated Peak Seasonal Population Served
Acushnet (from NB)	$2 hcf		$254	primarily sw	2,750
Bourne Water District	$48/year	0 included in base charge, all use at an additional $2.25/1000 gal	$251	gw	20,000
Buzzards Bay Water District	$66/year	40,000 included, excess charged $2.75/1000 cf up to 100,000 $3.75/1000 over 100,000	$198	gw	7,500
South Sagamore Water District	$48/year	$2.25/1000 gal	$251	gw	1,000
Carver	no town water				
Dartmouth	$44.10/yr	3200 cf/year, $19.85/1000cf next 900cf $23.15/1000cf next 1600cf $17.56/cf next 1950cf last step $31.97/1000cf	$259	gw	29,000
Fairhaven	$2.13/hcf		$256	gw	16,066
Falmouth	$2.36/hcf		$283	mostly sw	77,500
Marion	$90/year	$18.70/1000cf 0-5000cf $43/1000cf-5001-10,000cf	$363	gw	7,800
Mattapoisett	$92 year (5/8" meter) $120 year (3/4" meter)	2.37/hcf 1-2000 cf $3.25/hcf over 2000cf	$411	gw	6,800
Middleborough	$72.12/yr	2000 cf annual (500 cf/quarter) $1.51/hcf-500-2500 cf; $2.33/hcf 2600-2500 cf; $3.57/hcf over 25000 cf	$240	gw	17,000
New Bedford	26.17/yr	$1.05/cf	$157	sw	79,000 (2x accounts)
Plymouth		$1.33/hcf to 3000cf $1.59/hcf 3001-9000 cf $1.89/hcf over 9000cf	$175	gw	53,000
Rochester	no town water				
Wareham Fire District	$150/yr	8000 cf included, $2.40/hcf for excess	$246	gw	20,000
Onset Fire District	$150/year	7000 cf /yr included, with $2.19/hcf -7001-14000 cf $2.29/hcf 14001-100,000cf, $2.35/hcf over 100,001 cf	$260	gw	6,500
Westport	no town water				

Information collected by the Buzzards Bay NEP from Buzzards Bay municipalities in 2007. Abbreviations: sw=surface water, gw=ground water.

water withdrawal intakes to prevent stranding, mutilation, entrainment, or impingement of young herring should be made a condition of any WMA permits issued to growers.

Major Issues

An early study by the Massachusetts Department of Environmental Management's Office of Water Resources found that water withdrawals from the Mattapoisett River subwatershed in 1980-1981 amounted to 87% of the estimated base flow in the river, and that withdrawals from the Paskamanset River subwatershed equaled 21% of estimated base flow in the river.

In a 1995 study of the hydrology of the Buzzards Bay watershed (Bent, 1995), the USGS identified well withdrawals within the Paskamanset River and Mattapoisett River subwatersheds as having significant impacts on the flows of both rivers, particularly during natural low flow periods. Approximately 78% of the groundwater pumped from the Mattapoisett River subwatershed is transported out of the subwatershed to supply other communities.

Most water withdrawn from the Paskamanset River subwatershed by the Town of Dartmouth serves homes outside the subwatershed. Most of this exported water serves homes tied into the town sewer system that discharges directly to Buzzards Bay. Estimated stream flow deficits for both subwatersheds were of similar magnitude to the water exported out of the subwatersheds for water supply. Furthermore, stream flow measurements in the Paskamanset River subwatershed upstream and downstream from significant groundwater withdrawals proximal to the river showed that the stream flow deficit measured between the two stations was approximately equivalent to the water volume pumped from the intervening wells.

In the 1980s and 1990s, models and studies of the Mattapoisett River aquifer predicted that the Mattapoisett River would run dry if the existing municipal wells withdrew 4 million gallons a day during drought conditions. In 1999, the Massachusetts Natural Heritage and Endangered Species Program observed the upper reaches of the Mattapoisett River to be dry with some isolated pools of water near town wells for Marion, Fairhaven, and Mattapoisett located close to the river. This was the first time the river was known to have run dry, and it occurred during drought conditions with peak water withdrawals exceeding 4.0 MGD.

In 2004, the Buzzards Bay Coalition (then called the Coalition for Buzzards Bay) assisted DCR's RIFLs program and began monitoring the Mattapoisett River. The River again ran dry in 2007, under drought conditions and with water withdrawals exceeding 4 MGD. To date, only the Mattapoisett and Paskamanset rivers are suspected to be significantly impacted by water withdrawals, but smaller river systems have been unstudied.

The relative importance of increasing impervious surfaces and stormwater management in any of the Buzzards Bay subwatersheds is likewise uncertain. However, without concerted attention to sustainable development practices and water conservation, increasing population and development in the subwatersheds will tend to reduce the amount of available groundwater recharge while simultaneously increasing the demand for water withdrawals. This will result in an overall decrease in the water budget for the watershed.

Although only two of the Buzzards Bay river subwatersheds were identified as having documented and significant impacts to water resources because of water withdrawals, the recommendations here are sound policy for all subwatersheds in the Buzzards Bay watershed. With approximately 45 inches of annual precipitation, adequate water is available to supply necessary water to a growing population without significant impact on sensitive water resources. Those subwatersheds that are not currently identified as stressed or have not experienced significant water resource impacts can plan now for future population growth in an environmentally sustainable manner. Communities in the Paskamanset River and Mattapoisett River subwatersheds, where impacts have already been documented, would be advised to follow the management approaches described here in order to not only maintain the current hydrologic balance but to improve the balance so that more water is available for local aquifer recharge than is currently the case.

There are other cumulative impacts to water withdrawals not fully explored here. These include impacts to private wells, combined demands of agricultural and municipal wells on the same system, and how water withdrawals may be affecting the flows of cold-water streams. These issues warrant further study.

Management Approaches

Water resource management in the Buzzards Bay watershed should strive to protect and preserve groundwater and surface water supplies in order to ensure a sustainable supply of high quality drinking water and to protect wetlands and habitat that depend on those water supplies. These seemingly contradictory goals must be met to ensure an adequate quantity and quality water supply for a growing population, while simultaneously protecting sensitive water resources. Clearly, these goals can only be met through a comprehensive strategy that includes conservation, management of uses, requiring more water reuse, as well as stormwater management practices as epitomized by LID practices. Tools for estimating sustainable yield are available (e.g. Archfield et al., 2010) to guide well development, but a better understanding is often needed to predict withdrawal impacts on wetlands, as well as the effects of impervious area in watersheds.

For all these reasons, managers should strive to preserve or restore the natural hydrology of subwatersheds to the greatest extent practicable. This is achieved by:

- keeping water use local at the subwatershed level (where practical),
- adopting water conservation measures,
- uniformly regulating both public or private withdrawals (including agriculture),
- limit non-essential water use during droughts,
- encourage the reuse of treated wastewater for irrigation and industrial use, and
- implementing stormwater LID management practices to maximize groundwater recharge.

In addition, when new water supplies are needed, efforts should be made to site them as far from significant surface water resources as possible, and ensure all the practices above are implemented.

For some non-impacted subwatersheds where maintaining current hydrologic conditions may be adequate, following such practices may be relatively easy. In contrast, regulators may need to take action that is more dramatic in apparently impacted subwatersheds like the Mattapoisett River valley and the Paskamanset River watershed.

In recognition of the daunting challenge in providing an abundant supply of safe drinking water to the public, government officials have begun to consider desalinization as an option for diversifying potable water supplies. While no desalinization, plants are currently planned for the Buzzards Bay watershed, two plants have been planned in the neighboring Taunton River and Mount Hope Bay watersheds, and three other proposals are being explored in coastal Massachusetts. Impacts to the environment from desalinization plants can arise from both entrainment and impingement at the intake and discharges of concentrated brine at the outfall. The Executive Office of Energy and Environmental Affairs has drafted a comprehensive statewide policy for addressing environmental issues and to ensure that desalinization plants do not damage water quality or habitat.

Financial Approaches

In most Buzzards Bay municipalities, the costs of developing new sources and maintaining existing water supplies are funded by ratepayers through an enterprise fund. If a town does not yet have an enterprise fund, adopting one becomes a financial solution in those cases. Most of the actions to meet this plan have relatively low real costs, as most of the effort focuses on better planning, management approaches, and encouraging of water conservation measures. Some of the more expense actions involve eliminating water loss in old water distribution systems.

Monitoring Progress

Documenting stream flow with respect to precipitation, and documenting times when rivers run dry, especially in known stressed stream watersheds, together with tracking municipal water withdrawals and agricultural withdrawals, will be the principal environmental measures that need to be tracked for this action plan. Regulatory action, changes in residential average water use, and outreach efforts can be used to track programmatic actions.

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