August 11, 1998

David Pincumbe
US EPA
Boston, MA 02203

re: Nitrogen loading in the Wareham River watershed

Dear Mr. Pincumbe:

As you requested, I have reexamined nitrogen loading estimates and recommended nitrogen loading limits for the Wareham River watershed as reported by the Buzzards Bay Project in its 1994 nitrogen subwatershed evaluation, the updated information prepared by Wareham's as estimated in the 12/16/96 correspondence from Massachusetts Coastal Zone Management to Mr. Ron Lyburger of the Massachusetts Department of Environmental Protection, and any new data gathered by the Buzzards Bay Project or loading assumptions now employed by the Buzzards Bay Project.

In particular, you have requested that these loadings be examined with respect to potential expansion of the Wareham Wastewater Treatment Facility, and its discharge to the Agawam River and Wareham River Estuary, and the Buzzards Bay Project's nitrogen loading strategy as defined in the Buzzards Bay Comprehensive Conservation and Management Plan finalized in 1991. Based on recent discussions I have prepared this preliminary evaluation report for consideration.

Sincerely,

Joseph E. Costa, Ph.D.
Executive Director

cc: Ron Lyberger, MA DEP
Tom Delair, MA DEP
Jeff Gould, DEP-SERO
Peg Brady, MCZM
Dave Janik, MCZM-South Coastal
Joe Murphy, Town of Wareham

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Evaluation of Nitrogen Loading and Water Quality of the Wareham River Estuary as it Relates to the Wareham Wastewater Treatment Facility.

By

Joseph E. Costa, Ph.D.

Buzzards Bay Project National Estuary Program

August 11, 1998

Introduction

The US EPA will soon draft a renewal permit for the Wareham wastewater treatment facility. This facility discharges to the tidal portion of the Agawam River, which in turn is part of the Wareham River Estuary. One of the considerations when reviewing discharges of any wastewater facility to coastal waters is the loading of nitrogen and its impacts on ecosystem health. Such a loading evaluation is especially important when those discharges are to a poorly flushed coastal embayment as is the case of the Wareham River.

Because the renewal of the Wareham wastewater treatment plant is currently under review, the Buzzards Bay Project (BBP) has conducted an analysis of data we have on hand, particularly land use information, flushing data, and water quality data undertaken by Buzzards Bay Citizen Water Quality monitoring program. We have also evaluated data summarized in a 1996 critique of the Buzzards Bay project's 1994 nitrogen loading evaluation by the Town of Wareham's consultant, Camp Dresser and McKee (CDM), and a response to this critique dated December 1996 from the Massachusetts Coastal Zone Management Office to the Massachusetts Department of Environmental Protection. In this report we focus on the relative loading contribution of the Wareham sewage treatment facility and other watershed sources and how they compare to the recommended nitrogen loading limits for the Wareham River estuary as a whole as defined by the methodologies contained in the Buzzards Bay Comprehensive Conservation and Management Plan adopted by the state in 1991. This report does not address the localized impacts at the wastewater discharge site in the Agawam River.

Watershed Characteristics, Hydrology, and Nitrogen sources

The BBP characterized the Wareham River Estuary drainage basin based on 1985 land use statistics (BBP, 1984). Important features of the drainage basin include the fact that it is the third largest drainage basin in the Buzzards Bay watershed, but is among the least developed. Agricultural land, however, mostly as cranberry bogs, accounts for 10% of the land area, with an equal area defined as developed.

Table 1. Wareham River Estuary and Watershed characteristics [1].

Parameter	quantity	units	Rank of 30
Sub-basin Characteristics[2]			
Land area (= 11,343 ha)	28,028	acres	3
Fresh surface waters (= 606 ha)	1,497	acres	
Salt marsh (= 98 ha)	241	acres	7
Embayment Characteristics			
Embayment area (= 249 ha)	615	acres	5
residence time, spatial model	4.2-7.4	days[3]	
residence time, numerical model, avg. tide	5.75	days[3]	
Mean depth (mean low water)	0.96	m	
Mean depth (half-tide)[4]	1.6	m	
Land Use			
Forest	75.3	%	5
Residential	6.0	%	26
Total developed	9.7	%	24
Agriculture use (primarily bogs)	9.6	%	11
Demographics			
Population 1990 US Census		10,009	7
Housing Units Est. from 1990 US Census		5,200	5
Occupancy Rate		1.9 per unit	

[1] Data from the 1994 BBP subwatershed evaluation report unless noted.
[2] Basin coverage by town: Plymouth: 52%, Wareham: 37%, Carver: 12%
[2] Aubrey Consulting, Inc. 1995
[4] Half tide volume is used to calculated N-limits in the BBP nitrogen loading

The estuary is the fifth largest in Buzzards Bay, but is fairly shallow (only 0.96 m MLW). For the BBP's N methodology, the estuary's half-tide depth (1.6 m) and volumes are used in the calculations for determining nitrogen limit.

For the 1994 subwatershed evaluation, hydraulic turnover or residence time of the estuary was conservatively assumed to be 7.4 days (178 h), the longest value Aubrey Consulting, Inc (ACI) identified using their spatial model for the upper 1/3 of the embayment. ACI actually gave a range of 4.2 to 7.4 days represent a plausible range of dispersion coefficients. Using a different approach defined as a

Numerical Model, ACI estimated the upper embayment to have a residence time of 3.5 days during spring tides, 5.75 days during average tides, and 8.0 days during neap tides. The BBP's N methodology calls for using average summertime tidal flushing conditions and mid tide volumes. There is good agreement between the middle of the range given for the spatial model (5.8 days) and the numerical model for average tide conditions (5.75 days). Both models have their limitations, and a dye study and additional monitoring may be warranted to better define flushing in the upper third of the estuary. Whether to use the upper bounds or the predicted average as the residence time in the nitrogen loading calculations is a management decision. In this report we use the 5.75 days average tide numerical model result in our calculations.

The Wareham River estuary is actually the confluence of two major rivers, the Wankinco and Agawam. The Wareham wastewater facility discharges to the Agawam River which represents the northeast lobe of the estuary. This part of the river is tidal and is fresh to brackish depending upon the tide. The watershed land use features and characteristics are shown in Table 1 and Figure 1. Wankinco represents the northwest lobe of the estuary. Other watershed information Appendix A, Table A-1.

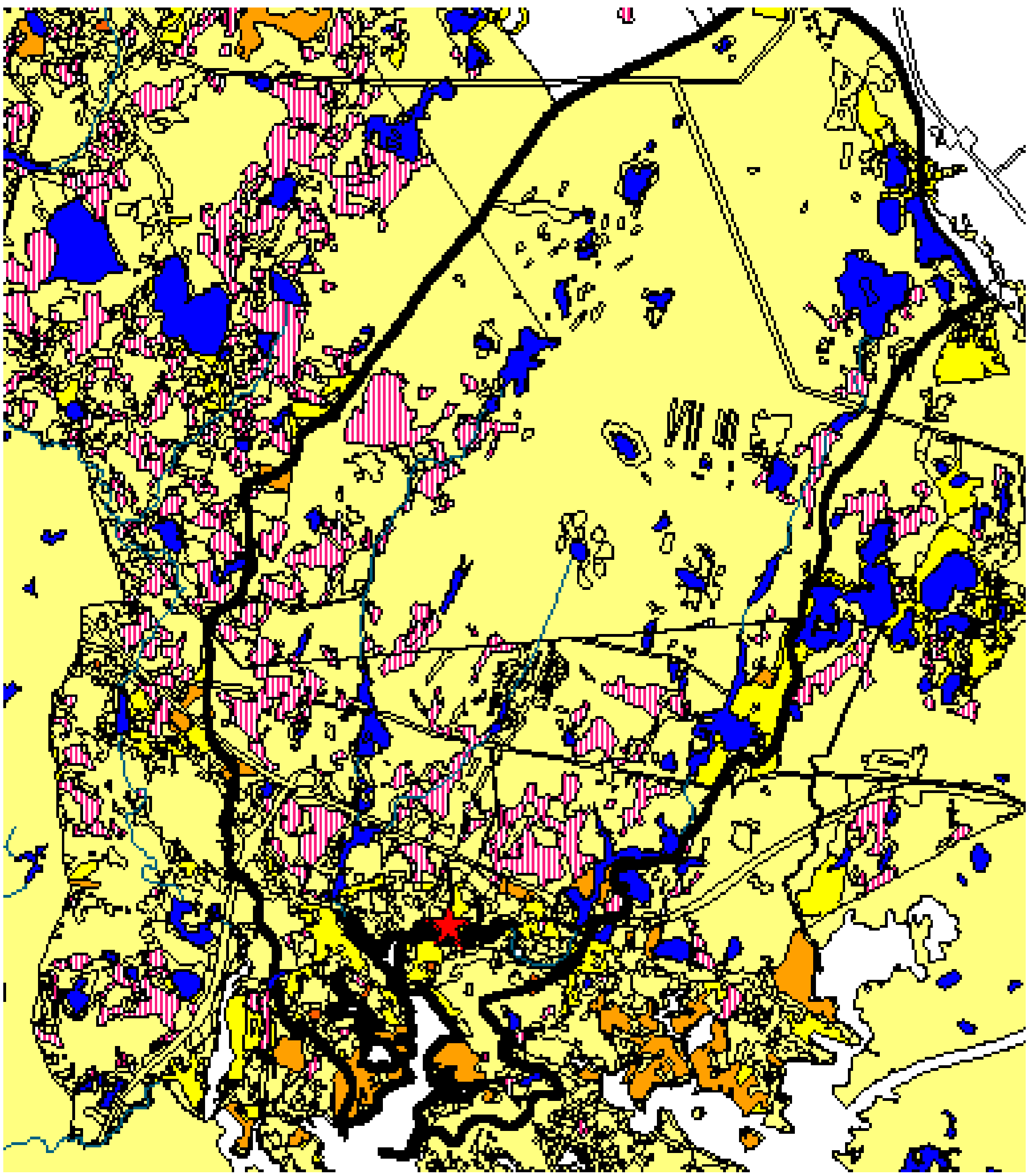

Figure 1. Wareham River Estuary showing major land use features and location of sewage treatment facility (star).

The BBP's 1994 subwatershed evaluation suggested that the Wareham River is the 5th most nitrogen loaded system in the Buzzards Bay watershed when inputs are adjusted for volumes and flushing times. In the 1994 assessment, discharge from the wastewater facility plant was assumed to be at a worse-case treatment plant discharge of 35 ppm N. The high discharge concentration estimate was used in the absence of nitrogen monitoring data available at the time. Existing flows were assumed to be 0.85 MGD with future flows at design limits (1.8 MGD).

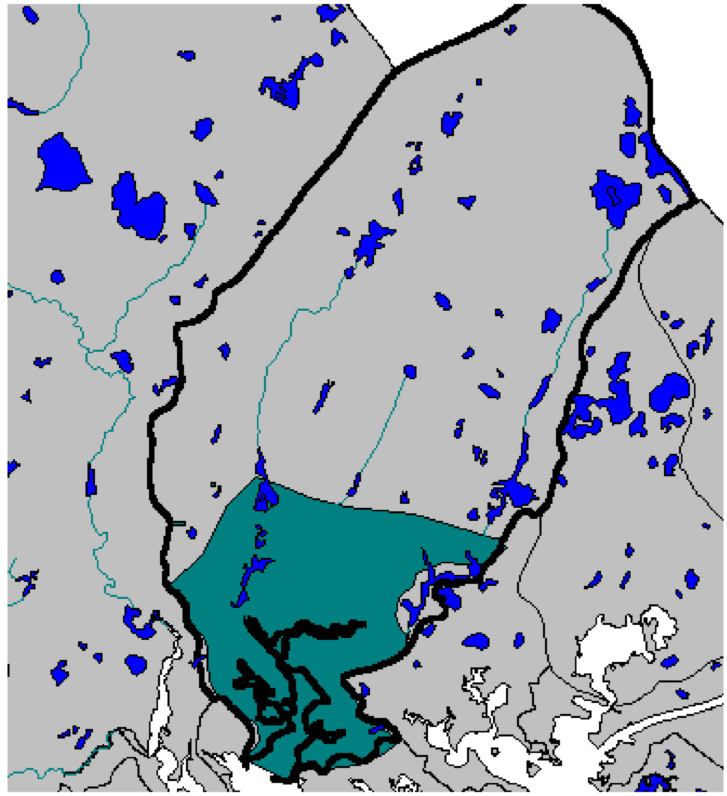

Figure 2. Preliminary delineation of "lower" watershed (bounded by routes 25 and 195, and "upper watershed areas where a 30% attenuation coefficient was applied.

In this report we have used a discharge concentration of 18 ppm as being more representative of the likely discharge concentration from the plant, and we use an actual average plant discharge volume of 1.0 MGD. Whether the 18 ppm N is representative can be determined by periodic monitoring of the discharge for all nitrogen species. CDM has proposed a 12.7 ppm actual discharge concentration, but we have not reviewed the source data to determine whether all nitrogen species were monitored or whether the sampling dates were representative.

Table 2 shows the updated nitrogen loading for the watershed based on BBP nitrogen loading methodologies and assumptions, but with the revised wastewater facility loads. A more detailed breakdown of the various loading sources are shown in Appendix A, Table A-2.

With respect to Tables 2 and A-2, other important assumptions in our methodology are worth highlighting. First, the BBP is currently revising its methodologies for large watersheds like that for the Wareham River. Specifically we are considering a 30% attenuation factor for nitrogen sources in the"upper" portions of watersheds-namely those areas discharging to large wetland or pond systems as opposed to groundwater discharges near shore, or discharges to streams and rivers which travel directly to the estuary without retention by significant pond systems. That is to say, nitrogen sources discharging directly to estuaries or to streams and groundwater near estuaries are more likely to impact an estuary than sources far inland where nitrogen can be captured or attenuated in many ways.

A definition for the "upper" and "lower" estuary drainage basin boundaries used in this evaluation are shown in Figure 2. The corresponding nitrogen analysis in Table 2 and Table A2 were calculated using land use areas for each basin sub area calculated using ArcView. Since ArcView does not calculate the areas of bisected polygons, land use areas in Table A1 are those only with centers in the subwatershed. Thus the land area totals in these tables are approximate and could contain errors, and therefore loadings are approximate. However, since it is equally likely that residential, commercial, and bog parcels that are bisected by the subwatershed boundary could be excluded or included by this technique, reported areas for land use in the two subwatershed areas probably represent reasonable estimates.

It is worth noting that the assessment in Table 2 is based on CDM's 1996 estimate of 4659 units in the entire watershed (1851 units sewered+ 2808 units unsewered). Of the 2808 unsewered units, 962 were estimated to be in the lower watershed and 1846 in the upper watershed. To independently evaluate this estimate we examined 1997 parcel information from the town using the same ArcView technique described above and found that there are approximately 1450 unsewered parcels (built **and** unbuilt) in the lower watershed. The discrepancy between the 962 units with septic systems and the total unsewered parcel number in the lower watershed (1450) is probably largely the result of the fact that many of the so-called "parcels" are either unbuildable small parcels or buildable parcels without homes.

Table 2. Major nitrogen sources in the Wareham River estuary.

EXISTING Potential Sources of N	# or annual volume	units	rate	units		Loading (kg/y)	% of total	Comments
Sewage Treatment Facility, 1.0MGD	1.38E+09	l/y	18	ppm		24,867	36.6%	annual liters (=1.0 MGD existing average flow) x concentration
Residential Sewered Land*	1,851	units	1.0	kg/unit		1,777	2.6%	lawns +runoff, units x kg/unit annual loading, avg. 3000 sq ft lawn
Residential w/ septic systems	2,808	units				13,728	20.2%	septic load + lawns + runoff, 1.9 avg occupancy
lower watershed	962	units	6.1	kg/y-unit	5,858			
upper watershed**	1,846	units	4.3	kg/y-unit	7,870			
Commercial Land*	64	ha				897	1.3%	all presumed sewered, runoff only, Mass GIS hecatares times loading
lower watershed	46	ha	15.3	kg/y-ha	704			
upper watershed**	18	ha	10.7	kg/y-ha	193			
Cranberry bogs	1,024	ha				15,044	22.2%	1985 Mass GIS ha, Project loading rate
lower watershed	351	ha	18.3	kg/y-ha	6,423			
upper watershed**	673	ha	12.8	kg/y-ha	8,621			
Other N NPS land uses	742	ha				5,188	7.6%	From 1985 Mass GIS land use data excluding Res., commercial, and bogs
lower watershed	294	ha	varies	kg/ha	2,953			
upper watershed**	448	ha	varies	kg/ha	2,235			
Precipitation to Embayment	249	ha	7.3	kg/ha		1,818	2.7%	hectares x kg/ha (1 hectare =2.47 acres)
Road Runoff	338	ha				4,553	6.7%	hectares x kg/ha (1 hectare =2.47 acres), loading to surface or groundwater
lower watershed	204	ha	15.3	kg/y-ha	3,118			
upper watershed**	134	ha	10.7	kg/y-ha	1,435			
Total						67,872		previous estimate with actual occupancy = 66,020 kg/y
New Homes at Buildout	4,688	units				33,603		assume no homes sewered, worse case occupancy of 3.0 per units, and ½ upper watershed "forest" land publically owned for calculations.
lower watershed	1,168	units	9.1	kg/y	10,582			
upper watershed	3,520	units	6.3	kg/y	23,321			

* assumed all in "lower" watershed area for calculations (i.e. no attenuation of NPS).

** upper watershed attenuation assumed to be 30% after discharge to groundwater or streams.

Note: other assumptions include- 0.14 kg N/y for stormwater per residential unit from impervious, 0.6 lb/1000 sq ft of lawn. Average watershed lawn size = 3000 sq feet. Current occupancy = 1.9 persons per unit, 2.7 kg per person septic N load.

Other notes:

1. 4154 units were predicted to be in the watershed using BBP methodologies and 1985 MassGIS data. CDM reported 4659 as current number of units in 1996. Of the 4154 predicted units, 1646 were in upper watershed, 2508 in lower watershed. These ratios were used to adjust the CDM reported actual housing units to estimate unsewered homes in the lower watershed. For this report its was assumed that any sewered homes in the watershed were in fact found exclusively in the lower watershed.

When considering the loads identified in Table 2, it is important to recognize that the town is considering sewering additional areas, both within and outside the watershed. Sewering of properties within the

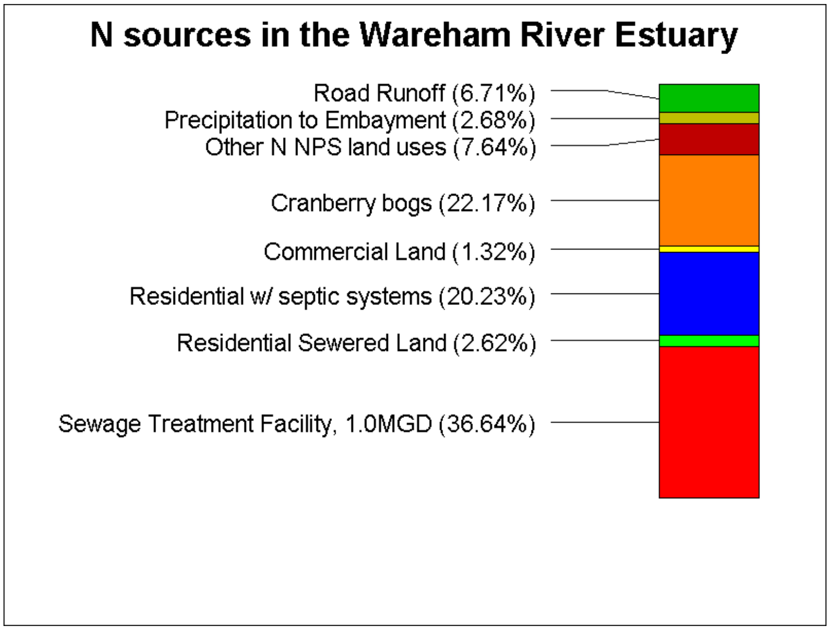

Figure 3. Current nitrogen sources to the Wareham River estuary.

Table 3. New sewering proposed for Wareham.

18 ppm Proposed Sewer Area	existing units	potential units	existing (kg/y)	potential new (kg/y)
Inside of watershed				
Beaver Dam (act. partial)	37	3	190	15
Cromset Park	93	0	479	0
Linwood/Ldd Ave	36	0	185	0
Mayflower Ridge	41	5	211	26
Oakdale	142	86	731	443
Parkwood Beach	280	157	1441	808
Tempest Knob	73	1	376	5
TOTALS:	702	252	3612	1297
NPS N loss (kg/y):			3612	1297
WTF gain (kg/y):			1877	674
assume sewage ppm =		18		
Outside of Watershed				
Agawam Beach	75	65	386	334
Briarwood Beach	136	23	700	118
Rose Point	201	23	1034	118
Sunset Island	17	7	87	36
Weweantic Shores	230	20	1183	103
TOTALS:	659	138	3391	710
NPS N loss (kg/y):			0	0
WTF gain (kg/y):			1762	369
Net Savings existing=			-27	
Net Savings future=				254
Net Savings combined=				227

watershed will have a benefit because the existing plant provides better nitrogen removal than what is assumed for a conventional septic system (18 ppm vs. 33 ppm). In Table 3 a summary of NPS reductions from new sewering is shown. As shown in that Table, any benefits obtained by sewering homes in the watershed are nearly negated by additional nitrogen discharged by the plant as a result of new nitrogen from homes outside the watershed. However, the net long term benefit of 227 kg/y by the proposed new sewer extensions would equal a reduction of 3,348 kg/yr benefit if the treatment plant discharge was reduced to 6 ppm for example.

Water Quality Monitoring

Water quality in the Wareham River estuary was monitored between 1992 and 1996 as part of the joint Coalition for Buzzards Bay--BBP Citizens Water Quality Monitoring Program. Data collected through that program (BBP and Coalition for Buzzards Bay, 1996) shows that the Wareham River is ranked as the 8th most eutrophic estuary among 28 embayments monitored; based on measures of Total Nitrogen, Dissolved inorganic nitrogen, oxygen saturation, water transparency, dissolved organic nitrogen, and chlorophyll concentrations. The 4 year results are shown in the Appendix A map, Figure A-1 map. More recent data is available including data on N to P ratios in the upper river to determine whether nitrogen or phosphorus is the limiting nutrient in the Agawam River, but the Buzzards Bay Project has not yet analyzed this information

Nitrogen Management

The BBP proposed a tiered nitrogen loading strategy in 1991 as an approach to protect nitrogen sensitive coastal embayments. Two methods were proposed, one was based on limits incorporating the volume and flushing time of the embayment. The other was based on embayment surface area, particularly for embayments that have flushing times greater than 4.5 days.

The intent of the latter so-called"aerial" method was to provide a somewhat more "lenient" N limit for poorly flushed systems because of uncertainties as to whether more poorly flushed embayments show the same proportional response to changes in flushing as rapidly flushed systems. However, strict application of the aerial method to very shallow embayments like the Wareham River estuary results in limits much more restrictive than the volume-flushing method. Data collected through the citizen monitoring program shows that the volumetric scale is a better predictor of ecosystem response than the aerial scale (in preparation). Consequently, the BBP has adopted the policy of proposing the higher of the two methodologies as the recommended limit for very shallow poorly flushed systems.

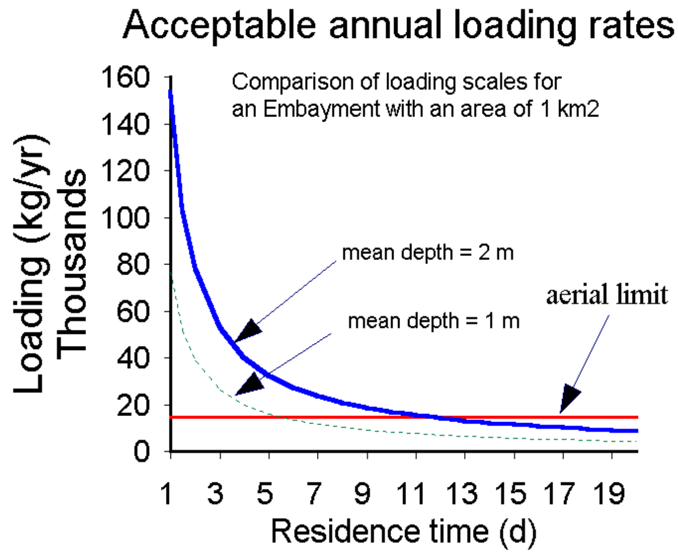

Figure 4. Comparison of aerial limit to volumetric limit in a hypothetical embayment.

In this case, the limits for the Wareham River estuary are shown below using the volumetric-flushing model. The limits shown from the 1994 subwatershed report were based on an assumed 7.4 day (178 h) turnover time for the upper 1/3 of the estuary (both the Wankinco and Agawam River lobes), which as noted above represented the maximum range on the spatial model (ACI, 1995) for a half tide depth of 1.6 m MLW, and a half-tide volume of 3.9 x 10^6 m^3.

Recommended N loading limit:

ORW=	21,980	kg/yr
SA =	43,950	kg/yr
SB =	76,910	kg/yr

The tiered approach for acceptable loading limits shown above was meant to reflect that degraded waters like those already designated SB (usually because of existing sizeable pollution inputs) had lower resource values to protect in the regulatory process, whereas Outstanding Resource Waters (ORW) deserved the strictest level of protection. Currently the Wareham River estuary is designated as SA waters. In Massachusetts, no estuary with a sewage treatment plant discharge is designated as ORW, although this is admittedly a worthy long term goal.

ACI considered three different methodologies for estimating flushing times of the Wareham River. The first was a simple box, good for showing relative degrees of flushing, but not appropriate for establishing nitrogen limits. The second was termed a Spatial Model and based on dispersion coefficients. ACI's third approach, a numerical model also termed a one dimensional model, was the most detailed applied to the Wareham River. Using this latter method, ACI estimated the upper third of the estuary to have an 84 hour flushing time during spring tides, a 192 hour flushing time during neap tide, and a 138 hr flushing time (5.75 day) for average flushing conditions.

Applying this latter flushing rate, acceptable loading limits would be as follows:

Recommended N loading limit:

ORW=	27,760	kg/yr
SA =	55,730	kg/yr
SB =	97,520	kg/yr

The Wareham River estuary has one of the highest nitrogen loading rates, in terms of volume and flushing rate, of all Buzzards Bay embayments. Table 2 suggests the Wareham River estuary is more than 140% over recommended ORW limits, and more than 12,000 kg or 22% over SA limits.

Growth Potential and impact on management options

A comparison of the loadings summarized in Table 2 to the recommended limits above suggest that modest improvements in the Wareham Wastewater Facility nitrogen removal capacity, coupled with the proposed sewering would make the SA limit achievable. More appreciable nitrogen removal capacity, coupled additional sewering and efforts manage nitrogen from residential sources and cranberry bogs would be a requirement to achieve the ORW standard.

Table 4. Sewage Treatment Facility sensitivity analysis

1.0 MGD	conc.	N Kg/y
	3 ppm	4145
	4 ppm	5526
	6 ppm	8289
	8 ppm	11052
	10 ppm	13815
	12 ppm	16578
	16 ppm	22104
	18 ppm	24867

However, when the expansion of the plant and future growth potential are considered, more stringent reductions in the wastewater plant's nitrogen discharge may be warranted. For example, at design limits (1.8 MGD) and 18 ppm, the treatment facility alone would account for 80% of the acceptable SA standard for the estuary. The benefits of improved treatment is shown by the sensitivity analysis Table 4 which suggests that at current flows and an 8 ppm discharge limit, the treatment plant and all other existing sources would meet a 55,700 Kg/y limit for the estuary.

A reduction to 8 ppm, however, could not mitigate long-term future growth potential in the watershed because of new potential growth. Using a Buzzards Bay Project technique for estimating the growth potential based on forested land, we estimated 8,208 additional homes in the watershed. However, this technique is not appropriate for the upper watershed since a large part of the upper watershed is unbuildable because it is part of the Myles Standish State forest or other public lands. To adjust for this fact we assumed as an approximation that only half the forest land in the upper watershed had buildout potential (a visual approximation), and Table 2 reflects this approach. As shown, we estimate 4,688 additional units at buildout with 33,603 kg/y additional load. This might be still somewhat of an overestimate since some of the forested land is part of cranberry crop property upland that will unlikely be converted to residential land. Better buildout potential estimates are possible only with a detailed parcel level analysis.

Nonetheless, even if the watershed growth potential only resulted in an additional 20,000 kg/y, meeting a 55,700 kg/y total watershed limit would be a great challenge. In the long term, the improvement and long term protection of the Wareham River estuary will only be achieved by advanced nitrogen removal at the sewage treatment facility, connection of homes especially in the lower watershed to nitrogen removal wastewater disposal (either to an improved wastewater plant, smaller community based package facilities, or alternative onsite systems), protection of open space to minimize future buildout potential, and application of BMPs on cranberry bogs to minimize fertilizer runoff and leaching to groundwater.

Wastewater disposal (point + non-point) however will remain the largest single source of nitrogen in the watershed. Should advanced nitrogen removal be required at the Wareham sewage treatment plant, each tie in of homes on septic system **within the lower watershed** can result in a sizeable nitrogen reduction. In Table 5 below we show the net benefit gained for treatment facilities with different levels of discharge.

Table 5. Potential benefits of sewering (assumes current 1.9 person occupancy)	discharge ppm	loading kg/unit-y	savings kg/unit-y
Wastewater loading per unit, onsite disposal		5.13	
Wastewater loading per unit, STP discharge=	18	2.65	2.48
Wastewater loading per unit, STP discharge=	12	1.76	3.37
Wastewater loading per unit, STP discharge=	10	1.47	3.66
Wastewater loading per unit, STP discharge=	8	1.18	3.95
Wastewater loading per unit, STP discharge=	6	0.88	4.25
Wastewater loading per unit, STP discharge=	4	0.59	4.54

Appendix A. Current nitrogen loading to the Wareham River estuary by each source category based on BBP adopted loading coefficients.

Table A-1. Land Use of the Wareham River Estuary drainage basin, and respective land use in upper and lower portions of the drainage basin (see text for explanation. Data is for 1985 land use statistics. Revised from BBP 1994.

Landuse type (areas in hectares unless specified)	Entire Wareham river basin	% of total	Lower Wareham river basin	Upper Wareham river basin
Cropland	58.7	0.5%	2.65	56.03
Pasture	14.2	0.1%	6.16	8.08
Forest	8611.3	75.3%	1227.46	7383.87
Non-forested wetland	213.4	1.9%	98.19	115.17
Mining	12.5	0.1%	9.82	2.64
Open land	253.9	2.2%	59.51	194.40
Participatory recreation	57.9	0.5%	2.50	55.37
Spectator recreation	10.2	0.1%	10.2	0.00
Water based recreation	18.4	0.2%	14.03	4.35
R0: residential multi-family	9.6	0.1%	6.84	2.71
R1: Residential- <¼ acre lots	185.0	1.6%	150.68	34.30
R2: Residential- <¼-½ acre lots	370.1	3.2%	152.22	217.88
R3: Residential- <½ acre lots	124.1	1.1%	79.17	44.91
Salt marsh	97.4	0.9%	81.74	15.63
Commercial	64.1	0.6%	46.20	17.91
Industrial	29.2	0.3%	17.13	12.05
Urban open	150.6	1.3%	44.04	106.59
Transportation (maj. highways)	115.8	1.0%	115.78	0.00
Waste disposal	20.2	0.2%	12.20	8.04
Water (ponds, other freshwater)	606.0		36.43	569.53
Woody perennial (bogs, orchards, etc.)	1023.9	9.0%	351.04	672.89
TOTAL: (excluding water land use)	11,440		2,487	8,953

Table A-2. N-loading for "lower" drainage basin, with 30% attenuation of "upper" basin loads (see text). Note that in this table residential loadings with sewering adjustment were based on BBP assumptions and GIS methodologies whereas loadings in Table 2 use the better estimates of actual residential units (sewered and unsewered) identified in the CZM 1996 correspondence to DEP.

Landuse type (areas in hectares unless specified)	landuse (ha) Wareham river basin	Lower 0% atten. N (kg)	landuse (ha) Wareham river basin	Upper 30% atten. N (kg)	N (kg) Upper+ lower loading	combined % of total
Cropland	2.7	53	56.0	784	837	1.5%
Pasture	6.2	62	8.1	57	118	0.2%
Forest	1227.5	0	7383.9	0	0	0.0%
Non-forested wetland	98.2	0	115.2	0	0	0.0%
Mining	9.8	72	2.6	13	85	0.2%
Open land	59.5	0	194.4	0	0	0.0%
Participatory recreation	2.5	73	55.4	1136	1209	2.2%
Spectator recreation	10.2	299	0.0	0	299	0.5%
Water based recreation	14.0	102	4.3	22	125	0.2%
R0: residential multi-family	6.8	482	2.7	12	494	0.9%
R1: Residential- <¼ acre lots	150.7	8532	34.3	206	8738	15.7%
R2: Residential- <¼-½ acre lots	152.2	5483	217.9	1215	6698	12.0%
R3: Residential- <½ acre lots	79.2	1354	44.9	119	1473	2.6%
Salt marsh	81.7	0	15.6	0	0	0.0%
Commercial	46.2	730	17.9	1517	2247	4.0%
Industrial	17.1	271	12.1	133	404	0.7%
Urban open	44.0	0	106.6	0	0	0.0%
Transportation (maj. highways)	115.8	1829	0.0	0	1829	3.3%
Waste disposal	12.2	193	8.0	89	282	0.5%
Water (ponds, other freshwater)	36.4	0	569.5	0	0	0.0%
Woody perennial (bogs, orchards, etc.)	351.0	6424	672.9	8620	15044	27.0%
Major road length	6.0		2.0	0		0.0%
Secondary Road length	100.0		53.5	0		0.0%
Road Area	203.7	3116	133.6	1431	4547	8.2%
Embayment area (km2)	2.5	1818		0	1818	3.3%
Total Land ACRES/ Loading	6146.8	30892	22122.4	24729	55620	100.0%
"Other" subtotal	294	2953	448	2235	5188	
Actual occupancy	1.9					
Predicted # of units (existing)	2508.0		1645.8			
actual units						
Unit density (per acre)						
Predicted population (existing)	4815.3					
Pred. Kg/y, occupancy=3.0		38205			66293	
Animal units		0			0	
Point sources		24867			24867	
Sewering adjustment (units/kg)	525.0	-2722			-2722	
Adjusted NPS loading, w/ actual occupancy		53038		24729	77766	
Forest" and other zero land use loading	575.4	2749			14344	
Additional units w/ buildout	1168	1 acre zoning		7029	8208	
Additional population w/ buildout	3506			21118	24624	
Total load buildout, occup=3.0					124936	