Stormwater and Nitrogen Management Options for Wareham, MA

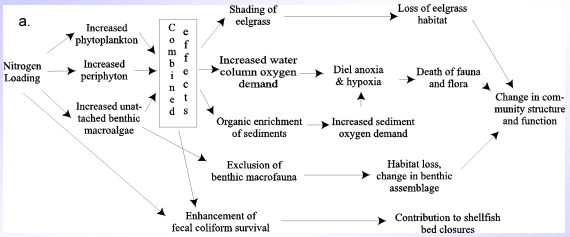
Nitrogen management

A Workshop for the
Wareham Planning Board

by the
Buzzards Bay Project
National Estuary Program

9/30/02

The Problem with Nitrogen



More Nitrogen >> More Algae
>> Less Eelgrass, Less Oxygen,
Less Shellfish Habitat, Poor Water Quality,
and even fish kills

Buzzards Bay Project National Estuary Program

Nitrogen Management Strategy

-Novel "Total Maximum Annual Load" strategy adopted in 1991 (for BB embayments)

- Most elements adopted by the Cape Cod Commission

Key Elements of BBP's Nitrogen Management Strategy

Based on Mass Loading Standard, not a water quality standards
- -Use recommended limits in the absence of other information
- -For impacted bays, try to do an historical assessment to establish loading limits
- -Where large $ decisions involved, develop embayment specific models needed
- -parcel level evaluation required

Proposed loading standards incorporated:
- o flushing
- o volume
- o bathymetry
- o water quality classifications
- o water quality goals

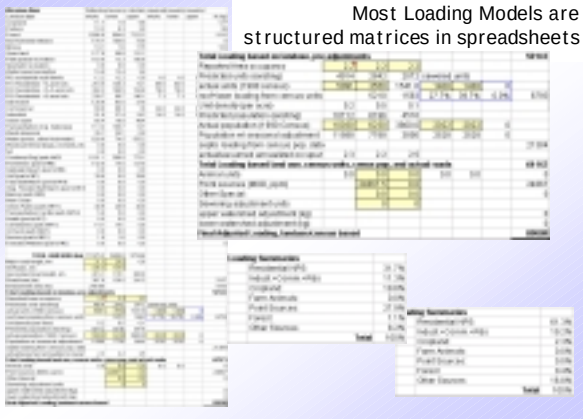
Buttermilk Bay Early Success

In 1991, the BBP worked with three municipalities to establish a nitrogen management strategy for Buttermilk Bay.

Loading to the bay was not yet over the BBP's recommended limits (54,000 kg/yr). Existing loading was estimated at 41,000 kg/yr, but at buildout loading was estimated at 65,000 kg/yr, 11,000 kg/yr over limits. Planned sewering or more than 800 homes in 1992 would eliminate 8,000 kg yr^{-1}.

Future loading targets could be achieved by increasing the minimum size of lots on unsubdivided parcels of land to 70,000 sq. ft., thereby reducing the number of dwellings that could be built in the watershed by 450, An equivalent to loading of 4,000 kg/yr.

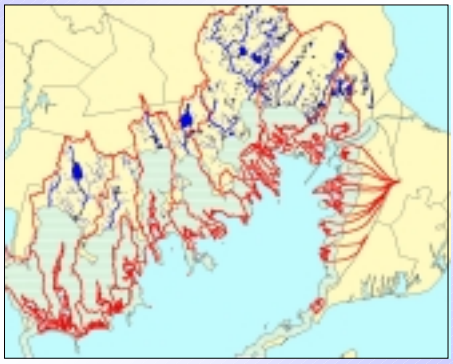
Most Loading Models are structured matrices in spreadsheets

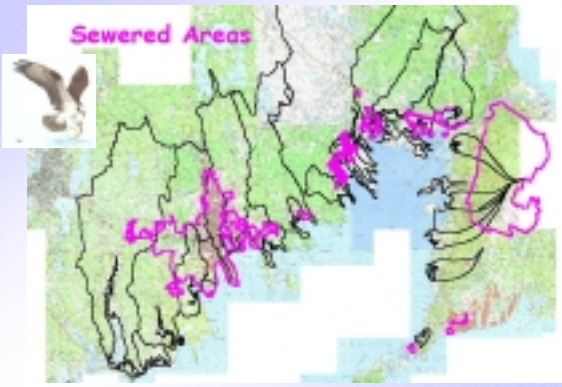


Assumptions about certain loading rates are more important than others

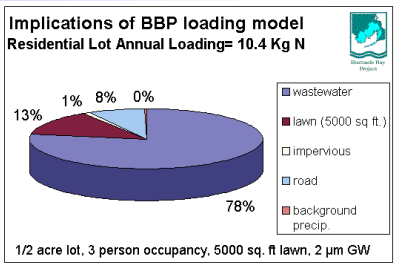
Specific N loading source		units and rates
Septic systems	2.7	kg yr^{-1} $capita^{-1}$
Occupancy rate (area average) residential unit; use actual census data [a]	3.0	persons per
Lawns	29.3	kg yr^{-1} per hectare (1.4 kg yr^{-1} per typical lawn)
Precipitation	1.19	m yr^{-1}
Road surface runoff	15.3	kg ha^{-1} yr^{-1} [b]
Roof, other impervious runoff	7.3	kg ha^{-1} yr^{-1} [c]
Natural landscapes	0.42	kg ha^{-1} yr^{-1}
Precipitation to bay	7.1	kg ha^{-1} yr^{-1} [d]
Dairy Cows	75.0	kg animal $unit^{-1}$ yr^{-1} (454 kg of animal)
Mass GIS Land use statistics 1:25,000 coverages:		
1: Cropland (corn, nurseries)	20.0	kg ha^{-1} yr^{-1}
2: Pasture (hay, dairy)	10.0	"

BB Sub-basins: Upper and lower watersheds

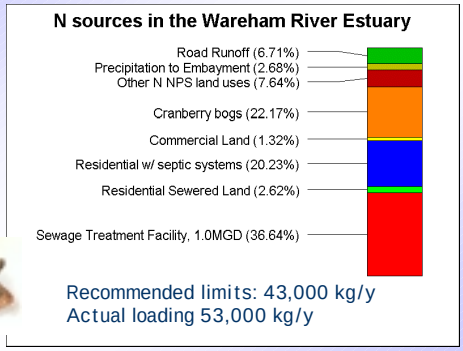




Implications of Buzzards Bay Loading Model

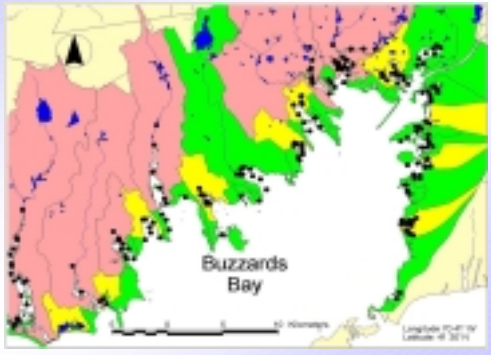


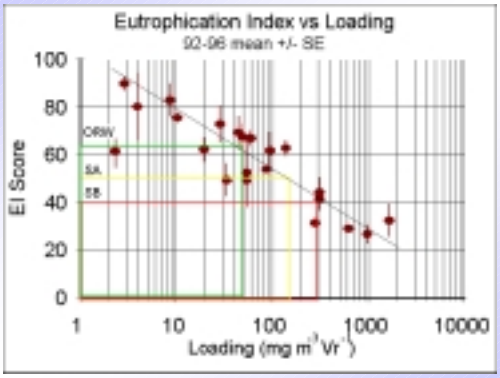
Wareham River Nitrogen Sources



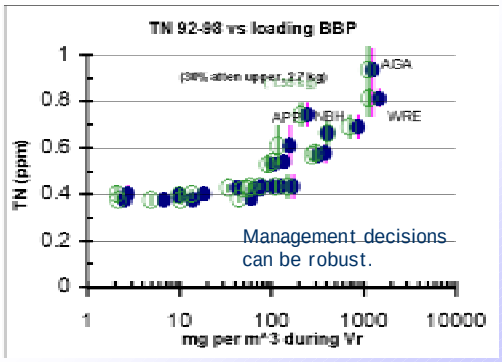
Recommended limits: 43,000 kg/y
Actual loading 53,000 kg/y

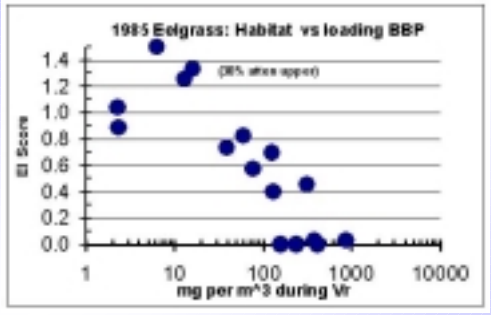
Citizen Monitoring Stations





Septic loading assumptions





Proposed water quality standards

Table 1. Proposed water quality standards, for various surrogate measures of nitrogen loading, that correspond to the proposed TMALs for nitrogen. Targets are mean summertime concentrations when critical conditions are most likely to occur. Based on best professional judgment.

		(Formerly ORW	SA	SB)
Parameter	Excellent	Good	Fair	Poor
Eutrophication Index	70	60	50	40
Alternate Eutroph.Index (no 0_2)	65	55	45	30
Total N (ppm)	0.39	0.45	0.54	0.65
Chl a (µg/l)	4.0	6.0	7.0	9.0
Secchi depth (m)	2.0	1.7	1.5	1.3
Eelgrass to core habitat ratio	0.9	0.7	0.5	0.3

Wareham River Sewage Treatment Facility
What Discharge Limits to set?

Wareham Nitrogen loading analysis: Benefits of sewering of propose

assume sewage ppm = 5	existing	potential	(results independent existing	potential
Inside of Watershed	units	units	(kg/y)	new (kg/y
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):			521	187
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):			490	103

discharge conc	kg/y	kg savings
4 ppm	9947	14920
5 ppm	12434	12434
6 ppm	14920	9947
7 ppm	17407	7460
8 ppm	19894	4973
10 ppm	24867	0
12 ppm	29841	
16 ppm	39788	
18 ppm	44761	

But new development could 20,000 to 30,000 kg annually to the estuary

Management Tools

- Zoning Changes
- N overlay zones for Planning Boards, Con Coms and BOHs (limit lbs/acre, require innovative onsite systems)
- Subdivision regulations (limits on pounds per acre, etc)
- Protecting Open Space
- Con Coms require buffers between wetlands and turf
- Stormwater regulations
- Agricultural and Turf BMPs
- Sewering, STF upgrades, community wastewater systems
- Education

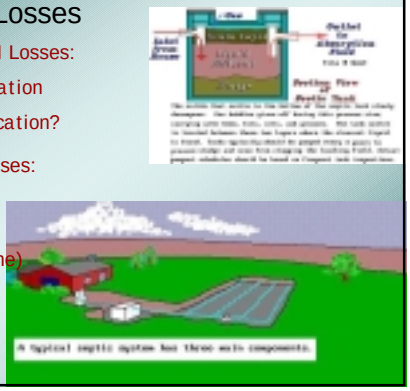
Conventional Septic System N Losses

Potential Tank N Losses:

- Sludge accumulation
- Some Denitrification?

Potential SAS Losses:

- Ammonia Binding
- Denitrification (esp. in biomat zone)



MA Septic Test Center Completed, Testing Commences 1999

Alternative Septic System Nitrogen Removal

Results of MA Septic System Test Center

- Conventional "Title 5" septic systems, remove 22-23% of nitrogen inputs overall
- Successful alternative denitrifying systems remove 61 to 66% of nitrogen inputs overall
- Bottom line: best alternative systems discharge less than half the nitrogen of a conventional system Title 5 system.

Advanced Onsite versus Community Scale Facility

Onsites:

- Cheaper initial cost
- More expensive long term costs to the homeowner (O&M $1,000 1st year, $500 annually thereafter)
- Requires more homeowner involvement and oversight
- Requires more state and local oversight

Community facility

- Single facility to oversee
- More capital costs, local sewer installation
- Annual O&M costs cheaper per homeowner
- More consistent performance, town can require performance bond
- Adopt local regulations for under 10,000 gpd facilities (=>23 four bedroom homes)

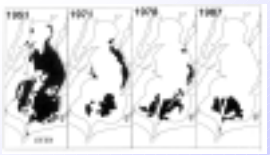
What Wareham Must Do

1) Adopt Nitrogen Overlay Districts at Town meeting authorizing the Planning Board, Conservation Commission, and Boards of Health to adopt supporting regulations
2) Each Board adopt consistent supporting regulations, with consistent subwatershed loading targets and loading assumptions
3) Some actions can be implemented without a nitrogen overlay district (e.g. maintaining vegetated buffers to wetlands).

Don't get Hung-up on Loading Model Differences

Loading recommendations are often "robust" irrespective of the Loading Model

For example, 1500 units in the watershed in the Waquoit Bay watershed in 1971. Loading models may differ by factor of 2, but Conclusion is the same. Nitrogen from 1500 units was too much.



The Bylaw need not go into method details

Strategy 1: First just get the N management District Boundaries approved

Strategy 2: Pass a detailed N loading bylaw at town meeting

Don't wait for the DEP estuaries project to be completed

New Proposal by DEP:
-Study of 82 embayments (Loading -Flushing –Modeling)
-$13 Million or $158,500 per embayment
-6 years to complete
-Completion of study may not result in detailed management recommendations for each estuary

Interim:
-BBP still being used as a starting point for STF upgrades
-Will likely be used for planning future growth elsewhere until the more detailed studies done

Zoning Versus Loading

Assume 4 bedroom, 4 person per unit occupancy,
5000 square foot lawn

Acre zoning	Occupancy	Net lb/acre	GW ppm N
3.0	4.0	9.7	1.7
2.0	4.0	15.1	2.7
1.5	4.0	19.7	3.5
1.0	4.0	28.8	5.1

For upper watershed parcels, 13.9 lb N per acre is the equivalent for 3 acre zoning N loading

CDM and BBP N loading Evaluation of Wareham River Nitrogen Loading

Differences in studies need to be reconciled, and all protected open space accounted for, but new loading could be cut in half to a third with a minimum effective loading standard of 10 pounds per acre

Example of Application 1

Sources			Total		Pounds/yr
Subdivision area (land only)			55.0	acres	
Lots	35	lots	48.2	acres	
avg lot size	60000	sq. ft.			
Bedrooms (average number)	4	per unit			
Total Bedrooms	140				
assumed occupancy, planning	1	per bedroom			
assumed occupancy, planning	4.0	per/unit	140	persons	
Wastewater Treatment by Septic?	TRUE	(true or false)			
septic system loading	1.0	loading factor			831.6
package facility loading		gpd			
package facility discharge limit	10	ppm nitrogen			
Road Length	4400	feet			
Road layout width	40		4.0	acres	55.6
lawn size	15000		12.1	acres	316.2
average driveway area	1000	sq. ft.	0.80	acres	5.2
roof area (average foot print)	1000	sq. ft.	0.80	acres	5.2
sidewalks	500	sq. ft.	0.40	acres	2.6
other disturbed	2000	sq. ft.	1.61		
wetlands in subdivision	2.0	acres			
unaltered upland	25060	acres per lot	39.3	acres	5.8
Total Nitrogen Loading					1222.3
net lb/acre					22.2
Use Upper Watershed Attenuation	TRUE		0.7	coefficient	
Total Nitrogen Loading to Bay					855.6
effective net lb/acre					15.6

Example of Application 2

Sources			Total		Pounds/yr
Subdivision area (land only)			55.0	acres	
Lots	35	lots	48.2	acres	
avg lot size	60000	sq. ft.			
Bedrooms (average number)	3.5	per unit			
Total Bedrooms	122.5				
assumed occupancy, planning	1	per bedroom			
assumed occupancy, planning	3.5	per/unit	122.5	persons	
Wastewater Treatment by Septic?	TRUE	(true or false)			
septic system loading	1.0	loading factor			727.7
package facility loading		gpd			
package facility discharge limit	10	ppm nitrogen			
Road Length	4400	feet			
Road layout width	40		4.0	acres	55.6
lawn size	5000		4.0	acres	105.4
average driveway area	1000	sq. ft.	0.80	acres	5.2
roof area (average foot print)	1000	sq. ft.	0.80	acres	5.2
sidewalks	500	sq. ft.	0.40	acres	2.6
other disturbed	2000	sq. ft.	1.61		
wetlands in subdivision	2.0	acres			
unaltered upland	35060	acres per lot	47.4	acres	7.0
Total Nitrogen Loading					908.8
net lb/acre					16.5
Use Upper Watershed Attenuation	TRUE		0.7	coefficient	
Total Nitrogen Loading to Bay					636.1
effective net lb/acre					11.6

Example of Application 3

Sources			Total		Pounds/yr
Subdivision area (land only)			55.0	acres	
Lots	35	lots	48.2	acres	
avg lot size	60000	sq. ft.			
Bedrooms (average number)	4	per unit			
Total Bedrooms	140				
assumed occupancy, planning	1	per bedroom			
assumed occupancy, planning	4.0	per/unit	140	persons	
Wastewater Treatment by Septic?	FALSE	(true or false)			
septic system loading	1.0	loading factor			
package facility loading	15400	gpd			
package facility discharge limit	10	ppm nitrogen			468.9
Road Length	4400	feet			
Road layout width	40		4.0	acres	55.6
lawn size	5000		4.0	acres	105.4
average driveway area	1000	sq. ft.	0.80	acres	5.2
roof area (average foot print)	1000	sq. ft.	0.80	acres	5.2
sidewalks	500	sq. ft.	0.40	acres	2.6
other disturbed	2000	sq. ft.	1.61		
wetlands in subdivision	2.0	acres			
unaltered upland	35060	acres per lot	47.4	acres	7.0
Total Nitrogen Loading					650.0
net lb/acre					11.8
Use Upper Watershed Attenuation	TRUE		0.7	coefficient	
Total Nitrogen Loading to Bay					455.0
effective net lb/acre					8.3

Example of Application 4

Sources			Total		Pounds/yr
Subdivision area (land only)			55.0	acres	
Lots	35	lots	48.2	acres	
avg lot size	60000	sq. ft.			
Bedrooms (average number)	4	per unit			
Total Bedrooms	140				
assumed occupancy, planning	1	per bedroom			
assumed occupancy, planning	4.0	per/unit	140	persons	
Wastewater Treatment by Septic?	TRUE	(true or false)			
septic system loading	0.5	loading factor			415.8
package facility loading		gpd			
package facility discharge limit	10	ppm nitrogen			
Road Length	4400	feet			
Road layout width	40		4.0	acres	55.6
lawn size	5000		4.0	acres	105.4
average driveway area	1000	sq. ft.	0.80	acres	5.2
roof area (average foot print)	1000	sq. ft.	0.80	acres	5.2
sidewalks	500	sq. ft.	0.40	acres	2.6
other disturbed	2000	sq. ft.	1.61		
wetlands in subdivision	2.0	acres			
unaltered upland	35060	acres per lot	47.4	acres	7.0
Total Nitrogen Loading					596.9
net lb/acre					10.9
Use Upper Watershed Attenuation	TRUE		0.7	coefficient	
Total Nitrogen Loading to Bay					417.8
effective net lb/acre					7.6

THE END