Comments on the Cape Cod Commission's Section 208 Wastewater Report

I commend the Cape Cod Commission for the excellent job done over the past year or so. The comments I present here are limited to a single topic that I believe needs attention as the Section 208 process proceeds. I am very concerned with creating a level playing field on which to assess technologies and scenarios as the Commission provides advice to towns and wastewater authorities through the Technology Matrix and the other tools you are developing. I will make five points.

1. There is a conceptual error in the Technology Matrix that I drew your attention to earlier this year but which has not been corrected yet. It involves the calculation of a $/#N figure for O&M for each nitrogen reduction technology and appears in the algorithms used to calculate columns BR and BS in version 48 of the Technology Matrix, the most recent version posted on the internet.

I document the error and suggest an easy correction on pages 2 and 3 below.

2. I would like you to reconsider the use of a 5% discount rate in the Technology Matrix. There is always controversy over what discount rate to use in financial calculations. I will only make this contribution to the discussion. You should either build an inflation rate into all future sums, for example a stream of O&M costs, or else you should use a lower discount rate. I would favor using a discount rate of 2%, if you do not want to introduce an inflation rate.

3. There are always difficulties in providing a level financial playing field when a municipality combines public funding of large public construction projects such as sewering with private funding of small private projects such as I/A systems or eco-toilets when making plans like CWMPs. It is much easier to provide public funding through taxation and SRF funds to public projects. Municipalities also can manage large projects more easily than many small private projects. Please, as you go forward, consider this issue seriously.

4. The portion of the Technology Matrix that appears on the internet fosters the impression that the construction and operation of a WWTF or a Satellite Plant is the only cost relevant to calculation of the $/#N for that technology. I am aware that figures for pipes and lift stations, and for construction of effluent disposal facilities are broken out and accounted for separately in the Matrix. But they are not considered when calculating the $/#N costs of municipal wastewater facilities. I am aware of the reasons why the total costs of municipal sewering are not calculated in that part of the Technology Matrix we can access on the internet. But omitting such a calculation can be seriously misleading. I should like you to either introduce a range of total costs for municipal sewering, for different densities of population, for example; or else expand the parts of the Technology Matrix available on the internet to include the sections where total costs are compiled.

5. The tools you are providing the towns can be excellent if they are completed and kept up-to-date. Do you have sufficient funds for those tasks? I completely agree with the point made in a recent meeting that there should be beta testing of all of the models and tools by independent auditors hired by the Commission. Failing completion, beta testing and continuing technical support for these tools, they will be seriously misleading when used by municipalities and wastewater authorities in planning.

A conceptual error in Tech Matrix v 48

Columns BR and BS contain a serious conceptual error.

1. Column BQ calculates the average project cost per pound of nitrogen reduction by dividing the sum of the present values of the average project cost and the replacement upgrade cost by the total nitrogen reduction over 20 years [Col BQ = (Col BC + Col BJ) / Col BK]. See Table 1, Column 5.

   This is an appropriate way to express the cost of nitrogen reduction associated with the capital cost of a nitrogen removal technology.

2. Column BR calculates the average annual cost per pound of nitrogen reduction associated with O&M cost by dividing a single year's O&M cost by the pounds of nitrogen removed in one year [Col BR = Col BF / (Col BK / 20)]. See Table 1, Column 6.

3. Column BS calculates the average life cycle cost per pound of nitrogen reduction associated with both the present value of the average project cost and the present value of the average annual O&M cost [Col BS = Col BQ + PV(0.05, 20, Col BR)]. See Table 1 Columns 7 and 8.

   The figures calculated in Table 1, column 7 from the formula, PV(0.05, 20, Col BR), show an estimate of the average life cycle cost per pound of nitrogen reduction associated with O&M cost that is 20 times too high, because it implicitly assumes that the present value of the O&M cost for 20 years is divided not by the 20 year total nitrogen removed, as in Column BQ, but by only a single year of nitrogen removed.

   Here is a commonsense way to express the error. The PV of the capital costs of installing an eco-toilet is estimated at $17,957. Given the 20 year reduction of nitrogen of 283 pounds, capital costs contribute $64/#N to the N reduction costs for this technology. The discounted PV of 20 years of O&M costs is estimated to be $5,141, based on a yearly O&M cost of $513. Yet O&M costs contribute $364 to the $/#N for this technology. Capital costs are estimated to be 3.5 times O&M costs, while the contribution of O&M costs to $/#N cost is 5.7 times as high. Similar calculations apply to other technologies. It is evident that something is wrong.

4. Correcting this error is not difficult. In order to obtain figures for Column BR', calculate the present value of 20 years of O&M costs at a discount rate of 5% and divide this by the total nitrogen removed over the 20 year period [Col BR' = PV(0.05, 20, Col BF) / Col BK]. See Table 1, Column 9.

   Then Column BS' = Col BQ + Col BR'. See Table 1, Column 10.

5. This error has two main consequences.

   First, the costs per pound of nitrogen in Column BS are massively overstated, by about an order of magnitude, for every nitrogen reduction technology. See Table 2, Column 4.

   Second, if a technology has a low capital cost relative to its O&M cost, the error will overstate its $/#N cost compared with costs of technologies with high capital costs relative to O&M costs. Table 2, Column 5 shows for each technology the ratio of the present value of capital costs to the present value of O&M costs. Table 2, Columns 6 and 7 illustrate the point being made here. For example, the $/#N for an advanced I/A system with a

low ratio of capital to O&M cost falls from 15.2 to 10.9 times that of a WWTF. On the other hand, the $/#N for a title 5 system, with a high ratio of capital to O&M cost, rises from 1.7 to 4.8 times that of a WWTF.

Table 1: Capital and O&M costs of Title 5 systems per pound of nitrogen showing error in Cols BR and BS in red and corrections in blue.

1	2	3	4	5	6	7	8	9	10
	Cols BC+BJ	Col BF	Col BK	Col BQ	Col BR	PV of Col BR @ 5%	Col BS	Col BR' = (PV BF)/BK	Col BS'
	Capital	O&M	# N	(BC+BJ)/BK	BF/(BK/20)		BQ+pvBR		BQ+BR'
CT ET	$17957	$413	#283	$63.5	$29.2	$363.7	$427.2	$18.2	$81.7
Incin ET	16521	963	351	47.1	54.9	683.6	730.7	34.2	81.3
Pack ET	8620	688	351	24.6	39.2	488.3	512.9	24.4	49.0
UD ET	14366	396	283	50.8	28.0	349.2	400.0	17.5	68.3
Title 5	16683	165	134	124.5	24.6	306.8	431.3	15.3	139.8
I/A	27354	1375	205	133.6	134.3	1,674.2	1807.9	83.7	217.3
I/A enh.	35431	3850	263	134.6	292.6	3,646.1	3780.8	182.3	316.9
Clust 1	30534	2270	242	126.3	187.8	2,340.2	2466.5	117.0	243.3
Clust 2	35838	2724	309	115.8	176.1	2,193.9	2309.7	109.7	225.5
WWTF	5598	299	322	17.4	18.6	231.3	248.7	11.6	29.0
WWTF+	6614	358	343	19.3	20.9	260.2	279.5	13.0	32.3
Satellite	8174	495	292	28.0	33.9	422.3	450.3	21.1	49.1
Sat adv.	9795	595	312	31.4	38.1	475.2	506.6	23.8	55.2

Table 2: Figures illustrating the consequences of the error in calculating $/#N for listed technologies

1	2	3	4	5	6	7
Title 5 and N reduction technologies	Col BS Life cycle $/#N	Col BS' Life cycle $/#N corrected	Col BS/Col BS' (Overstatement of $/# of nitrogen)	PV of Capital costs / PV of O&M costs for each technology	Each row in Col BS / 248.7 (WWTF life cycle $/#N)	Each row in Col BS' / 29.0 (WWTF life cycle $/#N)
CT ET	$427.2	$81.7	5.2	3.49	1.7	2.8
Incin ET	730.7	81.3	9.0	1.38	2.9	2.8
Pack ET	512.9	49.0	10.5	1.01	2.1	1.7
UD ET	400.0	68.3	5.9	2.91	1.6	2.4
Title 5	431.3	139.8	3.1	8.11	1.7	4.8
I/A	1807.9	217.3	8.3	1.60	7.3	7.5
I/A enh.	3780.8	316.9	11.9	0.74	15.2	10.9
Clust 1	2466.5	243.3	10.1	1.08	9.9	8.4
Clust 2	2309.7	225.5	10.2	1.06	9.3	7.8
WWTF	248.7	29.0	8.6	1.50	1.0	1.0
WWTF+	279.5	32.3	8.7	1.48	1.1	1.1
Satellite	450.3	49.1	9.2	1.32	1.8	1.7
Sat adv.	506.6	55.2	9.2	1.32	2.0	1.9