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**Ref.:** morris_russell_masterplan (total: 7 pages including CCME's policy & Mandaville's predictive TP/Cha models)
**To:** **Mayor Peter Kelly and The Regional Council, HRM**
**From:** S. M. Mandaville Post-Grad Dip. Professional Lake Manage., Chairman
**Date:** February 26, 2005
**Subject:** **Morris-Russell Lakes Master Plan:-- Public hearing to be held on March 22, 2005**

Based on our extensive chemical and biological monitoring together with our precedent setting TP/Cha predictive modelling, we suggest that HRM set a firm enforceable management objective for mean inlake deep station total phosphorus (TP) values for the two clearwater lakes as follows:

## Morris Lake: Eight (8) µg/l (micrograms/litre) TP with a maximum cutoff value of ten (10) µg/l

☞ (this value is within reach based on data of last 20 years provided that HRM is strongly pragmatic and works immediately rather than indulging in perpetual studies; see also our enclosed graphical model for Morris)

## Russell Lake: Fifteen (15) µg/l (micrograms/litre) TP with a preferred value not to exceed twelve (12) µg/l

☞ (these values are too high in comparison with the natural background value based on the CCME policy [see our enclosed model for Russell], but at the present time we feel this is a reasonable compromise)

It is reported in some published literature that most other post-development inevitable urban pollutants can also be removed to a considerable degree by the same methodologies that are implemented for removal of those forms of phosphorus associated with particles smaller than twenty (20) microns as well as those in dissolved (soluble) form.

Advice sought of Mandaville by various parties: Since around 1999, this applied limnologist, Shalom M Mandaville, has been consulted variously by HRM's staff commencing with Ms. Renee Roberge PEng relating to a study conducted for HRM by Griffiths Muecke *et al*., 1998. A handful of Mandaville's personal data archives were also utilized by Griffiths Muecke *et al.,* but unfortunately they made a significant error in interpreting them. Another of HRM's consultants, the Jacques Whitford group, also consulted Mandaville. Further, around twelve (12), mostly dedicated/affluent residents of the Portland Estates area also consulted this writer in various detail! These do not include our associates in the area.

| | | |
|---|---|---|
| **Ref.:** | phosphorus_ccme2004 | (3 pages) |
| **From:** | S. M. Mandaville Post Grad Dip., Professional Lake Manage.<br>Chairman and Scientific Director | |
| **Date:** | March 10, 2005 | |
| **Subject:** | **Phosphorus management: Canadian Council of Ministers of the Environment-CCME (2004)- Phosphorus Management framework; and other published and peer-reviewed international literature!** | |

**"IT IS STRESSED AT THIS POINT THAT THE CCME ENDORSES A `NO DEGRADATION' POLICY, AND THAT THESE VALUES THEREFORE DO NOT PROVIDE, AND MUST NOT BE USED AS `POLLUTE UP TO LEVELS'."**

## [I] <u>The effects of accelerated eutrophication many of which are undesirable and some could even be lethal/sublethal</u>:

**"In Canada, the trophic status of water bodies that are impacted or unimpacted by anthropogenic releases of phosphorus range from oligotrophic to hyper-eutrophic. Typically unimpacted sites support relatively diverse and abundant communities of aquatic organisms that are self-sustaining and support various water uses. However, elevated loads of phosphorus can have many adverse effects on aquatic ecosystems. One of the most important consequences is the increased growth of algae and aquatic macrophytes. The senescence and decomposition of these organisms create oxygen deficit and can result in fish kills. In some freshwater systems, blooms of cyanobacteria contribute to a wide range of problems including summer fish kills, foul odours, tainted drinking water, and release of toxins that can kill livestock and may pose a serious health risk to humans."**

**"Although elemental phosphorus can be toxic, it is rare in nature, and therefore rarely of concern."**

## [II] <u>The CCME (2004) framework for phosphorus</u>:--

"The framework offers a tiered approach in which

(i) phosphorus concentrations should not exceed predefined `trigger ranges'; and

(ii) phosphorus concentrations should not increase more than 50% over the baseline (reference) levels. The trigger ranges are based on the range of phosphorus concentrations in water that define the reference trophic status for a site."

"**In large lakes, the 50% increase should be applied to the most sensitive area(s) (e.g., river mouth, point sources, or littoral zones) rather than averaged over the whole lake!**"

| Trophic level | Trigger Ranges for Total Phosphorus (µg/l) |
|---|---|
| Ultra-oligotrophic | < 4 |
| Oligotrophic | 4-10 |
| Mesotrophic | 10-20 |
| Meso-eutrophic | 20-35 |
| Eutrophic | 35-100 |
| Hypereutrophic | > 100 |

The baseline (reference) levels are defined as the values for sites in similar ecotones which can be ascertained either by predictive modelling or by hindcasting using diatom inference models unless data for pristine lakes is available; see also the indicator thresholds for anthropogenic stressors of freshwater lakes in Nova Scotia, http://lakes.chebucto.org/WATERSHEDS/PIC/mandell_reference.jpg

It is cautioned that these trophic levels based on TP may not apply to coloured (i.e., dystrophic) lakes where the natural TP may be quite high in comparison with clearwater lakes; see data of relatively undisturbed lakes within Nova Scotia in our web page, http://lakes.chebucto.org/lakecomp.html

When modelling shallow lakes (i.e., lakes which are completely mixed, and in which light penetrates to the bottom sediments), sediment phosphorus plays an important role in phosphorus cycling and should also be considered. Benthic and sestonic chlorophyll*a* also needs to be considered for these systems.

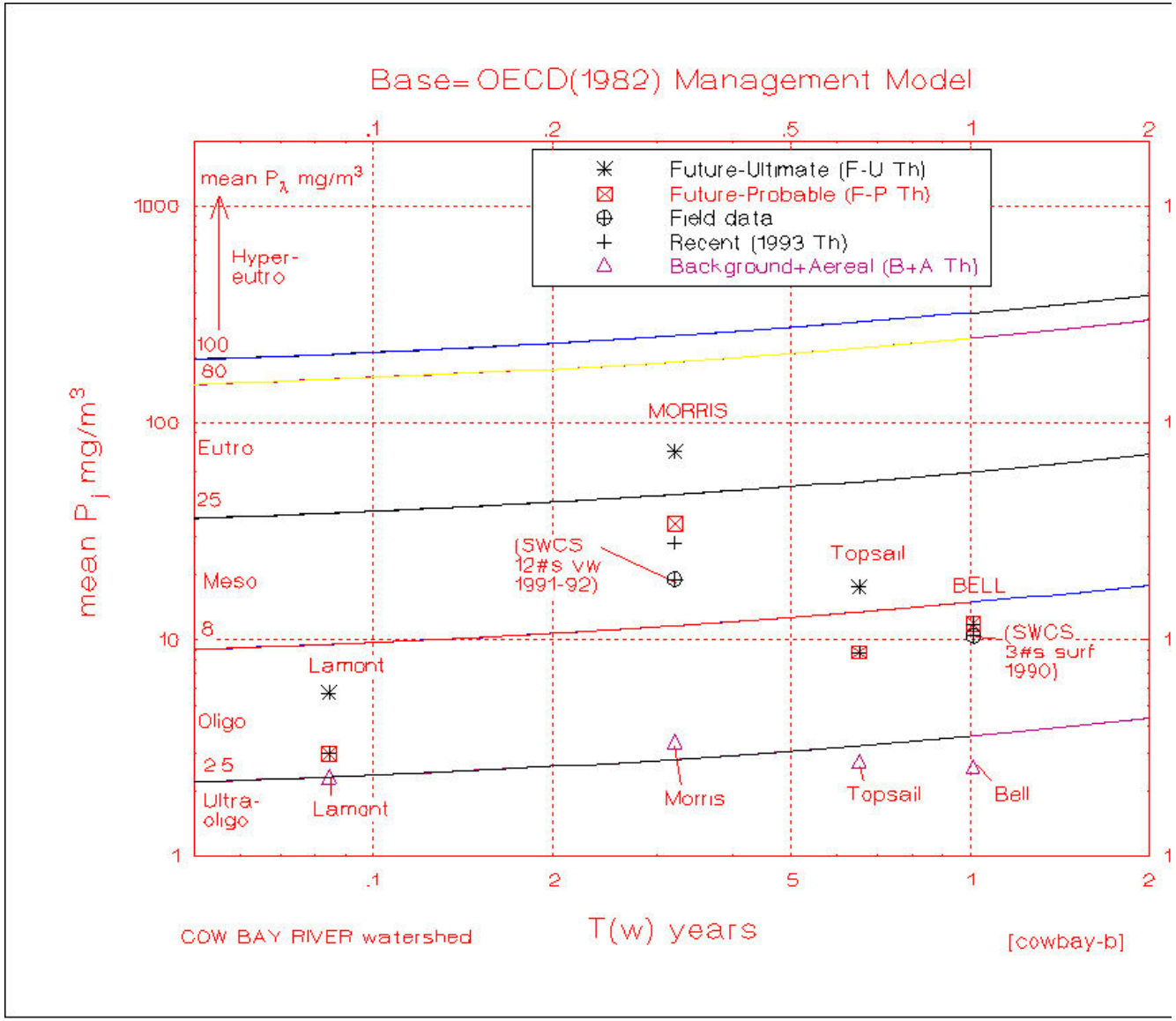
While the CCME Policy is dated February 2004, the 50% over baseline (reference) level concept has been known since around 1991 as published by Hutchinson *et al.*, then of the Ontario Ministry of Environment in the NALMS journal!

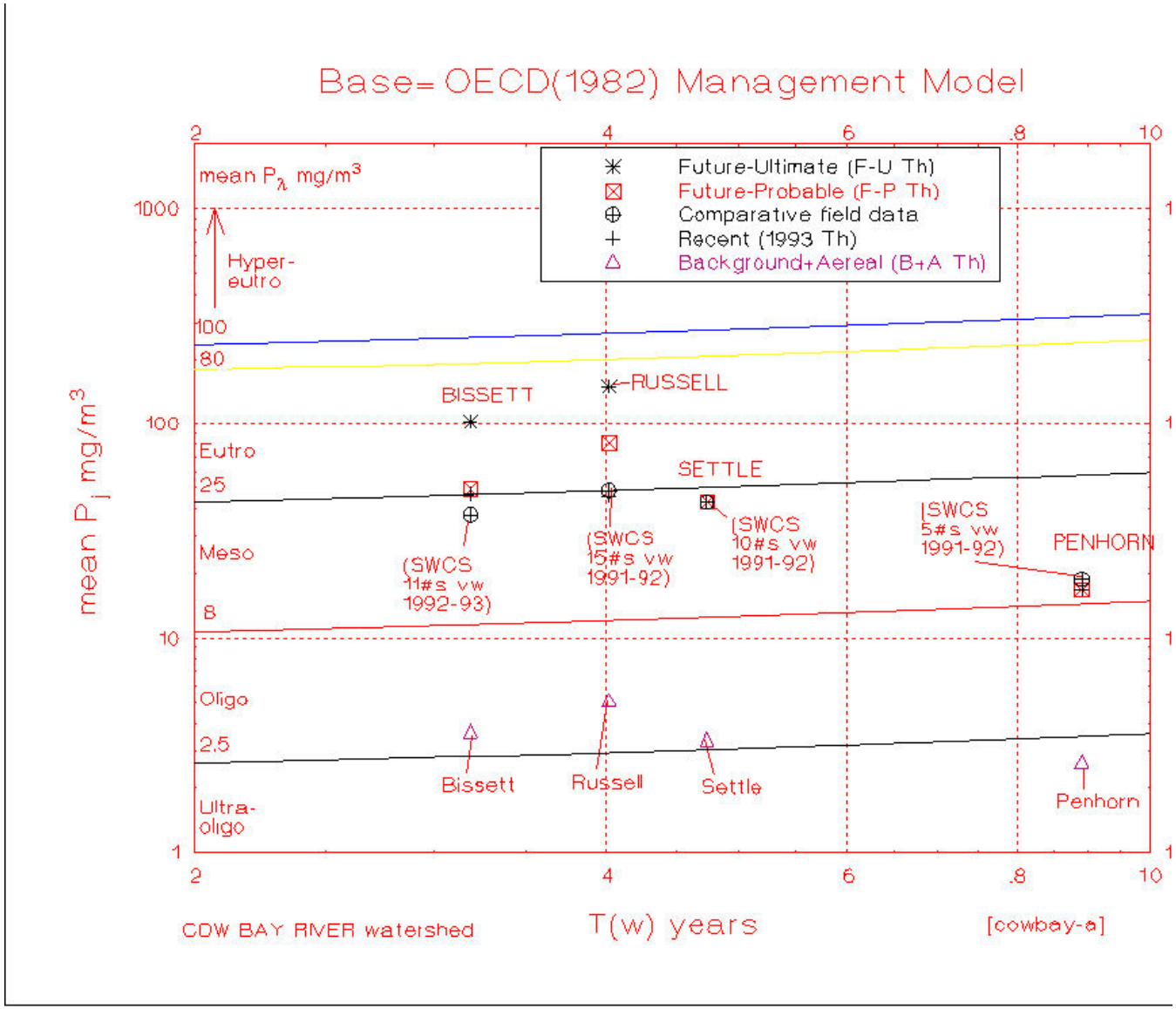
The trigger ranges accrue from the peer-consensus international OECD (Organization for Economic Co-Operation and Development) 14-year research culminating with the Final report in 1982!

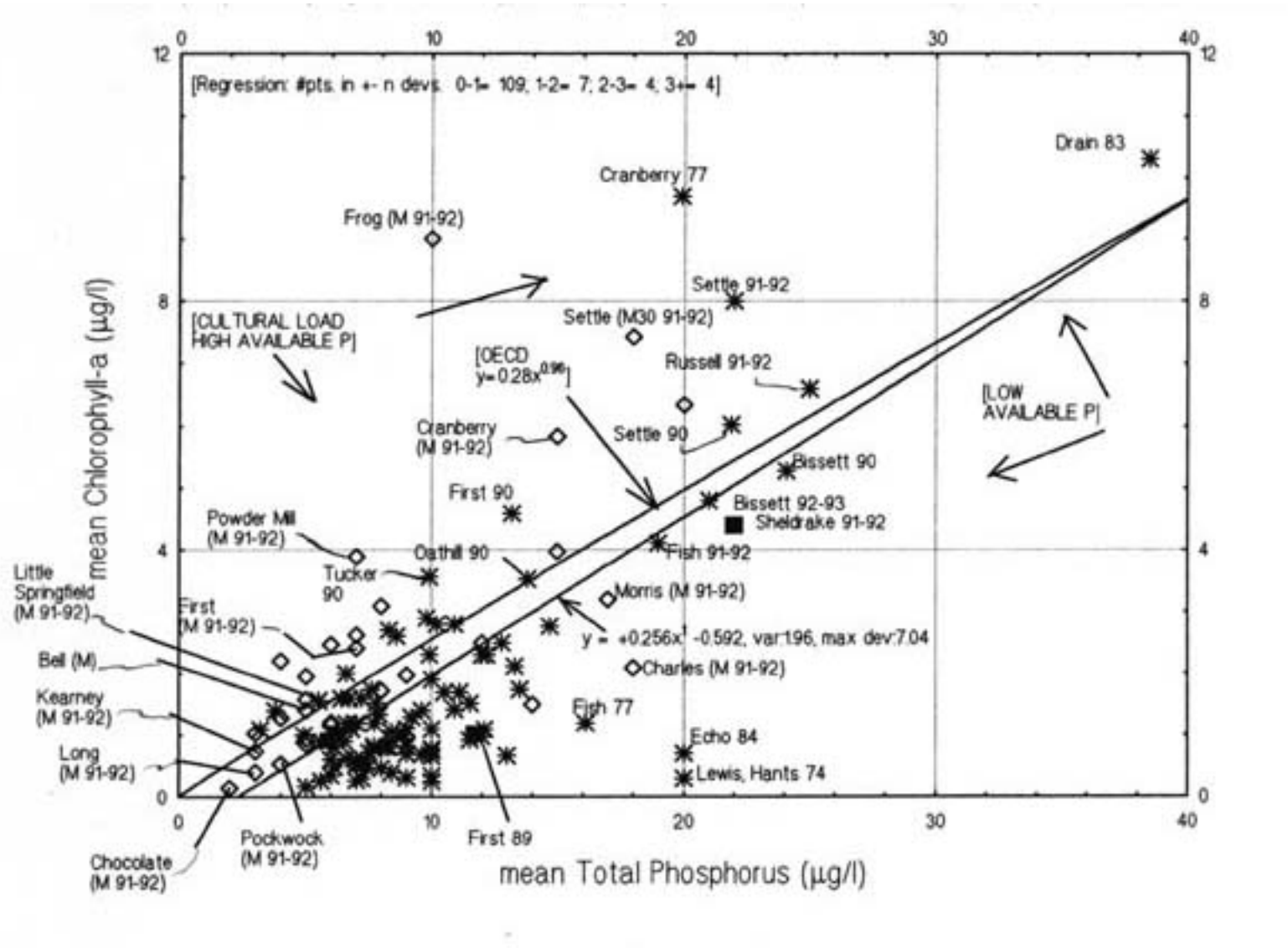
## [III] The CCME's trophic classification table below is also based on the OECD (1982) report:

**Table 4.1** Trophic classifications of lakes, with their corresponding phosphorus and chlorophyll concentrations and transparency (Secchi depth) (sources: Wetzel 2001; Vollenweider and Kerekes 1982).

| Trophic level | Total Phosphorus ($\mu g \cdot L^{-1}$) | | Chlorophyll *a* ($\mu g \cdot L^{-1}$) | | Secchi depth (m) | |
|---|---|---|---|---|---|---|
| | Wetzel (2001) | Vollenweider and Kerekes (1982) | Vollenweider and Kerekes (1982) | | Vollenweider and Kerekes (1982) | |
| | | | Mean | Max | Mean | Max ~~Min.~~ |
| Ultra-oligotrophic | < 5 | < 4 | < 1 | < 2.5 | > 12 | > 6 |
| Oligo-mesotrophic | 5-10 | 4-10 | < 2.5 | < 8 | > 6 | > 3 |
| Meso-eutrophic | 10-30 | 10-35 | 2.5-8 | 8-25 | 6-3 | 3-1.5 |
| Eutrophic | 30-100 | 35-100 | 8-25 | 25-75 | 3-1.5 | 1.5-0.7 |
| Hypereutrophic | > 100 | > 100 | > 25 | > 75 | < 1.5 | < 0.7 |


Base= OECD(1982) Management Model
mean P_λ mg/m3
Hyper-
eutro
1000
100
80
Eutro
25
Meso
8
10
Oligo
2.5
Ultra-
oligo
1
.1
.2
.5
1
2
Future-Ultimate (F-U Th)
Future-Probable (F-P Th)
Field data
Recent (1993 Th)
Background+Aereal (B+A Th)
MORRIS
(SWCS
12#s VW
1991-92)
Topsail
BELL
(SWCS
3#s surf
1990)
Lamont
Lamont
Morris
Topsail
Bell
mean P_λ mg/m3
T(w) years
COW BAY RIVER watershed
[cowbay-b]


Base= OECD(1982) Management Model
mean $P_\lambda$ mg/m$^3$
Future-Ultimate (F-U Th)
Future-Probable (F-P Th)
Comparative field data
Recent (1993 Th)
Background+Aereal (B+A Th)
Hyper-
eutro
1000
100
80
Eutro
25
Meso
8
Oligo
2.5
Ultra-
oligo
BISSETT
RUSSELL
SETTLE
PENHORN
(SWCS
11#s vw
1992-93)
(SWCS
15#s vw
1991-92)
(SWCS
10#s vw
1991-92)
(SWCS
5#s vw
1991-92)
Bissett
Russell
Settle
Penhorn
mean $P_j$ mg/m$^3$
2
4
6
.8
10
1
COW BAY RIVER watershed
T(w) years
[cowbay-a]


[Regression: #pts. in +- n devs. 0-1= 109, 1-2= 7, 2-3= 4, 3+= 4]
[CULTURAL LOAD HIGH AVAILABLE P]
[OECD y=0.28x^0.96]
[LOW AVAILABLE P]
y = +0.256x^1 -0.592, var:196, max dev:7.04
Drain 83
Cranberry 77
Frog (M 91-92)
Settle 91-92
Settle (M30 91-92)
Russell 91-92
Cranberry (M 91-92)
Settle 90
Bissett 90
First 90
Bissett 92-93
Sheldrake 91-92
Powder Mill (M 91-92)
Fish 91-92
Tucker 90
Osthill 90
Morris (M 91-92)
Little Springfield (M 91-92)
First (M 91-92)
Charles (M 91-92)
Bell (M)
Fish 77
Kearney (M 91-92)
Echo 84
Long (M 91-92)
Lewis, Hants 74
Pockwock (M 91-92)
First 89
Chocolate (M 91-92)
mean Chlorophyll-a (µg/l)
mean Total Phosphorus (µg/l)
0
10
20
30
40
0
4
8
12