Update on the 2004 Potomac Blue Green Algal Bloom

Prepared by:

Steve Bieber

Department of Environmental Programs

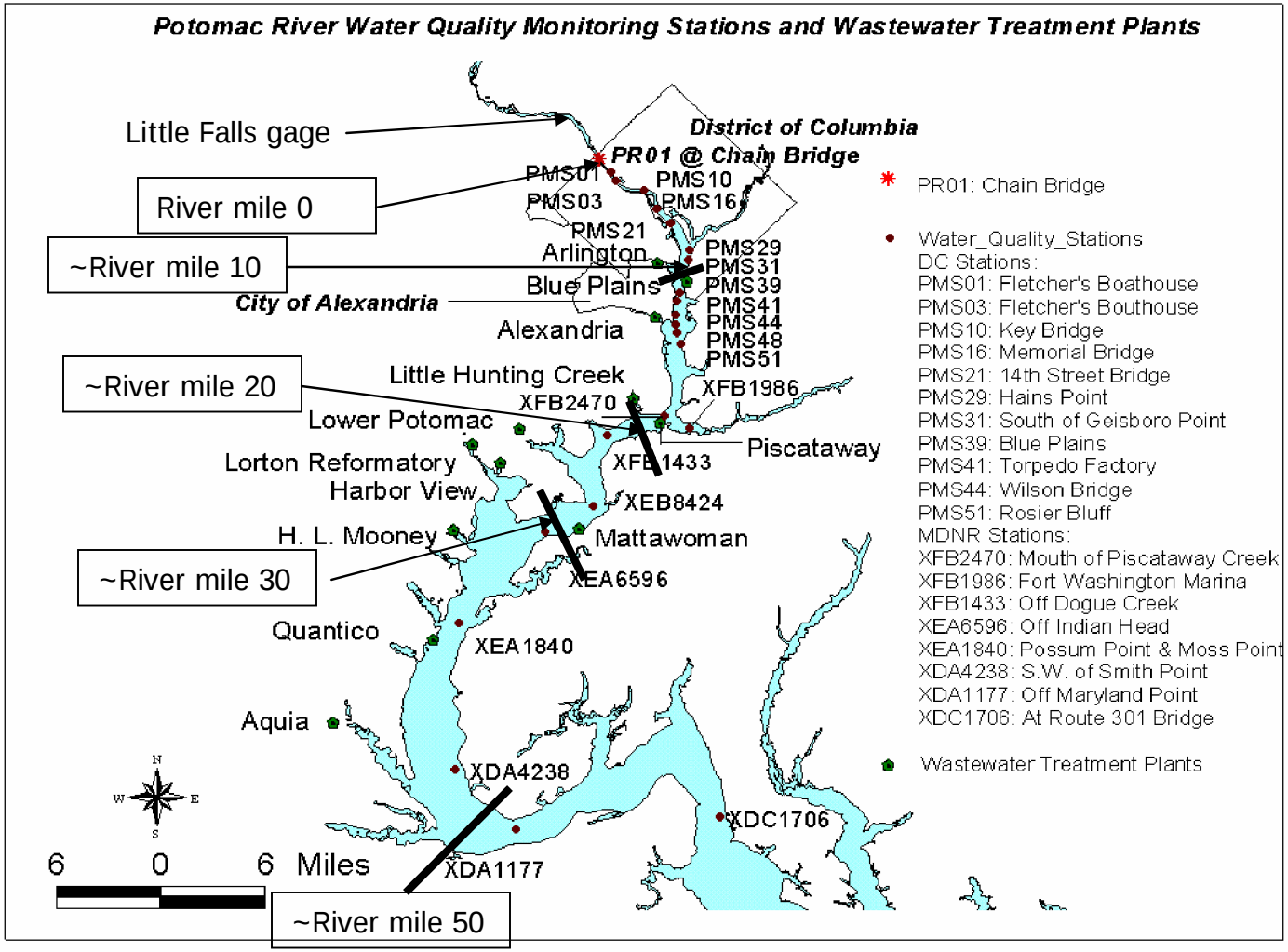
Metropolitan Washington Council of Governments

August 10, 2004

Presentation Overview

- 1983 Algae Bloom Summary
- 2004 Algae Bloom – what's happening now?
- 1983 Algal Bloom Expert Panel Conclusions
- Progress since 1985
- Next steps

Potomac Estuary Data Stations



The 1983 Algae Bloom

"For many who have struggled for years to understand the eutrophication of the Potomac Estuary, have invested large sums of money in nutrient control or have used this marvelous body of water in their recreation or commerce, the occurrence of a severe algal bloom in 1983 was a source of frustration, disappointment, and in some cases anger and accusation. The Potomac Estuary Community, including all those concerned with the water quality, ecology and aesthetic beauty of the estuary have spent more than 15 years in a search for an equitable and effective solution to the algal nuisance conditions of the late 1960s and 1977.

The installation of phosphorus removal at Blue Plains ... was greeted with a firm sense of hope that the estuary was going to be brought under some measure of control. But the Potomac was more elusive than originally thought...In 1983, it was as if the Estuary once more escaped our balanced attempts at control."

From the Foreword of the 1983 Expert Panel Report, Robert V. Thomann, Chairman, March 14, 1985

1983 Algal Bloom Statistics

- Began late July, ended in October
- Wet spring, hot dry summer, low wind
- Peak Chl-a levels 250 µg/l with up to 800 µg/l in embayments—primary species Microcystis aeruginosa (blue-green algae also dominant in 1960s)
- pH levels over 10 in bloom area
- Unusually low upper estuary alkalinity

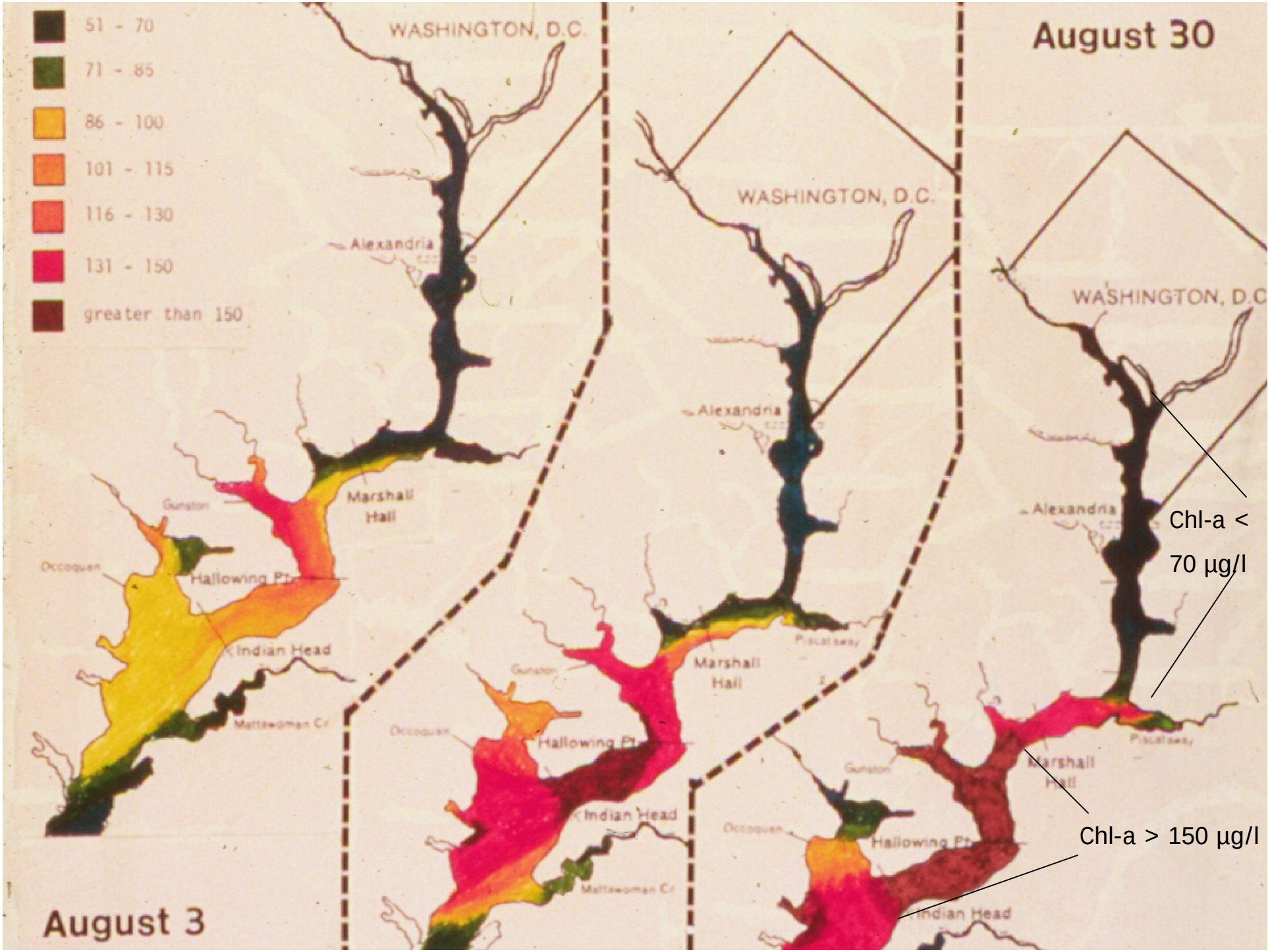

Elodea Cove (River Mile 20)
September 8, 1983

Potomac estuary algal bloom

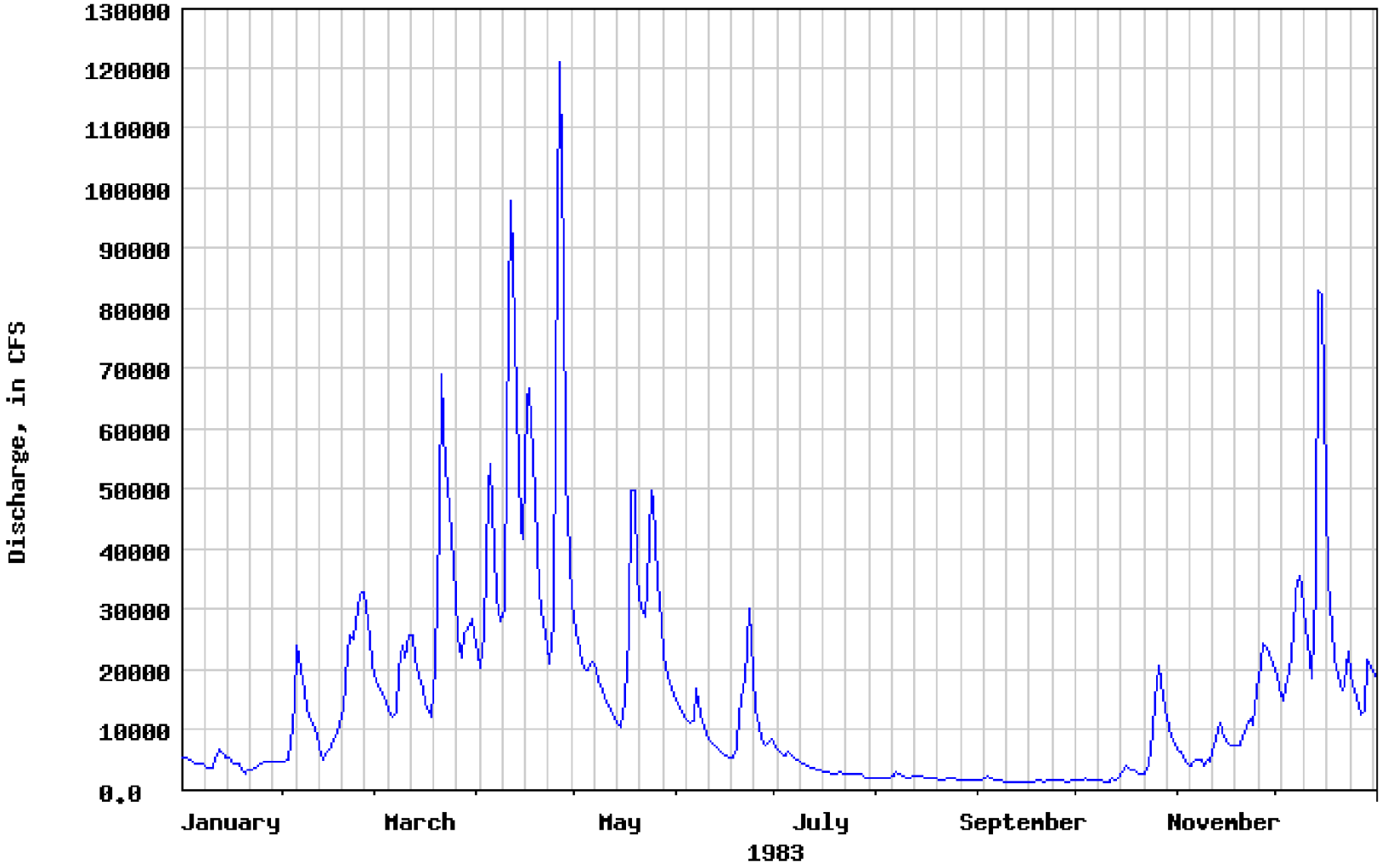
August, 1983

Potomac Estuary Algal Bloom

August, 1983


51 - 70
71 - 85
86 - 100
101 - 115
116 - 130
131 - 150
greater than 150
WASHINGTON, D.C.
Alexandria
Marshall Hall
Gunston
Occoquan
Hallowing Pt
Indian Head
Mattawoman Cr
August 3
August 30
Chl-a < 70 µg/l
Chl-a > 150 µg/l

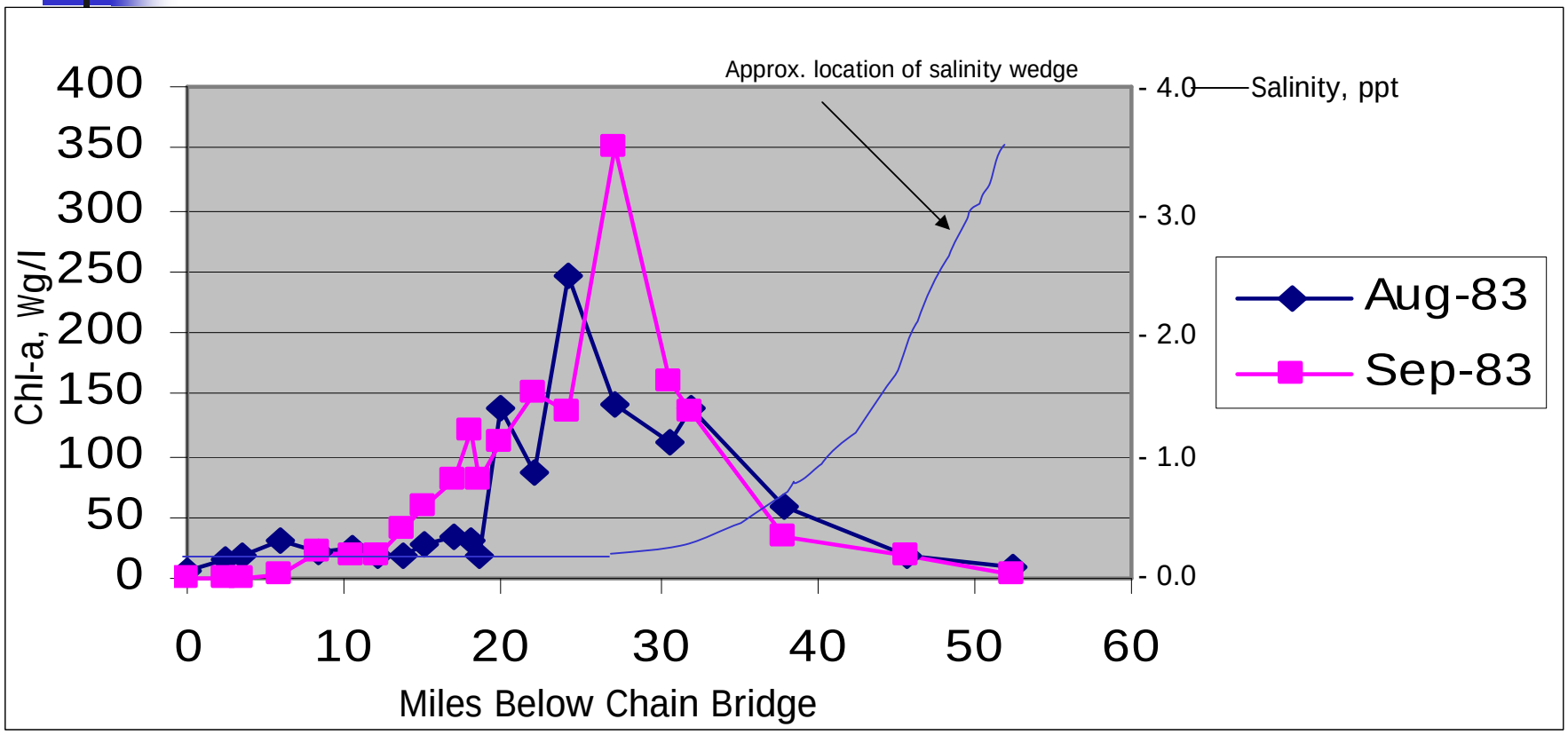
1983 Hydrograph: Little Falls



Summer avg=3899 cfs; Aug-Sep avg=1692 cfs

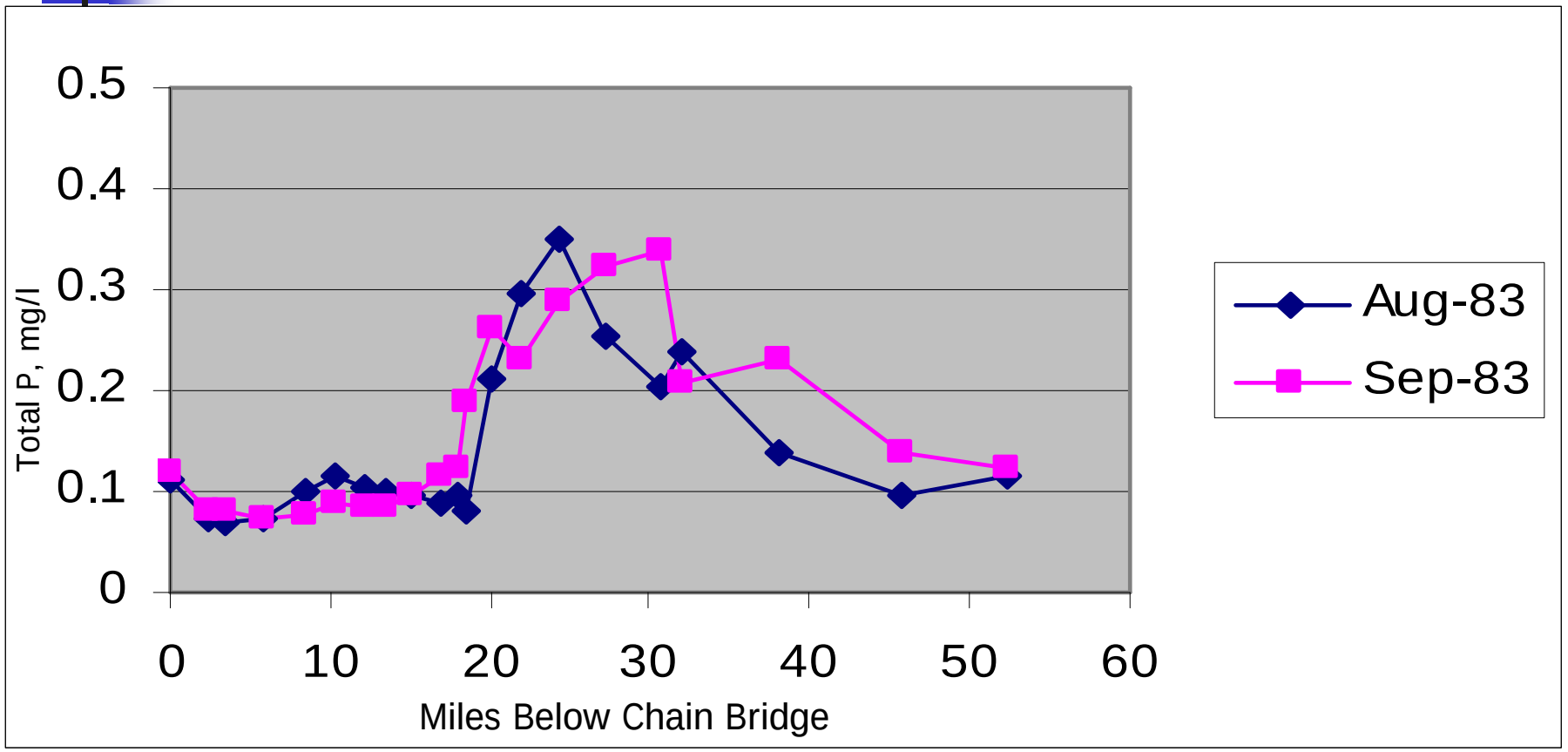
Legend: Discharge, in CFS
Estimated Discharge, in CFS

1983 Chlorophyll-a: August, 1983 and September, 1983



Note: data points represent weekly averages

1983 Total Phosphorus: August, 1983 and September, 1983



Note: data points represent weekly averages

2004 Algal Bloom Statistics

- Began late May or early June
- Wet weather, warm spring (especially May)
- Peak Chl-a levels up to 1,591 µg/l in embayments—primary species Microcyctis aeruginosa (blue-green algae also dominant in 1960s and 1983)
- pH levels between 7 – 9 in bloom area

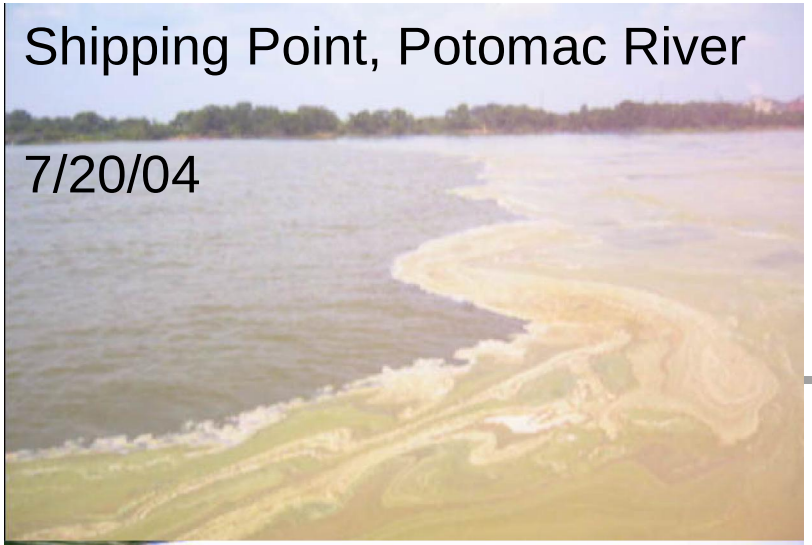
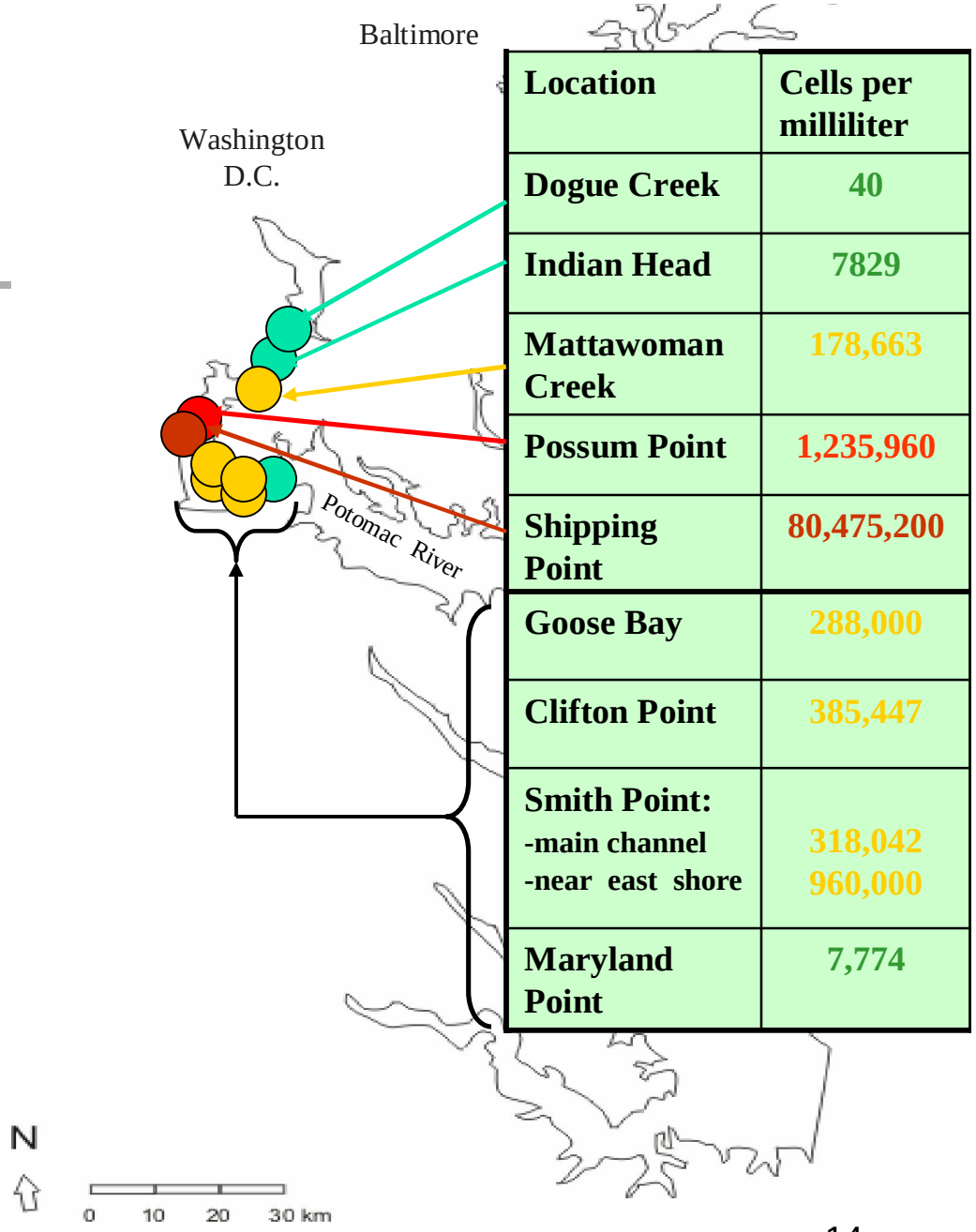
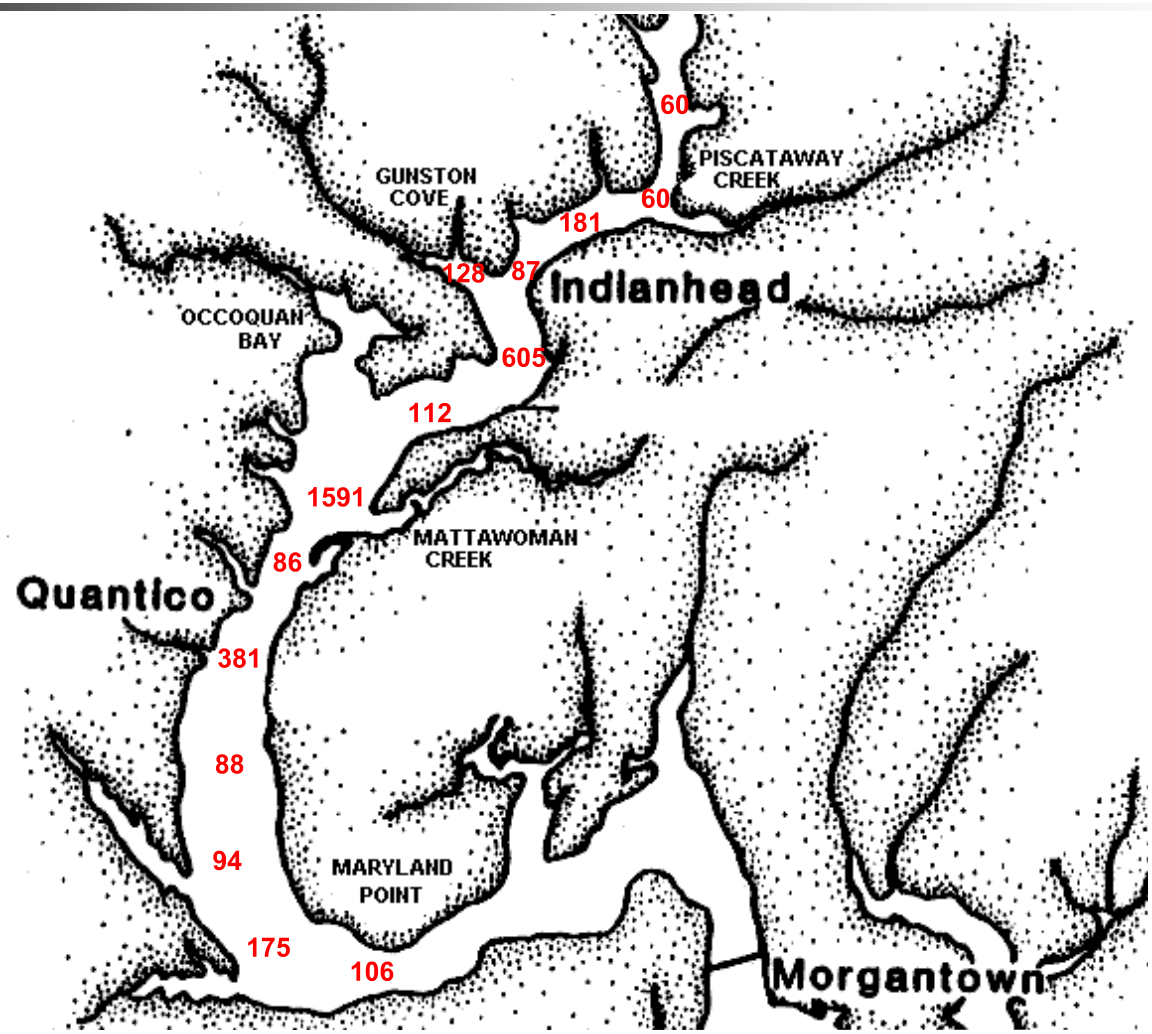


Figure 1. July 19-20 *Microcystis*-only results

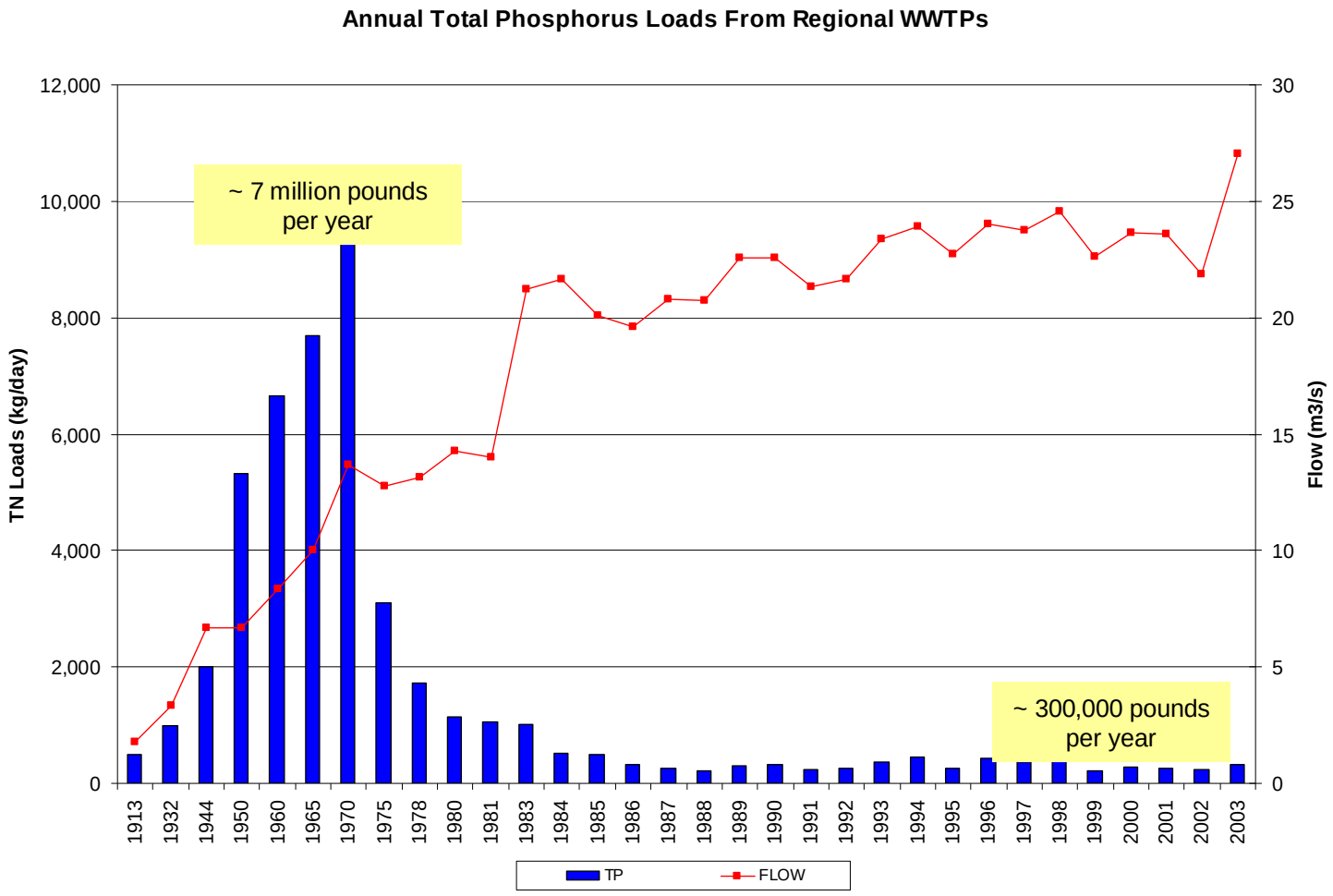


Location	Cells per milliliter
Dogue Creek	40
Indian Head	7829
Mattawoman Creek	178,663
Possum Point	1,235,960
Shipping Point	80,475,200
Goose Bay	288,000
Clifton Point	385,447
Smith Point: -main channel -near east shore	 318,042 960,000
Maryland Point	7,774

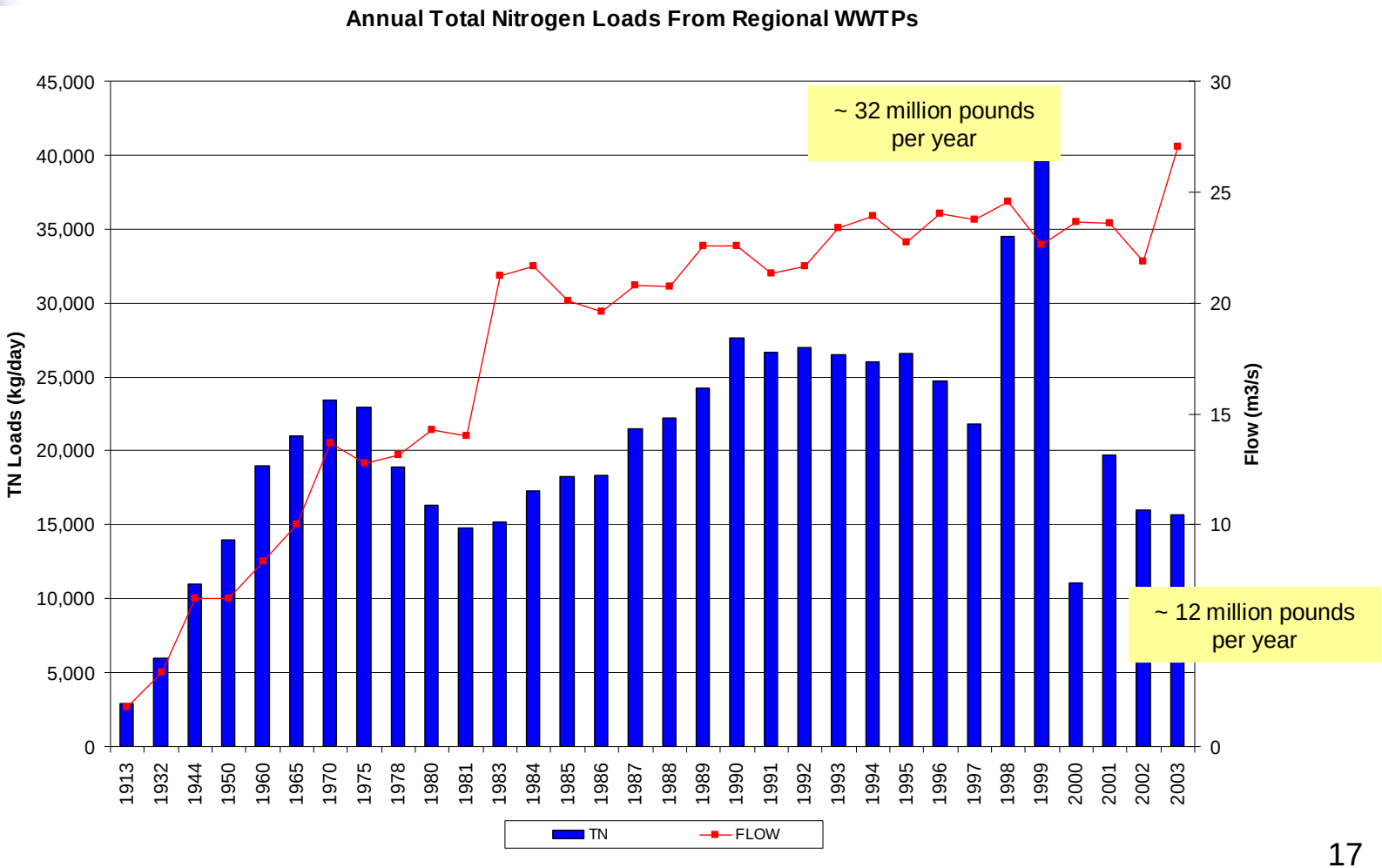
Chlorophyll from August 2, 2004



Potomac Estuary WWTP Phosphorus Loads

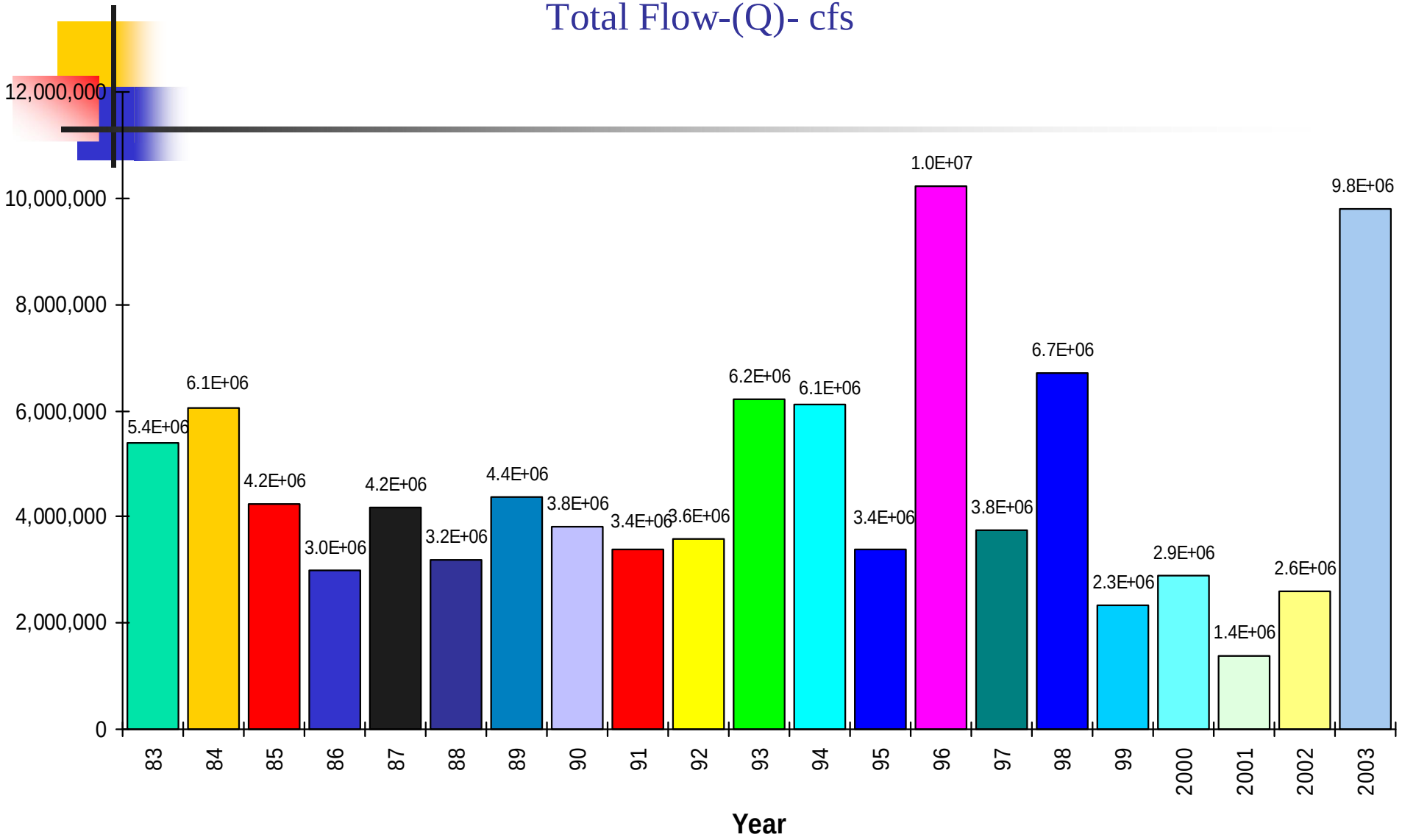


Potomac Estuary WWTP Nitrogen Loads



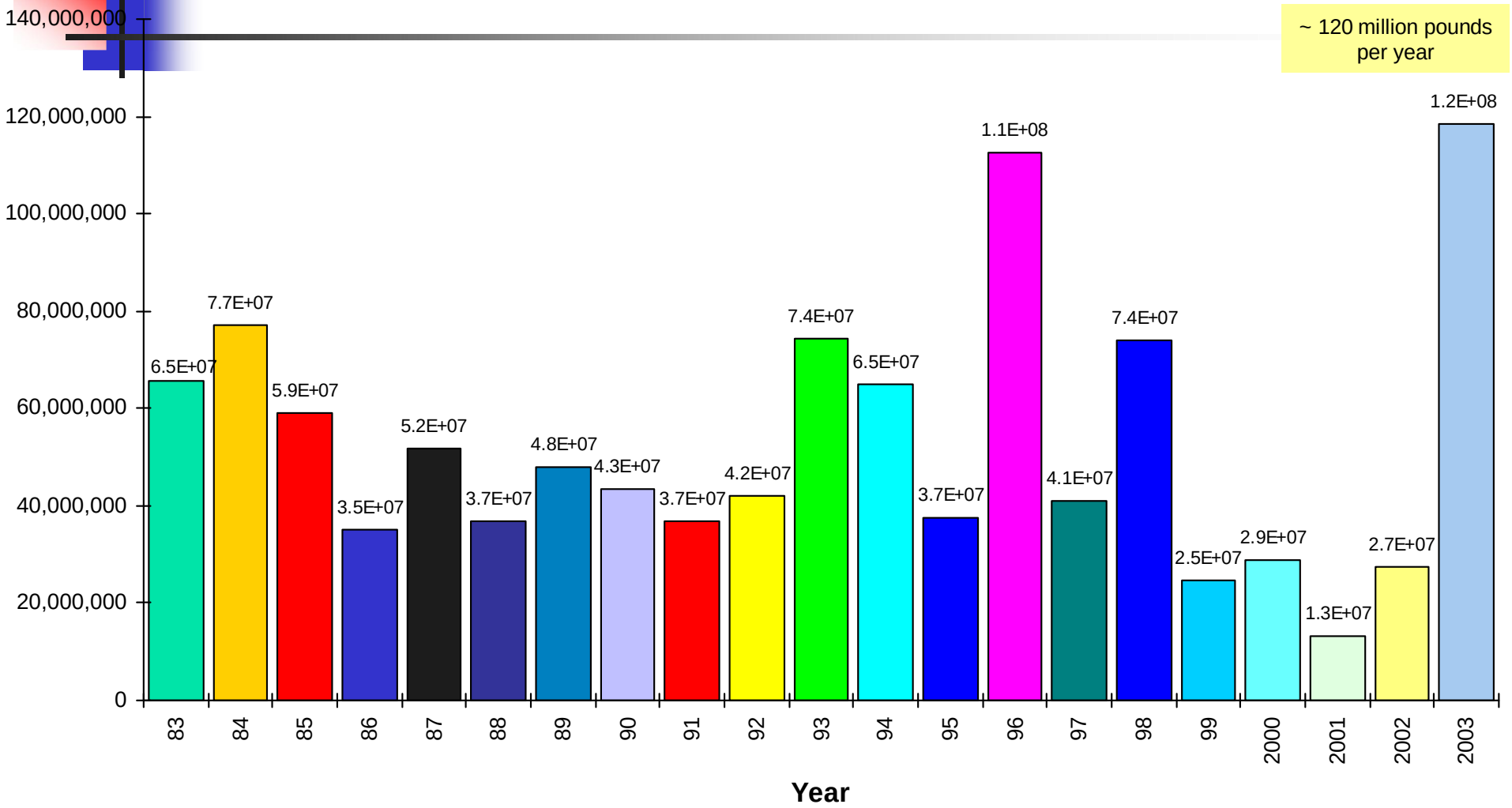
1983 - 2003 Chain Bridge

Total Flow-(Q)- cfs



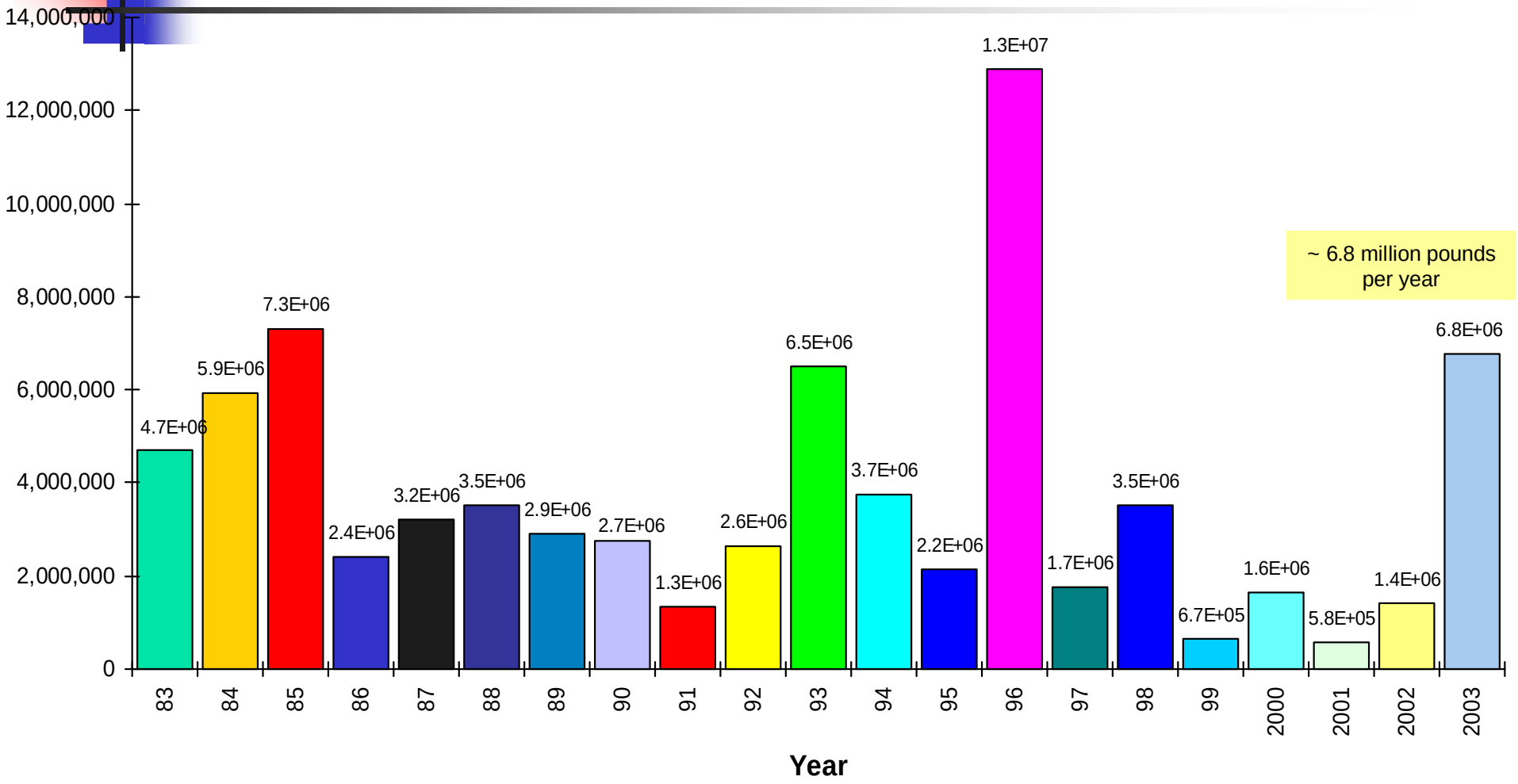
1983 - 2003 Chain Bridge Loadings

Total Nitrogen (TN) - Pounds

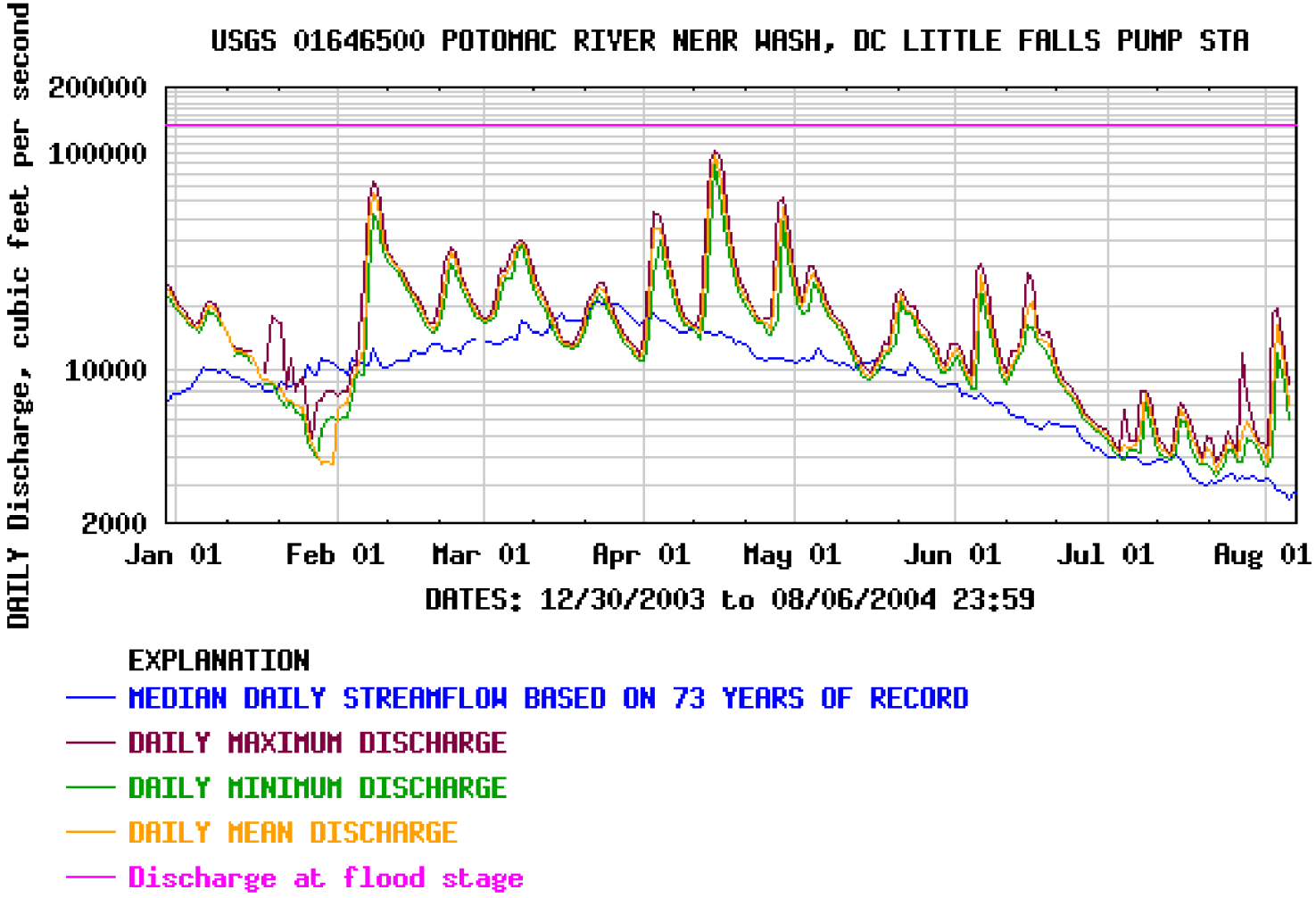


1983 - 2003 Chain Bridge Loadings

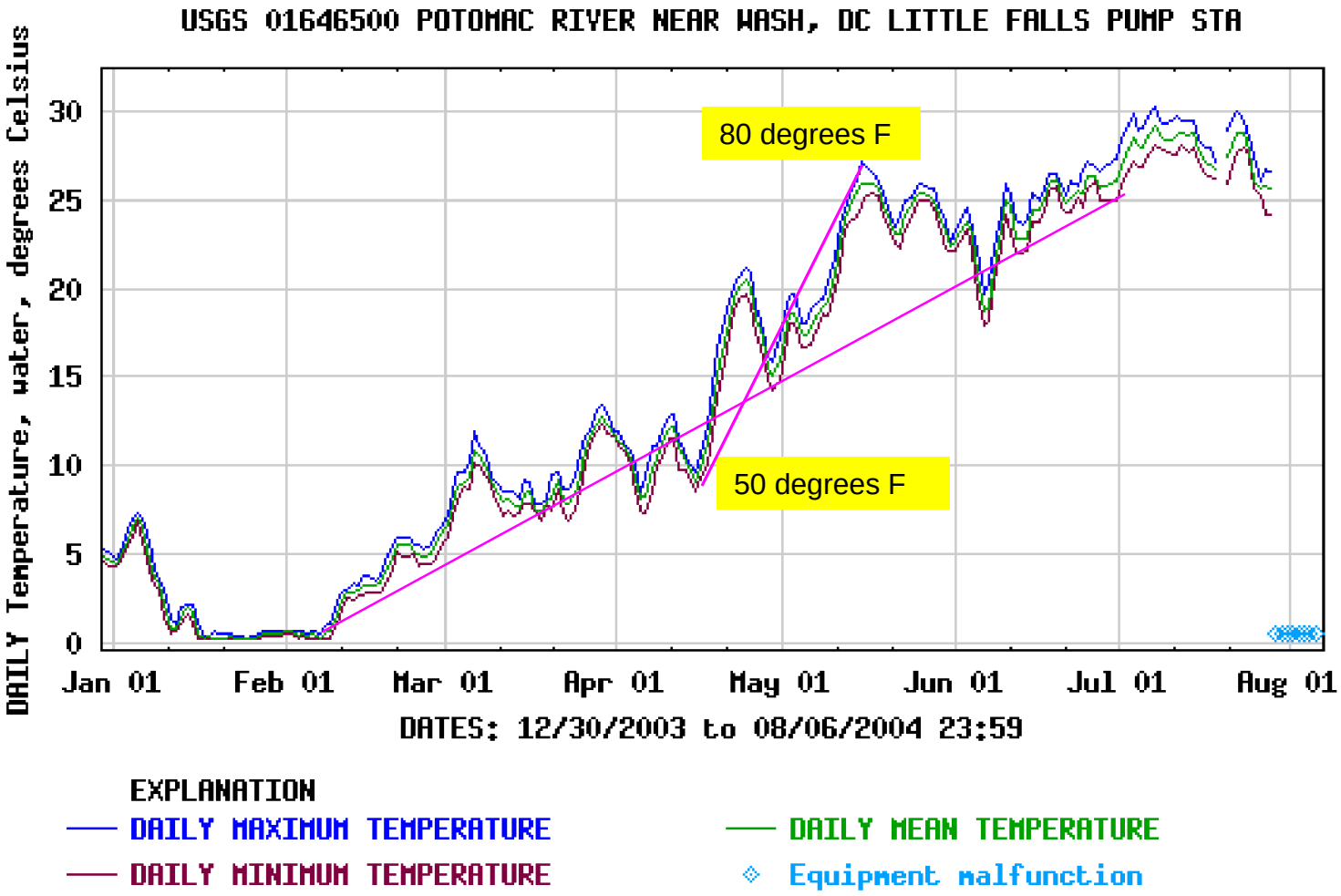
Total Phosphorus (TP) - Pounds



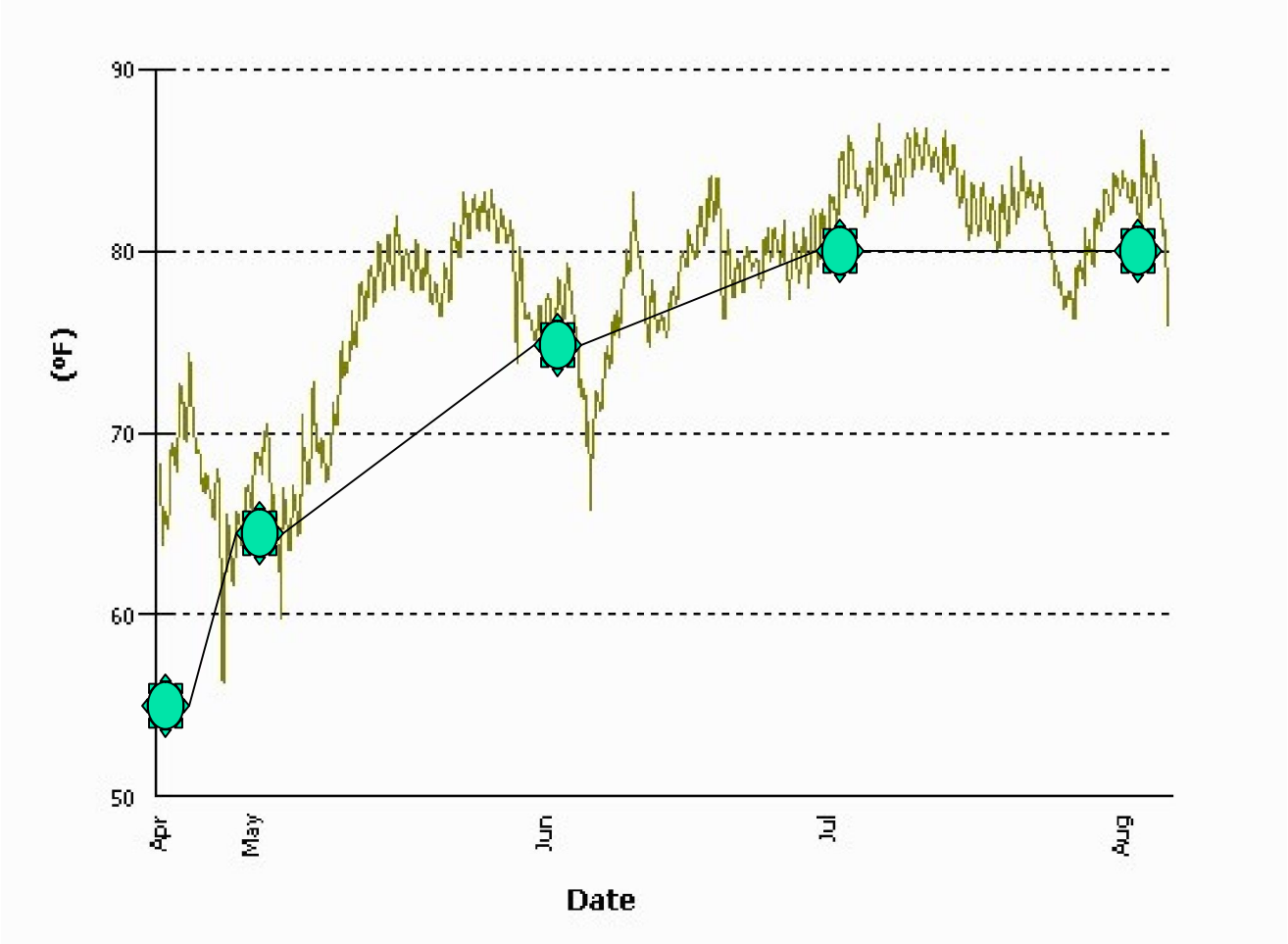
2004 Hydrograph: Little Falls



Water Temperature at Little Falls



2004 Temperature data near Mattawoman Creek



pH data near Mattawoman Creek

What about nitrogen fixing blue green algae?

- The best available monitoring information (from MD-DNR) indicates very high abundances of Microcystis (non-nitrogen fixing blue-green) and very low abundances of Anabena and Aphanizomenon (both nitrogen fixing blue-greens).
- This is consistent with conditions of both phosphorus and nitrogen sufficiency, and little (if any) nitrogen fixation.
- We also believe that loading rates of dissolved inorganic nitrogen are sufficiently high to prevent nitrogen depletion that would favor nitrogen-fixing blue-green algae.
- The best evidence from past studies and modeling is that Potomac River wastewater plants would all have to go to 3-5 mg/l TN and there would need to be low flow conditions in the Potomac to drive the system toward nitrogen fixing blue-green algae. The updated modeling work that COG is co-sponsoring with the Corps of Engineers, Maryland, and EPA is specifically going to examine this question.

1983 Algal Bloom Expert Panel Conclusions (3/1985)

- Environmental conditions ideal
- Intensification of bloom to 250 µg/l due to positive feedback system: algal growth raises pH, increases sediment phosphorus flux thereby supporting greater growth of algae
- Low alkalinity (from high spring runoff) in estuary contributing factor
- PEM predicted phosphorus controls should have limited bloom to about 100 µg/l chl-a
- >100 µg/l chl-a defines an undesirable Potomac nuisance algal bloom

Since 1985 ...

- PEM was partially upgraded (1988) to include an ability to model the pH-alkalinity chemistry observed in the 1983 bloom. Control of another “1983” bloom via alkalinity control did not appear promising.
- The potential for promoting nitrogen-fixing blue-green algae was examined (early 1990s). Under extreme low flow, such blooms may be favored but could be limited with phosphorus controls.
- All Potomac estuary wastewater treatment plants have regularly met the 0.18 mg/l P limit since 1985.
- Removal of nitrogen through BNR is ongoing at Blue Plains and other major facilities.
- Monitoring of the Potomac estuary has continued through the coordinated monitoring program.
- Chesapeake Bay Water Quality Model developed but does not explicitly model the algal speciation and chemistry in the Potomac estuary

Findings/Conclusions

- TP loads from wastewater plants have dropped by about 96% since 1970 despite flows increasing 77%
- TN loads have dropped about 44% since 1985.
- Phosphorus control program at 0.18 mg/l TP limit for Blue Plains and other Potomac estuary wastewater plants has been in place since mid-1980s
- Before 1983: summer chl-a >150 µg/l during low flow summers
- Since 1990: summer chl-a ~40 µg/l (range 10-80 µg/l) during low flow summers – until this year.

Findings/conclusions

- The totality of the data and empirical evidence over the past 20 years, combined with 1980s modeling studies indicates that continuing to meet the 0.18 TP limit, while adding nitrogen removal through BNR, could provide further improvement to freshwater Potomac estuary water quality while helping support Chesapeake Bay nutrient reduction goals.
- Chesapeake Bay Water Quality Model upgrade (sponsored by Blue Plains Users) will explicitly model the algal speciation and chemistry in the Potomac estuary.

In the very near term

- COG has been working with scientists and modelers to assess monitoring needs and gaps:
  - Total Inorganic Carbon
  - Calcium
  - Alkalinity
  - pH
- COG is presently working with OWML, MD-DNR and others to insure data gaps are filled, to the extent possible.
  - Additional monitoring at Chain Bridge
  - Additional monitoring at WWTPs
  - Sediment nutrient flux measurements in the Potomac

Longer term next steps

- Integrate 2004 data to explore potential causes of bloom (2004).
- Hold Potomac River monitoring workshop to better coordinate efforts (2005).
- Complete upgrade of Bay model (sponsored by Blue Plains Users) to explicitly model the algal speciation and chemistry in the Potomac estuary (2007).