Long Term Phosphorus Reduction at Four NYC Water Supply Watershed Wastewater Treatment Plants Upgraded to Tertiary Filtration

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Water Supply Background

- The NYC water supply consists of 19 reservoirs in a 1,969 square mile watershed separated into three main water supply systems.

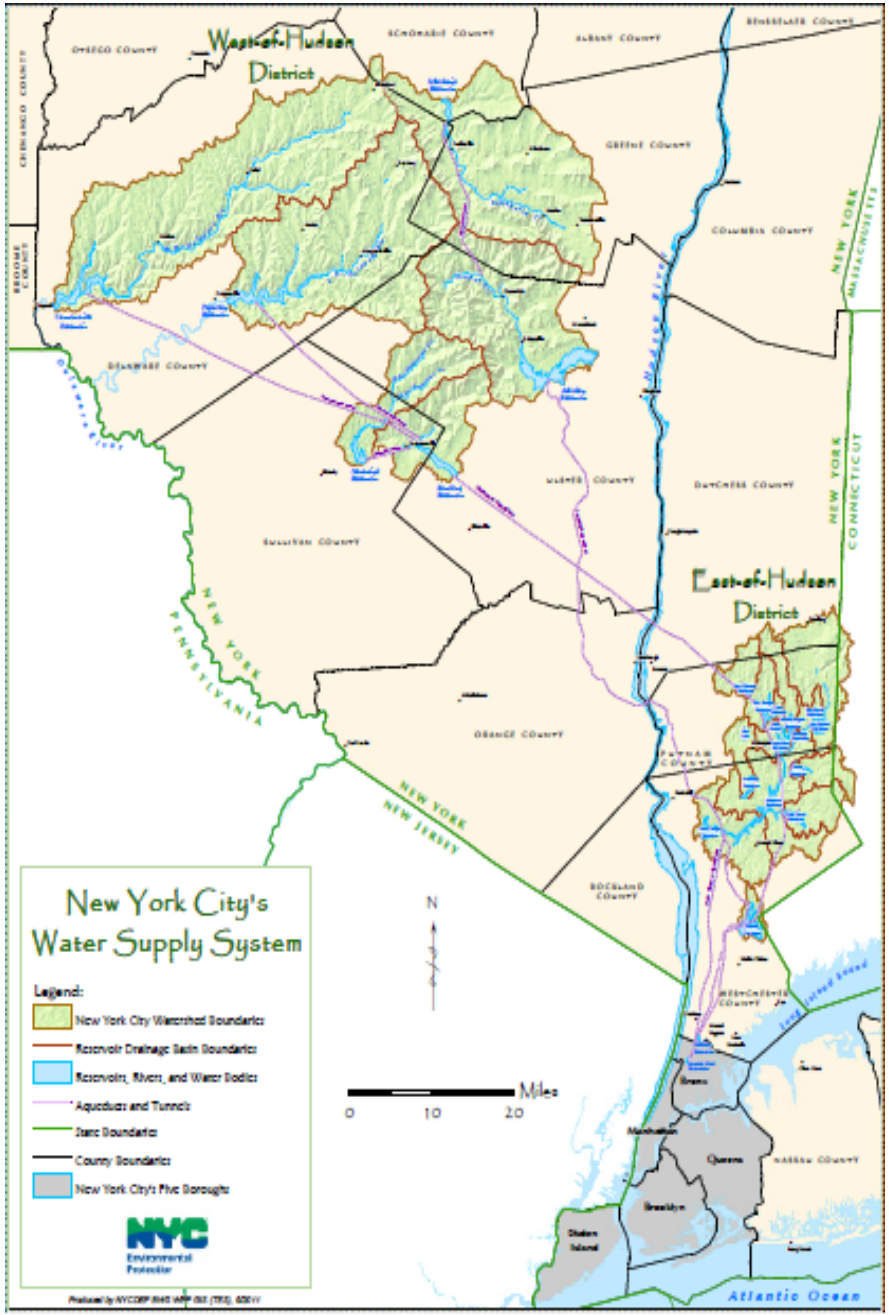
- Total storage capacity of 580 billion gallons with average daily consumption of 1.1 to 1.2 BGD.

- Supplies nine million NYC and upstate NY residents.

- Treatment consists of course filtration, long term settling and storage, fluoridation, pH adjustment, calcium orthophosphate addition and disinfection.

- The four wastewater treatment plants (WWTPs) studied discharge into the West Branch Delaware River which supplies 77% of the flow into the Cannonsville Reservoir. This reservoir is a major component of the Delaware system that normally supplies 50% of the City water supply.

NYC Water Supply Watershed Map



Why is Phosphorus a Problem?

- Excessive phosphorus can lead to reservoir eutrophication which has a negative effect on water quality;

- Eutrophication results in increased phytoplankton (chlorophyll) which in turn results in depleted oxygen, high turbidity, increased microbiological activity, increased fish mortality, aesthetic issues (increase in color, odor and unpleasant taste) and changes in reservoir ecosystem dynamics;

- In 1994, the Cannonsville Reservoir was identified as a top priority basin with phosphorus loadings in excess of 49% of critical load.

Vintage Eutrophication Images from Cannonsville Reservoir

Cannonsville Watershed Phosphorus Reduction Background

- USEPA's 1989 Surface Water Treatment Rule specified the need for water supply filtration unless specific filtration avoidance requirements could be met which included phosphorus reduction;

- DEP received its first Filtration Avoidance Determination (FAD) in 1993 and continues to maintain this status;

- Watershed Memorandum of Agreement, Watershed Rules and Regulations and the FAD all deal with phosphorus reduction. Phosphorus reduction programs began in 1993;

- The phosphorus reductions at the four WWTPs discussed in this presentation are a single component of the overall Cannonsville watershed phosphorus reduction initiative which includes control measures for point (WWTP) and non-point sources.

Phosphorus Reduction Programs

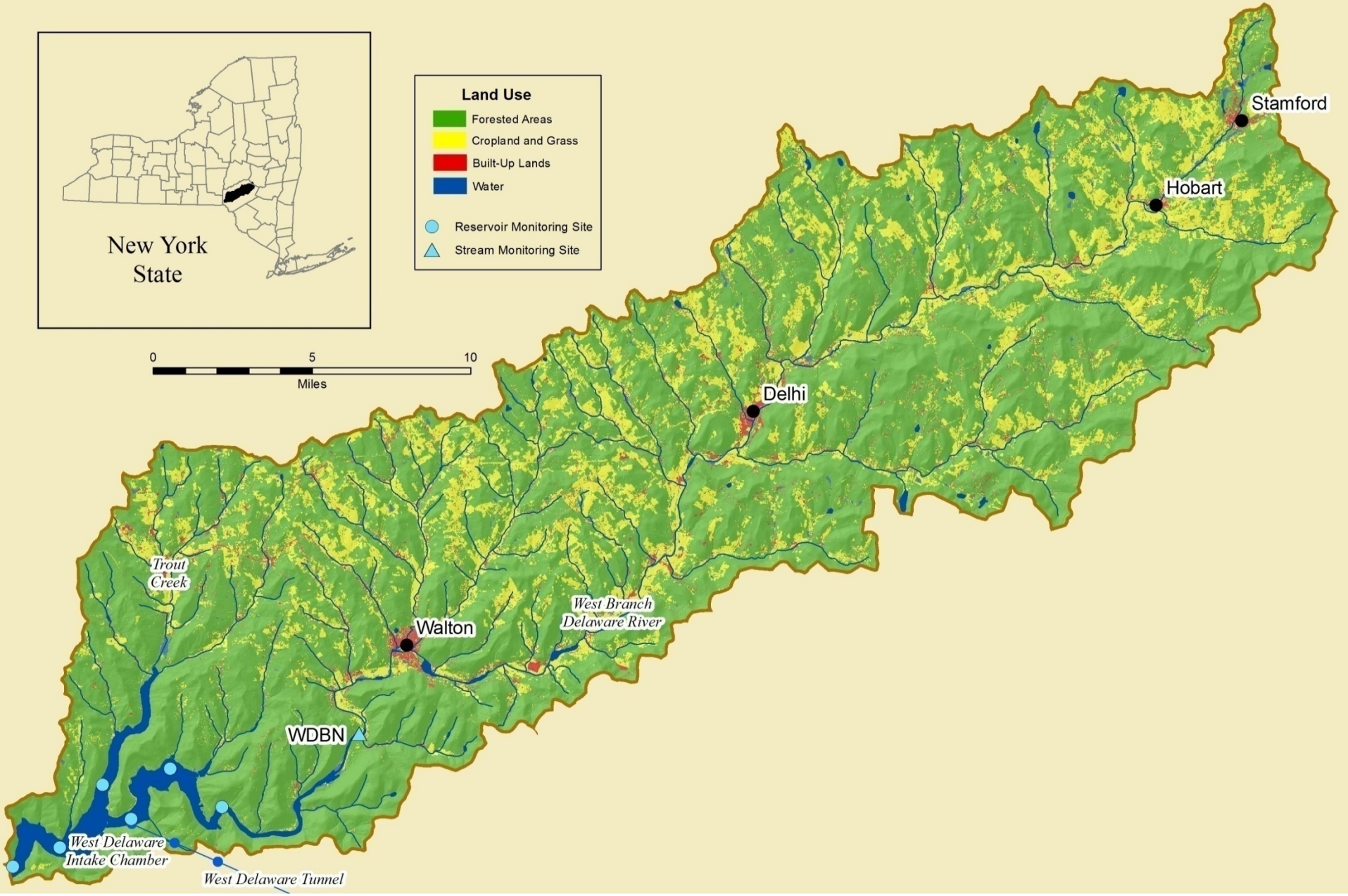
DEP manages and funds a broad spectrum of Cannonsville watershed phosphorus reduction initiatives including but not limited to:

- Land acquisition;
- Forest and natural resource management on City owned and private land;
- Whole farm planning program;
- Conservation reserve enhancement program (CREP);
- Stream and stormwater management;
- Implementation and construction of phosphorus control best management practices (BMP's) such as constructed wetlands;
- Process modification and re-direction of waste streams for industries;
- Installation of residential and community subsurface sewage treatment systems (Community Wastewater Management Program);
- Wastewater treatment plant tertiary system upgrades to improve effluent quality at pre-existing wastewater treatment plants. This particular program is the focus of this presentation.

Plant Upgrade History

- Reduction of pathogens, phosphorus and particulates was the main objective of the WWTP tertiary treatment systems.
- WWTPs delivered 37% of the reservoir phosphorus load in 1994.
- Plant effluent phosphorus limits were made more stringent (0.11 to 0.5 mg/l) after the tertiary systems became operational.
- DEP's required standard for tertiary treatment was originally microfiltration only; however a unique form of upflow sand media filtration known as Continuously Backwashing Upflow Dual Sand Filtration (CBUDSF) was pilot tested and approved as an equivalent.
- Village of Stamford WWTP upgrade was fully operational in January 2003, Village of Hobart in February 2003, Village of Delhi in January 2003 and Village of Walton May 2003.
- DEP funded the construction of all tertiary systems and related infrastructure, continues to fund tertiary system operation and maintenance costs, inspects facilities for operations and compliance, provides technical support and continuously evaluates treatment technology, plant performance and effluent data.

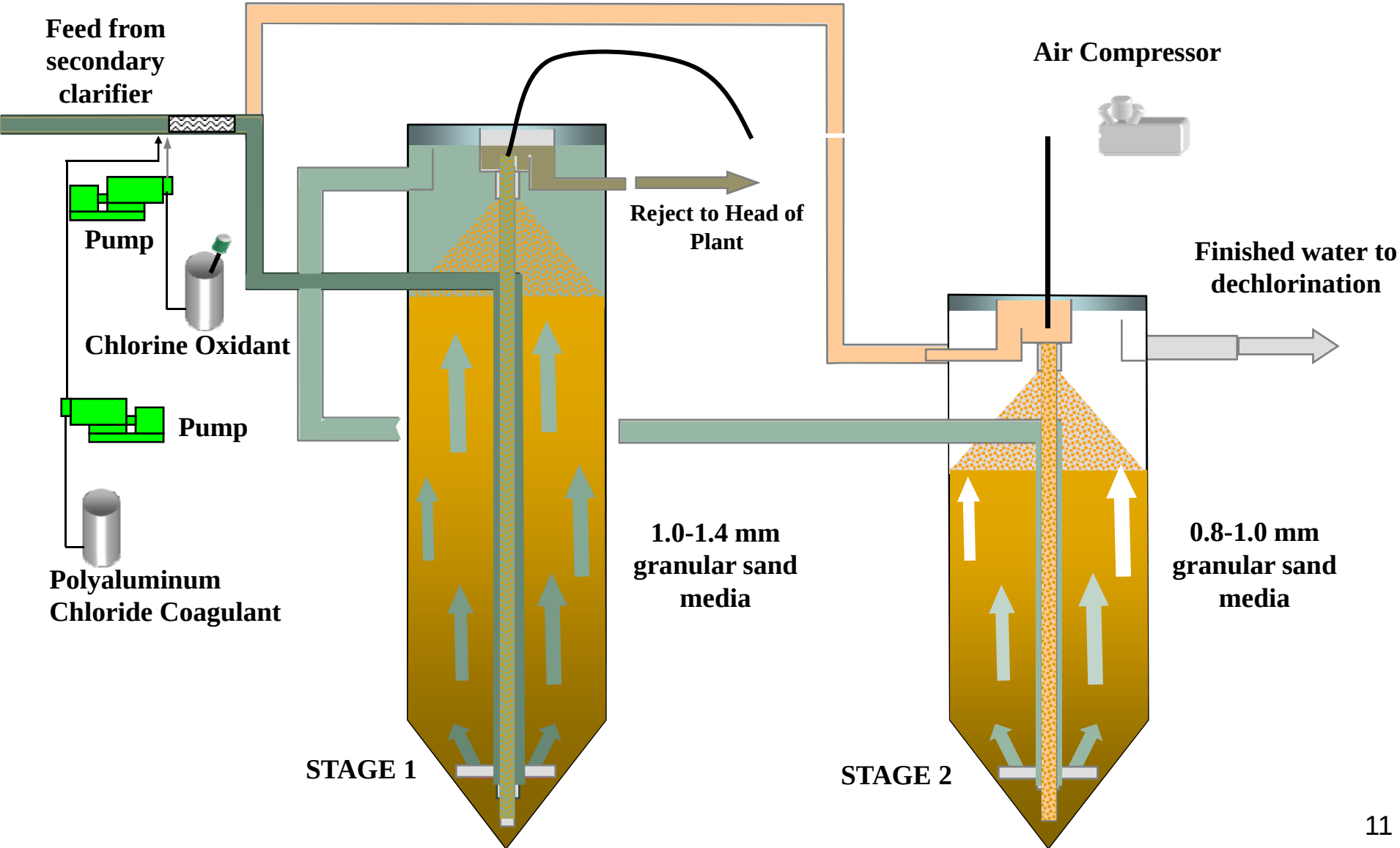
Cannonsville Reservoir Drainage Basin



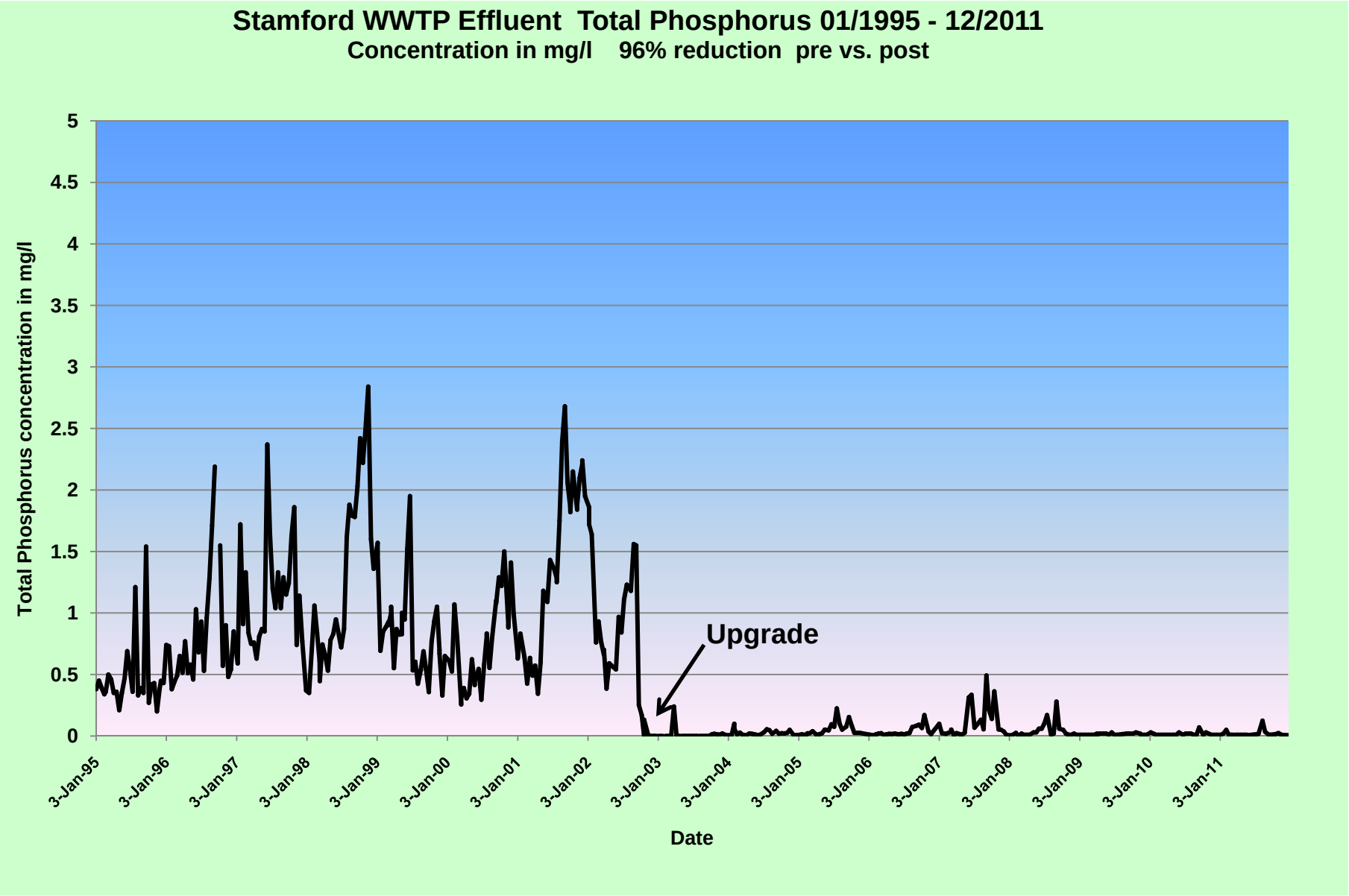
Village of Stamford WWTP Process

Permitted flow limit = 0.7 mgd, total phosphorus limit = 0.13 mg/l

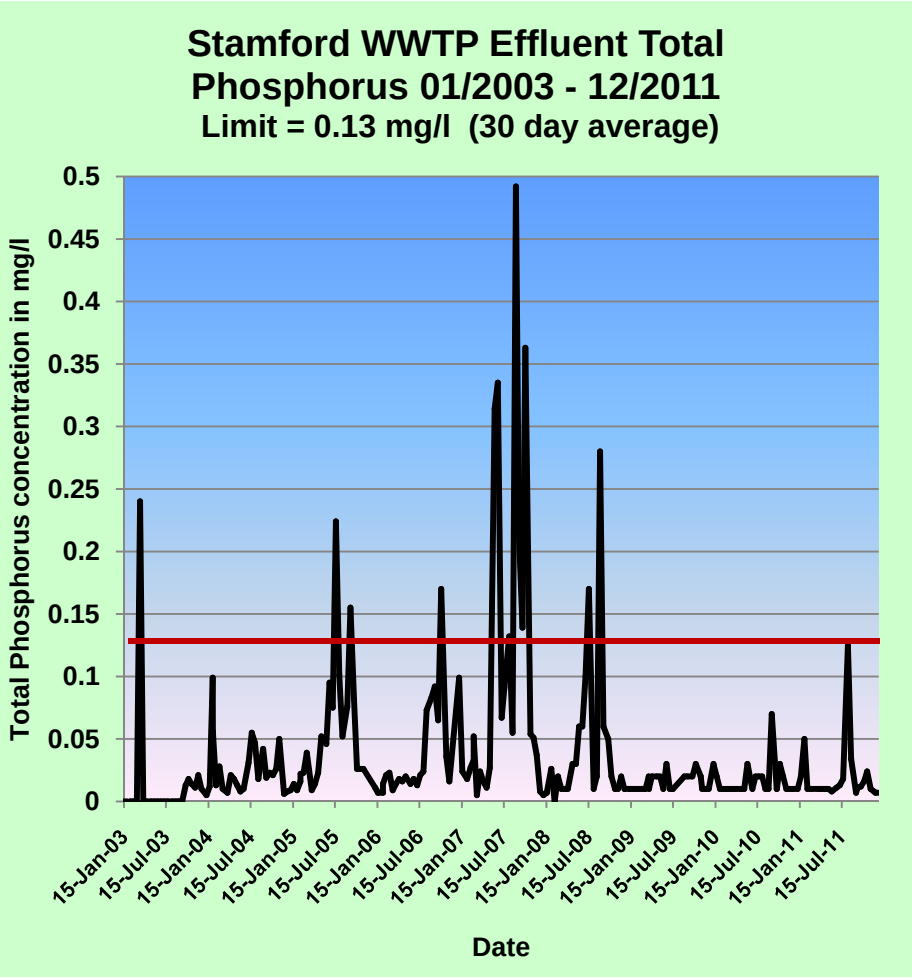
CBUDSF Cross Section View and Process

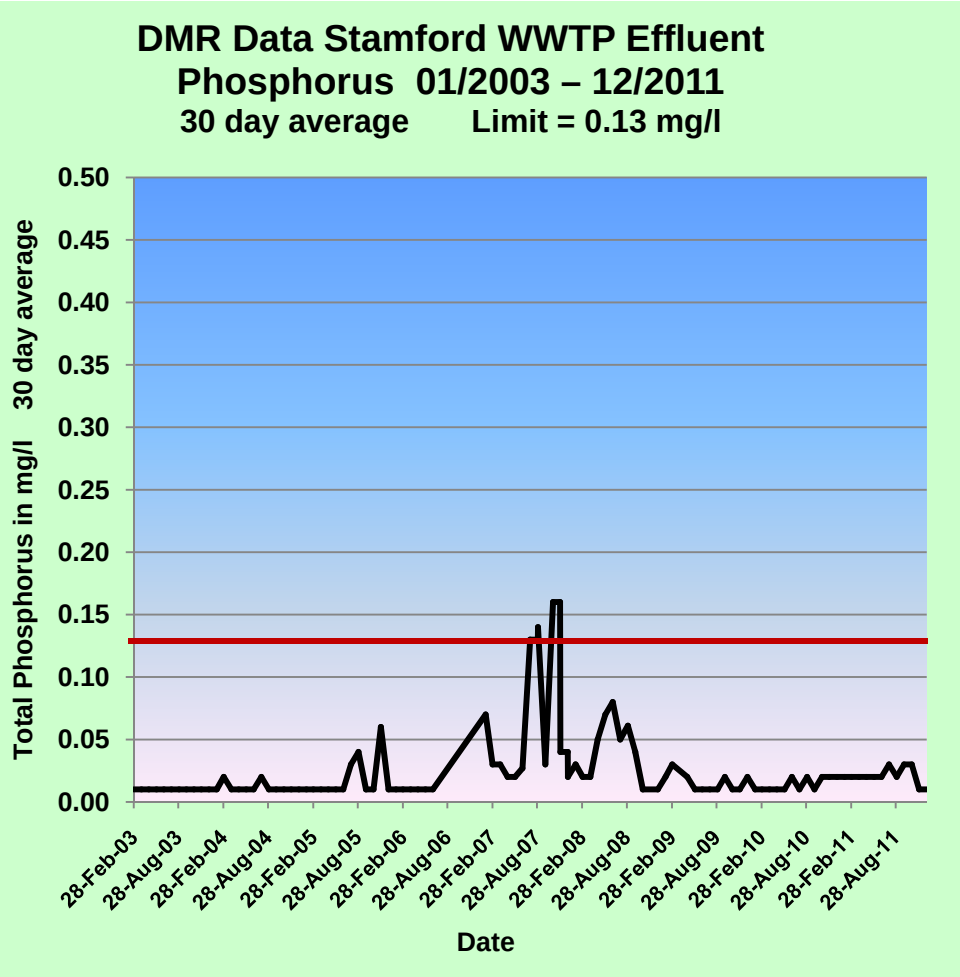


Stamford WWTP Pre vs. Post Upgrade Effluent Phosphorus



Stamford WWTP Post Upgrade Effluent Phosphorus 2003 - 2011

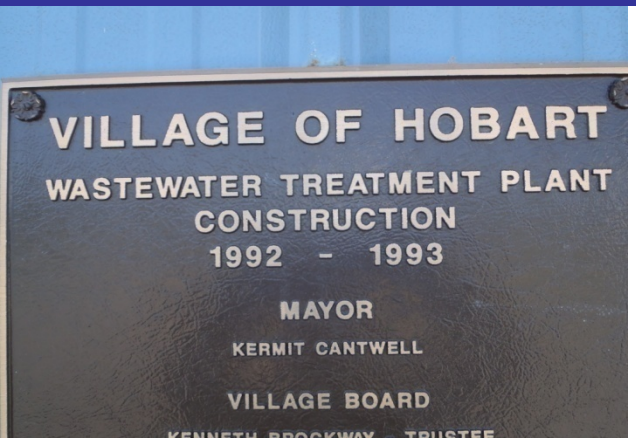


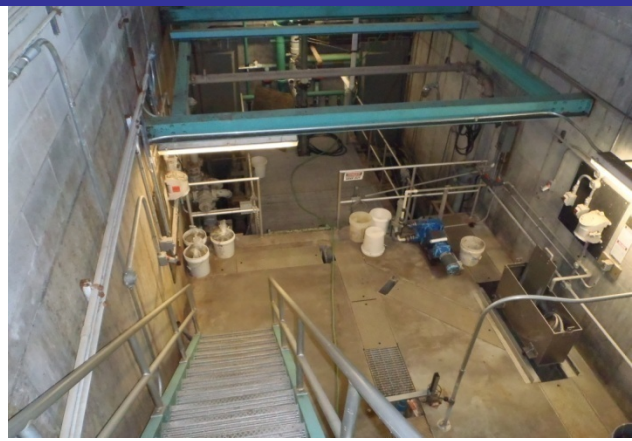


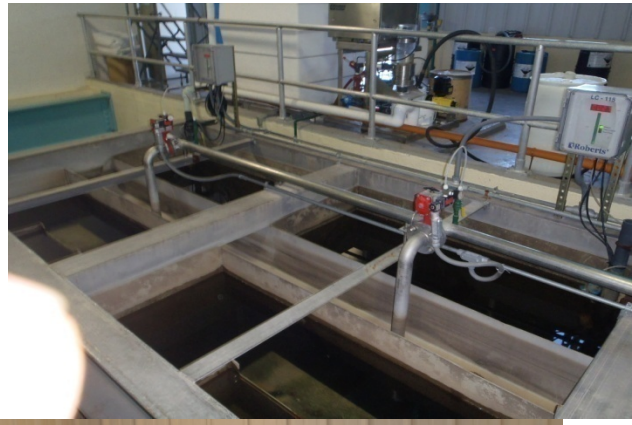
DEP grab sample data collected 2x/month

WWTP 24 hour composite sample data collected 4x/month, 30 day average

Village of Hobart WWTP Process

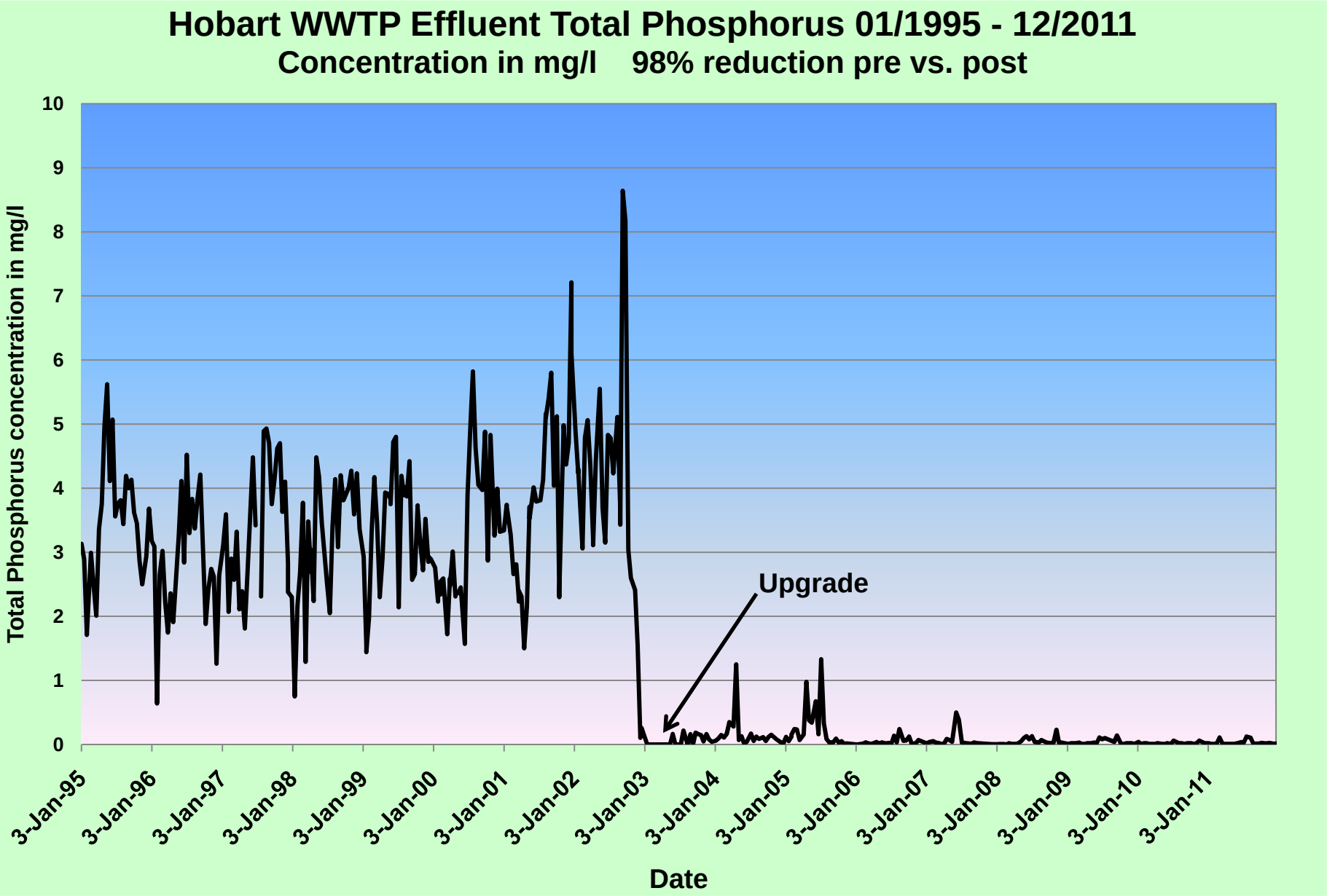




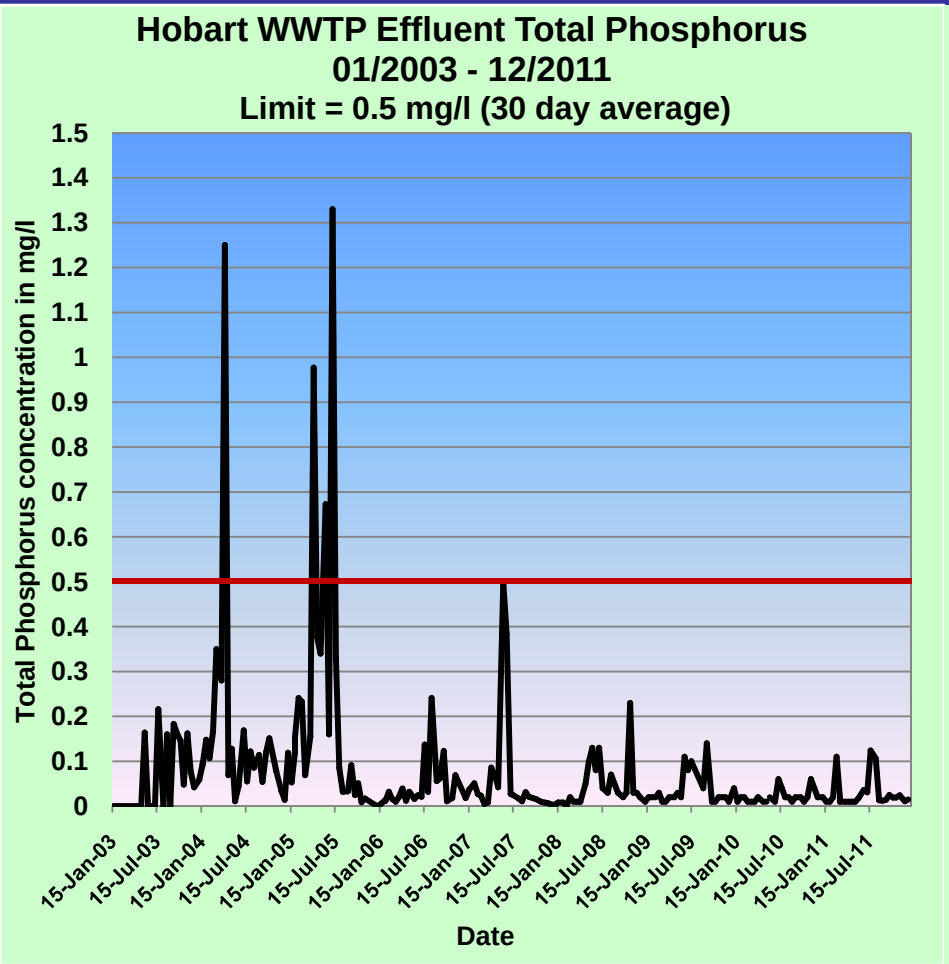


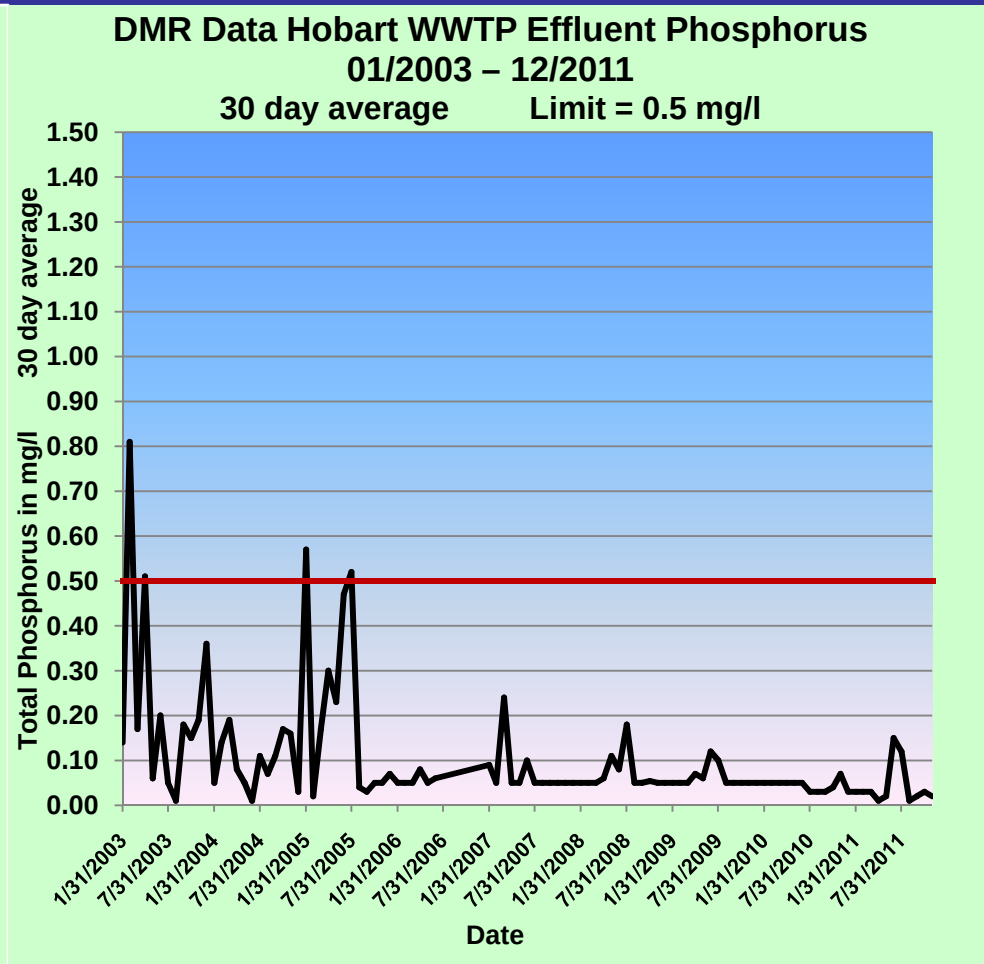
Permitted flow limit = 0.18 mgd,
total phosphorus limit = 0.5 mg/l

Hobart WWTP Pre vs. Post Upgrade Effluent Phosphorus



Hobart WWTP Post Upgrade Effluent Phosphorus 2003 - 2011





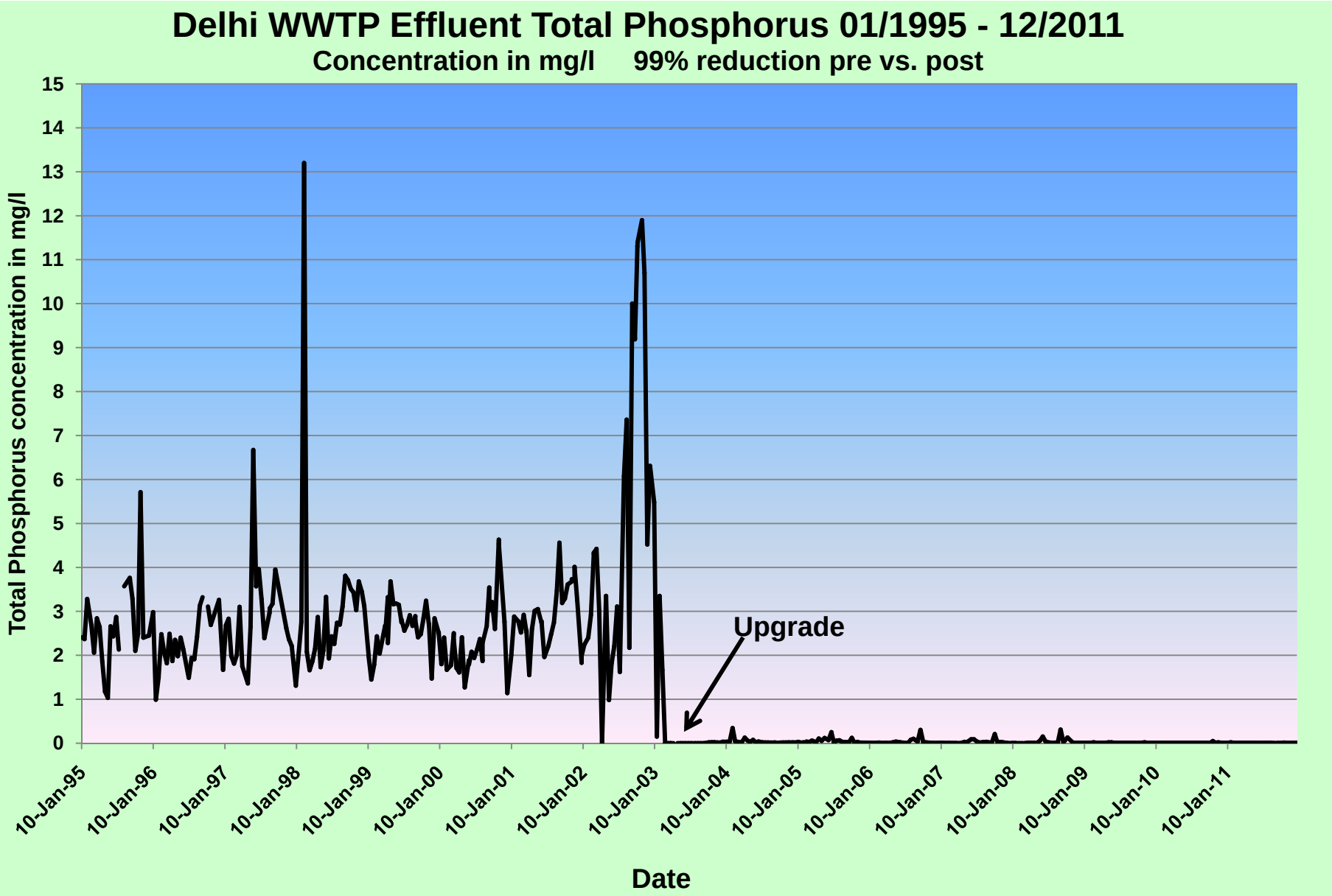
DEP grab sample data collected 2x/month

WWTP 24 hour composite sample data collected 4x/month, 30 day average

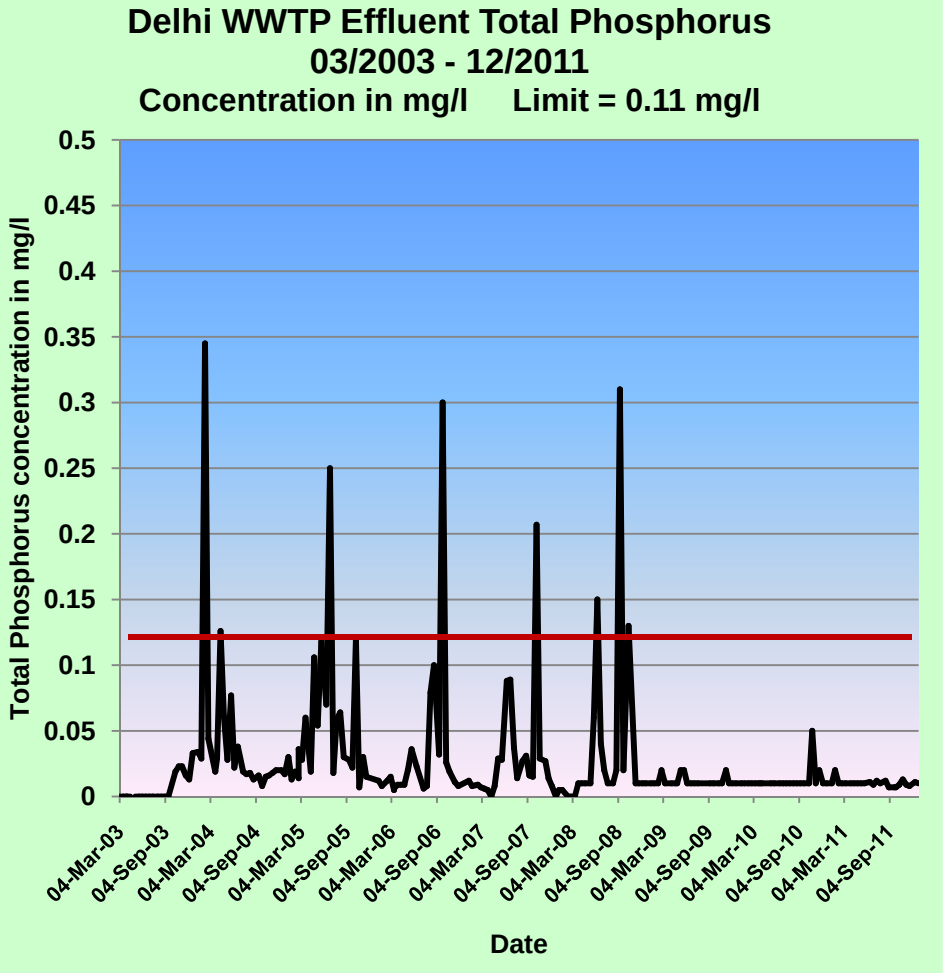
Village of Delhi WWTP Process

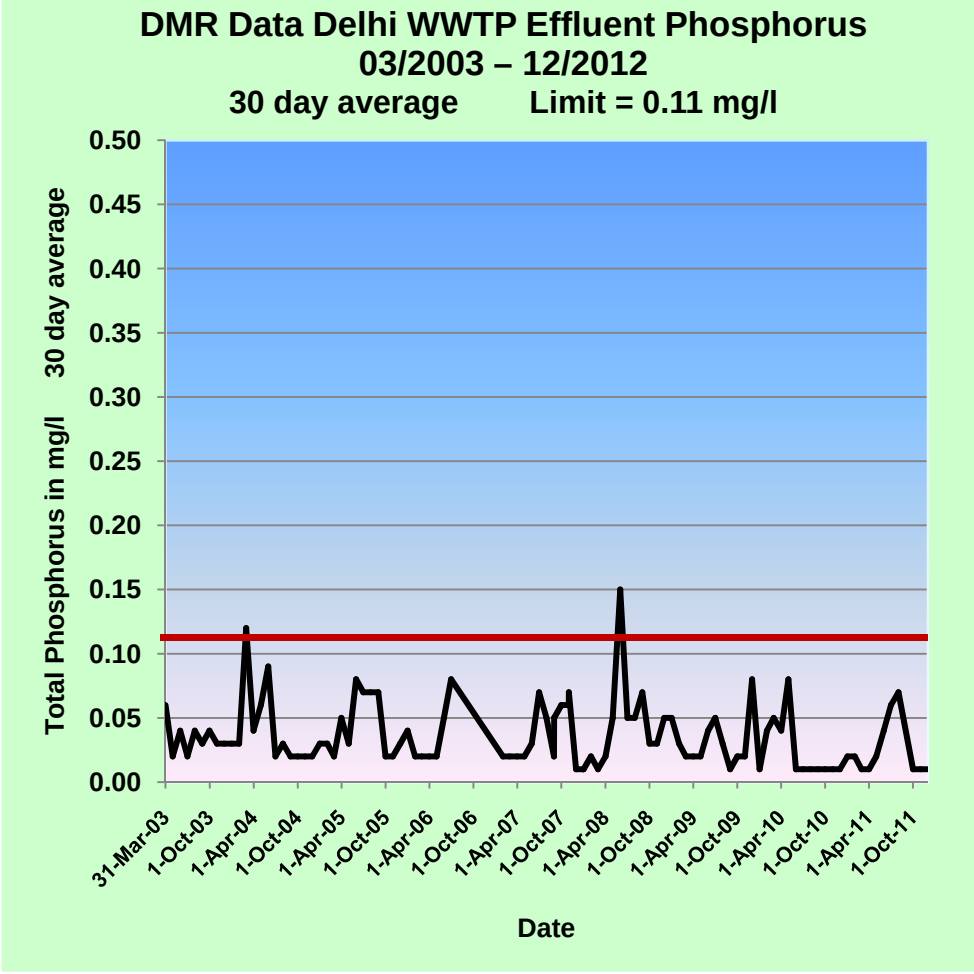
Permitted flow limit = 1.015 mgd, total phosphorus limit = 0.11 mg/l

Delhi WWTP Pre vs. Post Upgrade Effluent Phosphorus



Delhi WWTP Post Upgrade Effluent Phosphorus 2003 - 2011





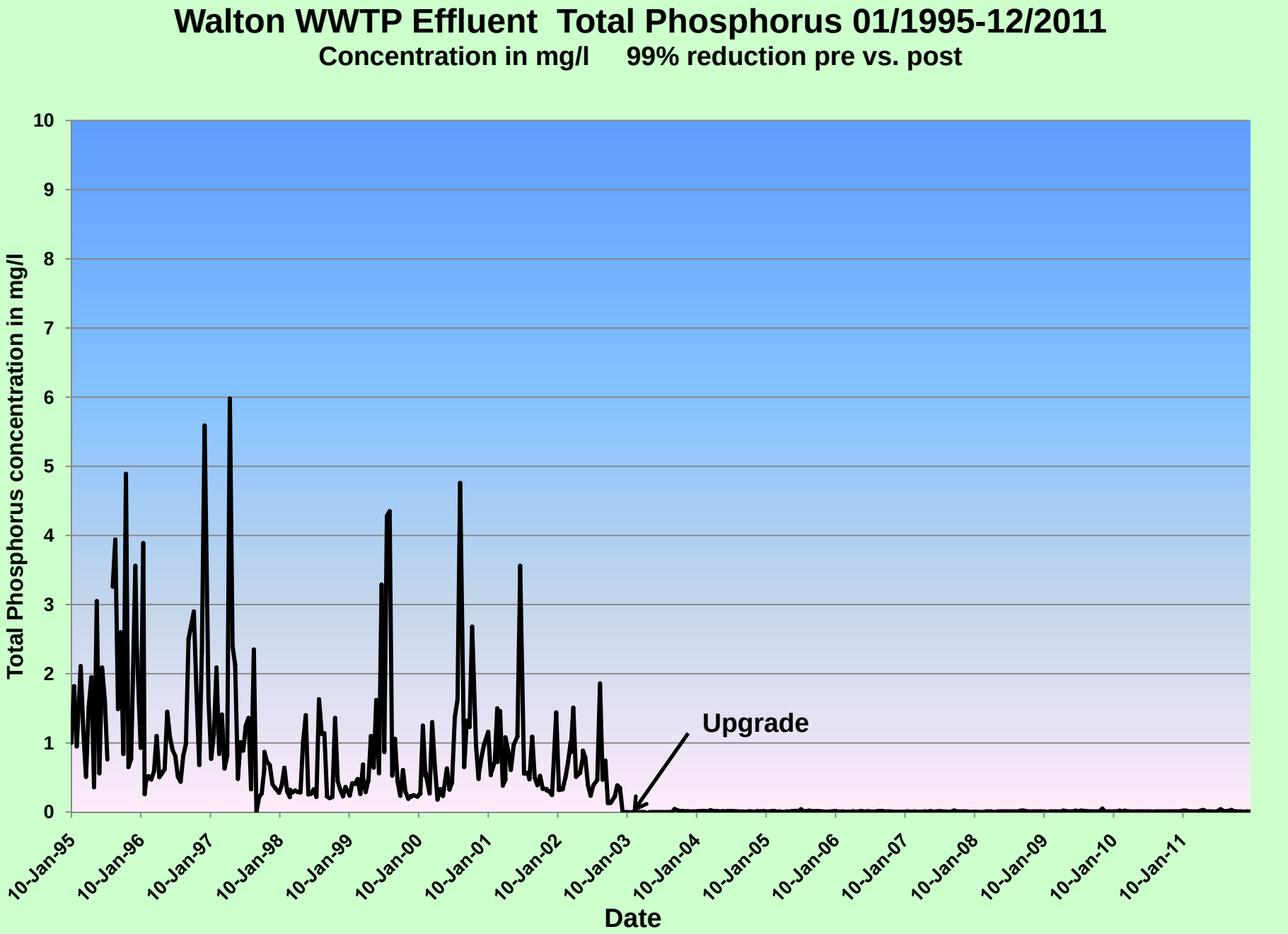
DEP grab sample data collected 2x/month

WWTP 24 hour composite sample data collected 4x/month, 30 day average

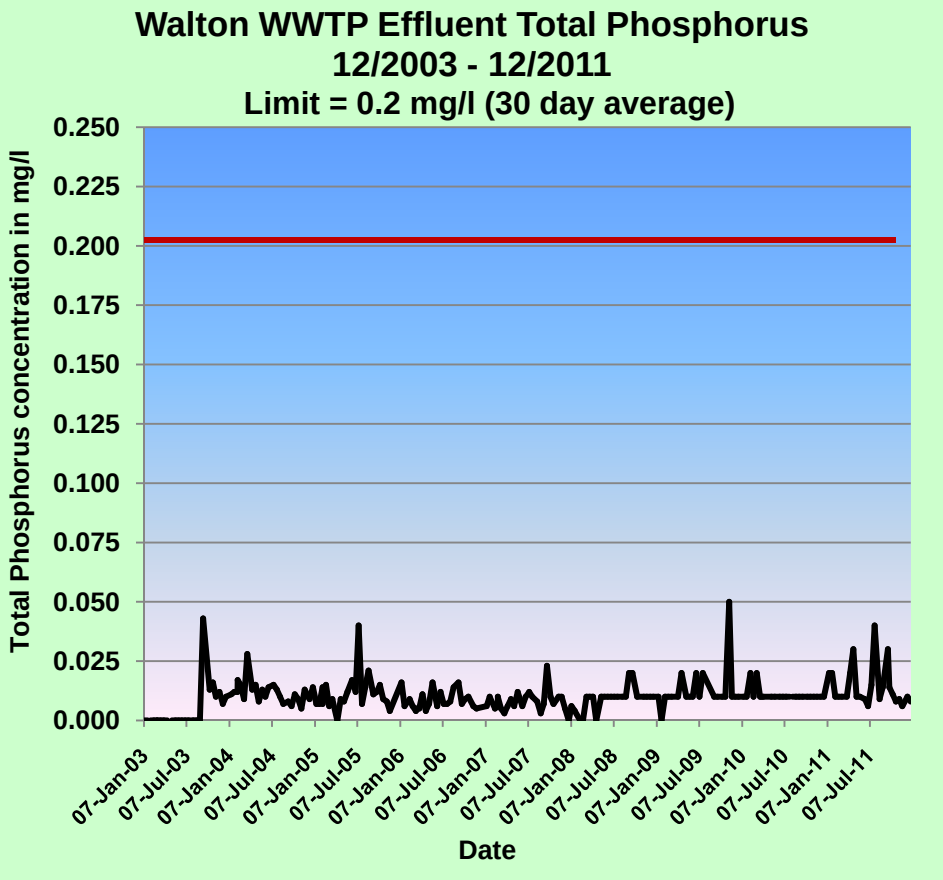
Village of Walton WWTP Process

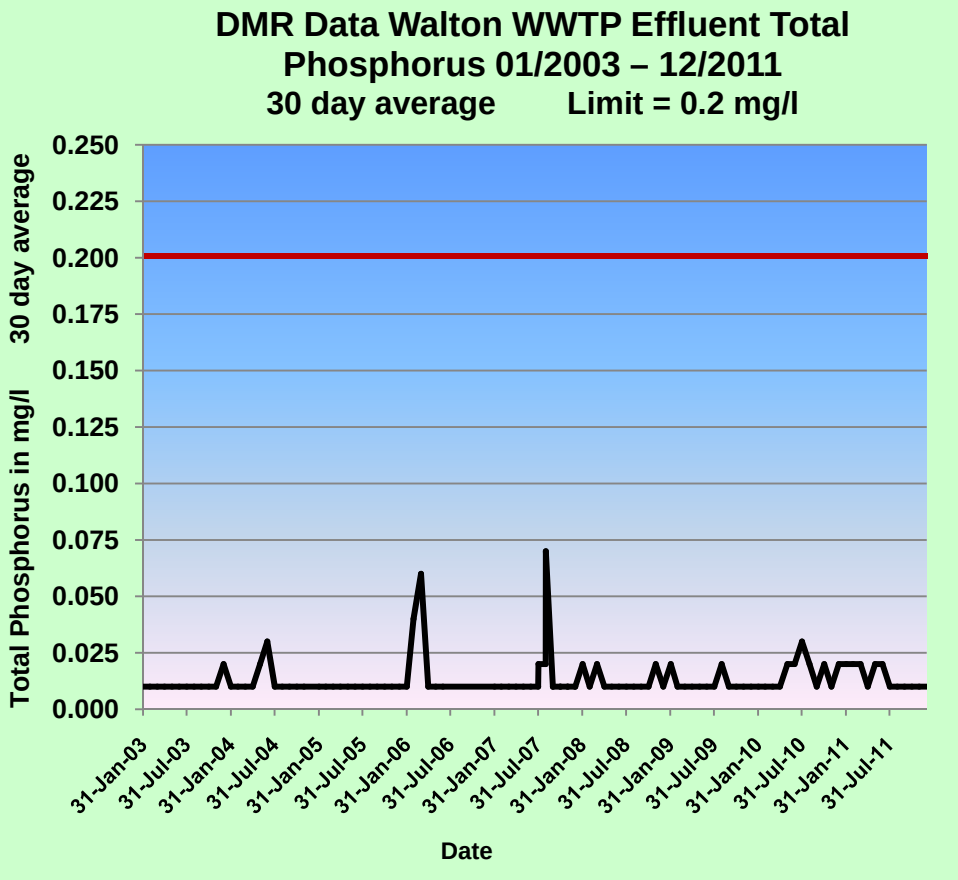
Permitted flow limit = 1.55 mgd,
total phosphorus limit = 0.2 mg/l

Walton WWTP Pre-vs. Post Upgrade Effluent Phosphorus



Walton WWTP Post Upgrade Effluent Phosphorus 2003 - 2011





DEP grab sample data collected 2x/month

WWTP 24 hour composite sample data collected 4x/month, 30 day average

Water Quality Improvements

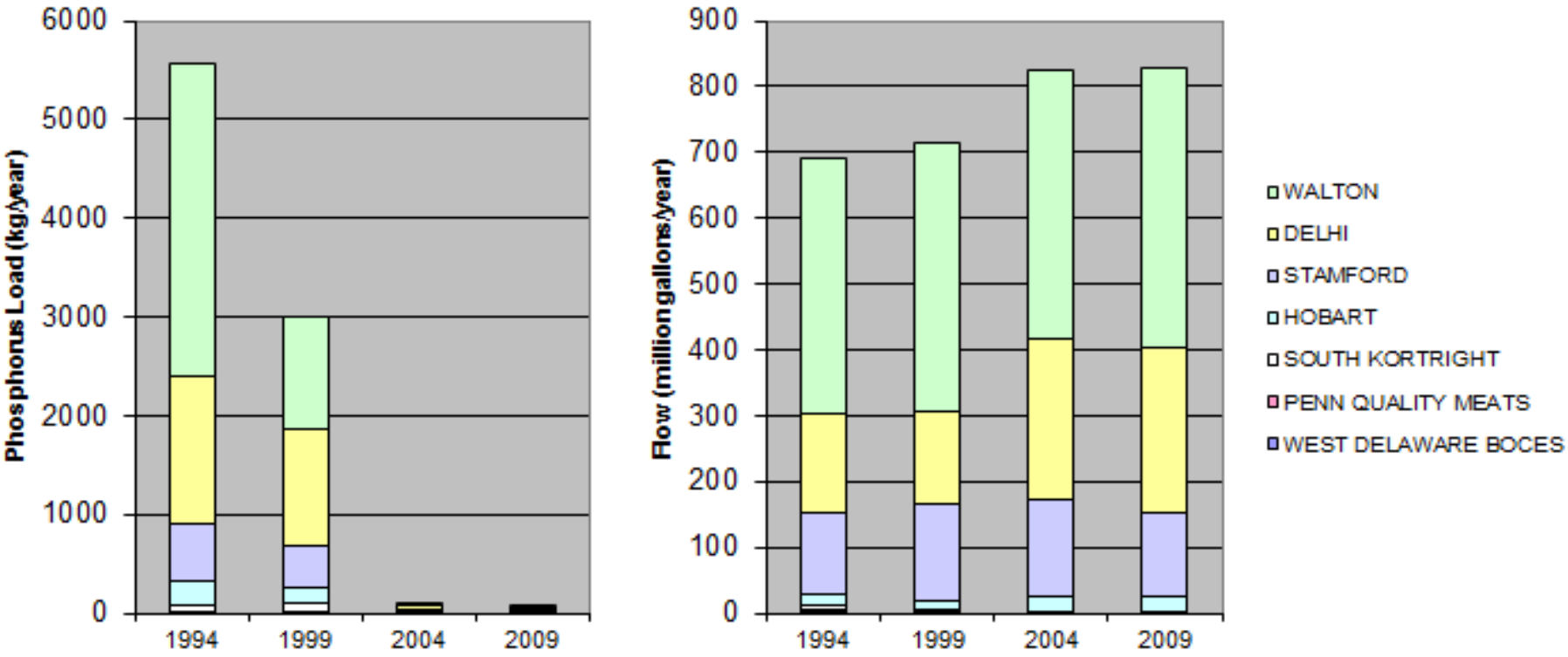
- There has been significant West Branch Delaware River and Cannonsville Reservoir phosphorus reductions in concentration and load since DEP's phosphorus reduction efforts began in 1994;

- The phosphorus reductions at the four WWTP's discussed in this presentation are a single component of the overall Cannonsville watershed phosphorus reduction initiative which include control measures for point (WWTP) and non-point sources;

- As of 2002, Cannonsville Reservoir is no longer considered a phosphorus restricted basin;

- Continued long term monitoring of watershed wastewater treatment plants, streams and reservoirs continues into the future to provide valuable plant performance and environmental data.

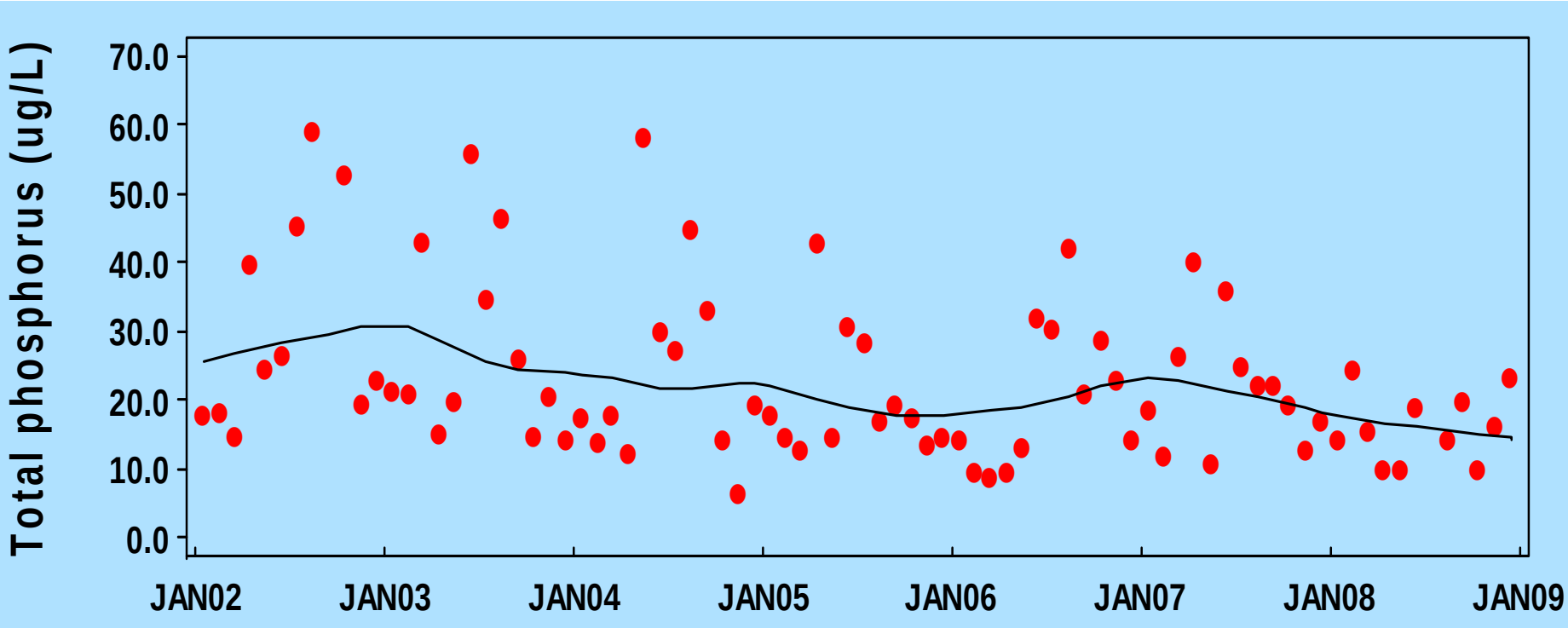
West Branch Delaware WWTP Phosphorus Loads and Flows



- Note drastic reductions in WWTP effluent phosphorus load from 1994 to 2009.
- Effluent flows increased during this time period.

Plot supplied from 03/2011 DEP Watershed Protection Program Summary and Assessment document

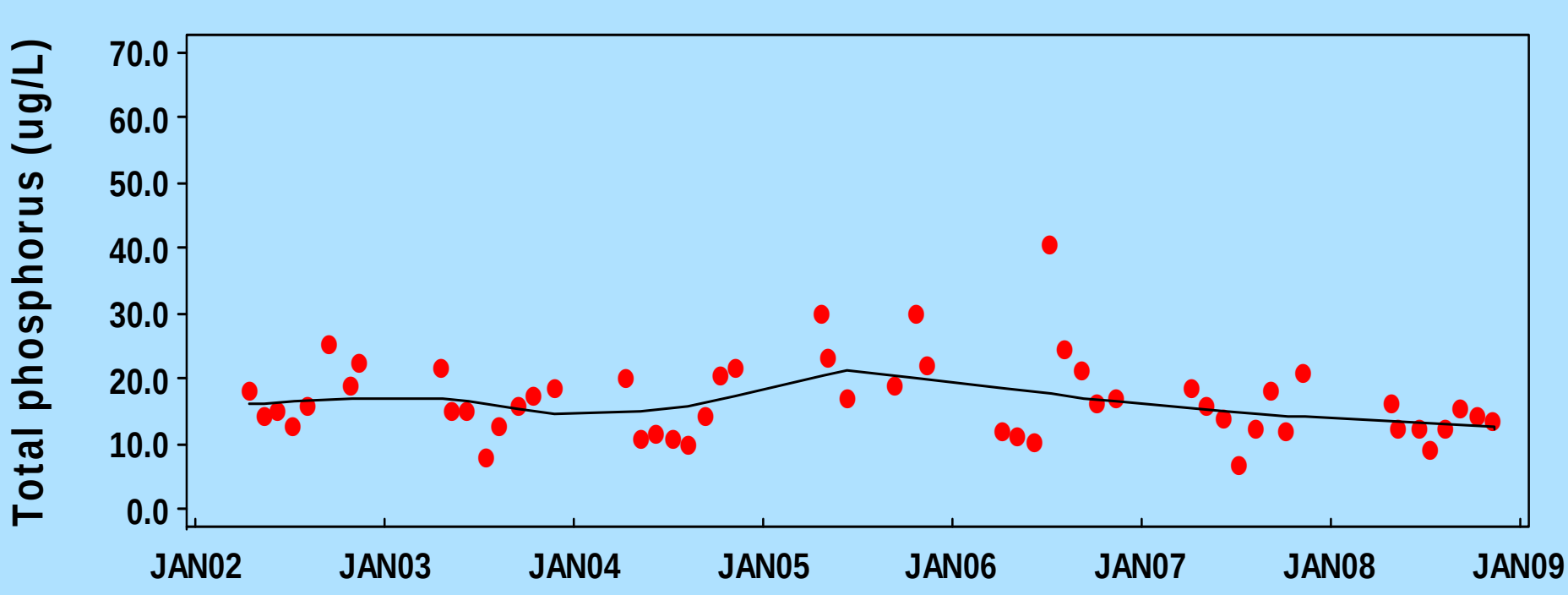
West Branch Delaware River Phosphorus Reduction 2002-2008



Overall decrease of West Branch Delaware River Total Phosphorus of 8.5% per year at sample site WDBN, downstream of all four WWTP's.

Plot supplied from DEP 2009 WSTC Presentation "Recent Trends in Cannonsville Reservoir"

Cannonsville Reservoir Phosphorus Reduction 2002 - 2008

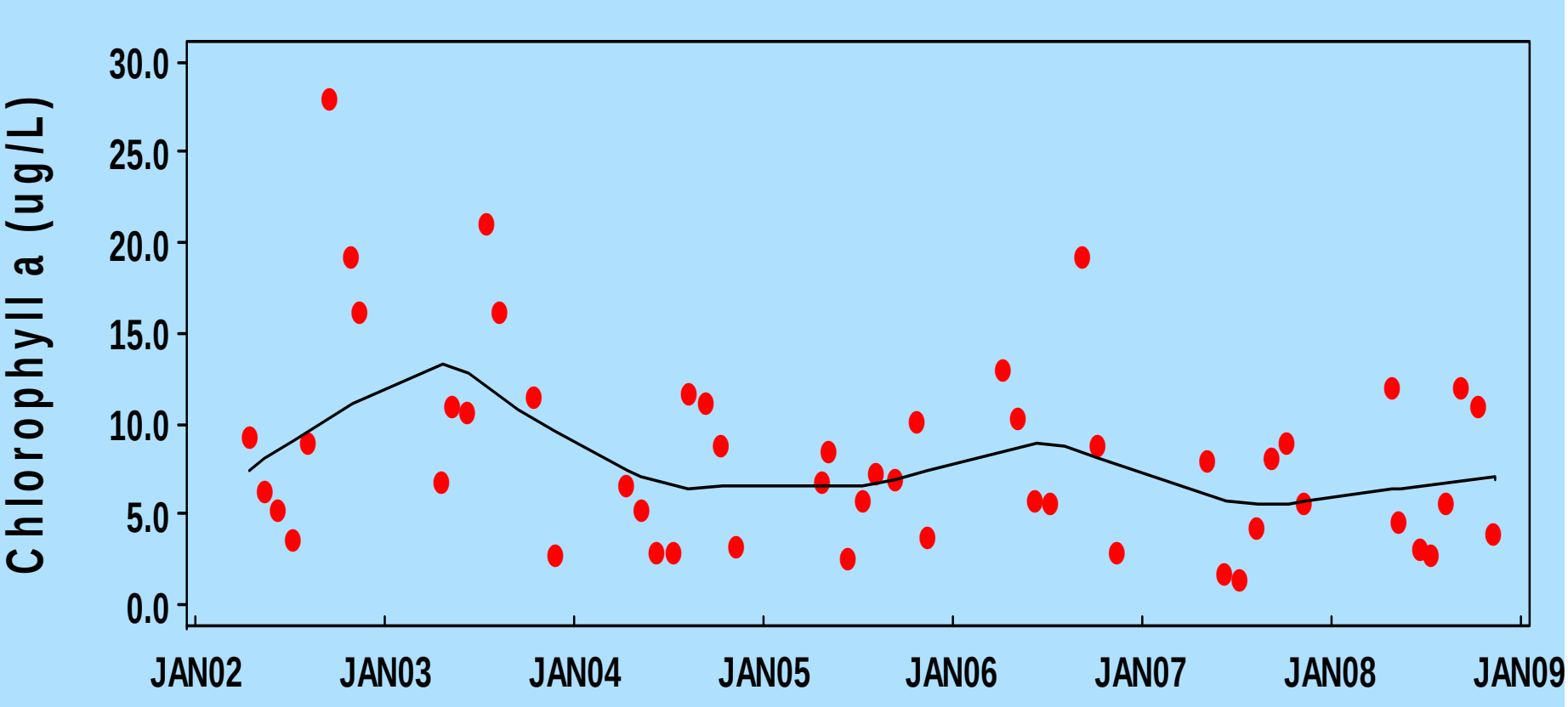


- Overall decrease of Cannonsville Reservoir Total Phosphorus of 3% per year;

- Downward phosphorus trend weakened by reservoir algal uptake, snowmelt in 2005, flooding in 2006 and reservoir re-suspension.

Plot supplied from DEP 2009 WSTC Presentation "Recent Trends in Cannonsville Reservoir"

Cannonsville Reservoir Chlorophyll Reductions 2002 - 2008



Overall decrease of Cannonsville Reservoir Chlorophyll of 7% per year.

Plot supplied from CDEP 2009 WSTC Presentation “Recent Trends in Cannonsville Reservoir”

Conclusions

- The tertiary treatment systems are capable of achieving stringent effluent phosphorus limits, operator friendly, robust, reliable and capable of uninterrupted long term effluent phosphorus reduction and service.
- Stamford WWTP average final effluent total phosphorus concentrations were reduced by 96% following the regulatory upgrade.
- Hobart WWTP average final effluent total phosphorus concentrations were reduced by 98% following the regulatory upgrade.
- Delhi WWTP average final effluent total phosphorus concentrations were reduced by 99% following the regulatory upgrade.
- Walton WWTP average final effluent total phosphorus concentrations were reduced by 99% following the regulatory upgrade.
- Significant measurable watershed water quality improvements have been achieved that are attributable to the diverse array of watershed nutrient reduction programs including the regulatory upgrade program.
- 2002 -2011total phosphorus reduced 8.5% annually in West Branch Delaware River and 3% annually in Cannonsville reservoir.

Are there any questions?

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