Speedway, Indiana
WWTP Biosolids Upgrade

Storage Nitrification-Dentrification Reactor Results in Ammonia Loading Reduction

Cindy Fort
Norm Berry

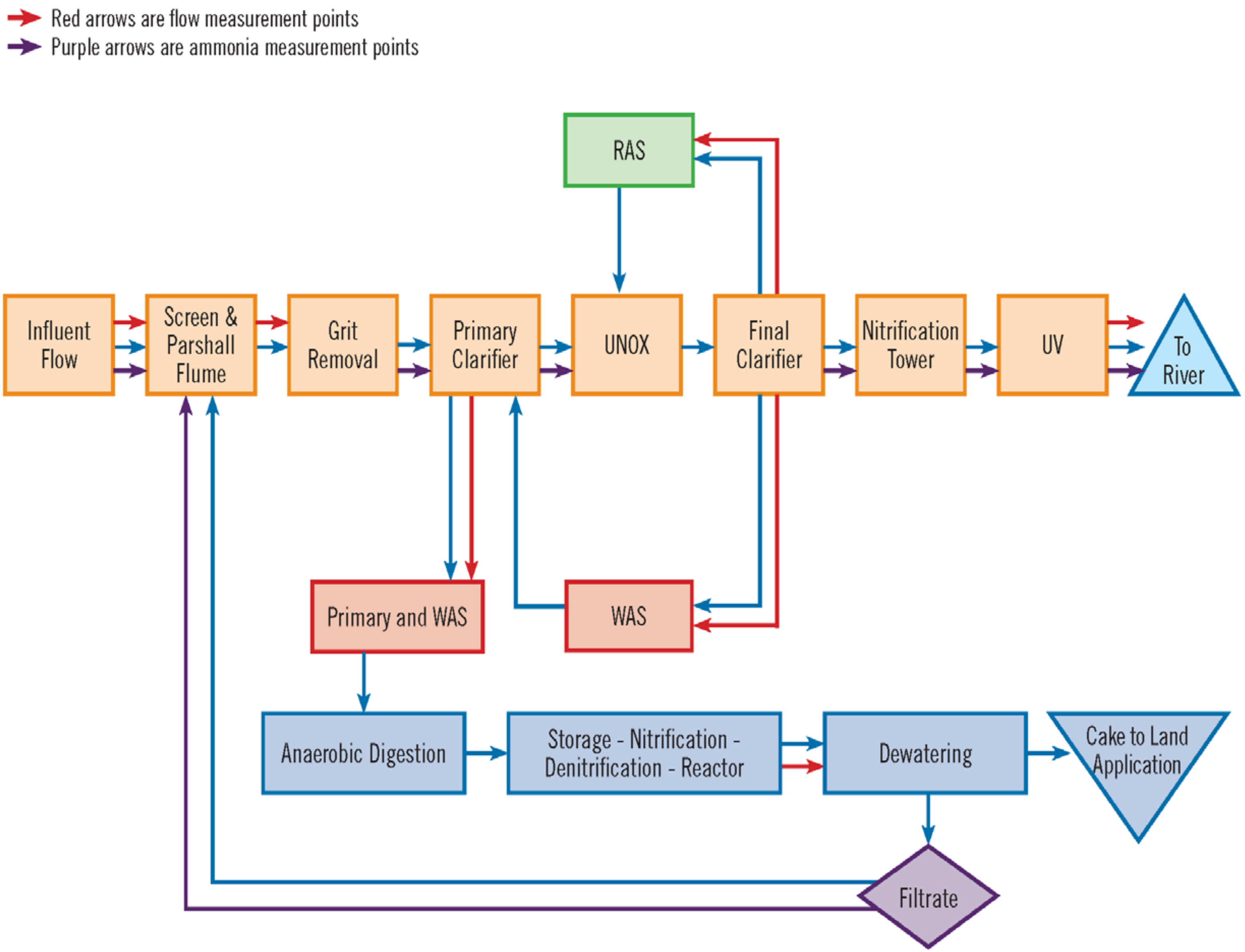
March 13, 2013

AMERICAN STRUCTUREPOINT INC.

TOWN OF SPEEDWAY INDIANA 1926 EDUCATION PROGRESS INDUSTRY

Speedway WWTP

- **1954** - 4 mgd trickling filter facility
- **1972** - upgraded 7.5 mgd secondary treatment using an innovative pure oxygen activated sludge facility – UNOX
- **1991** - addition of nitrification towers
- **2001** - replaced Zimpro process with Anaerobic Digestion
- **2001** - added BFP for thickening and dewatering

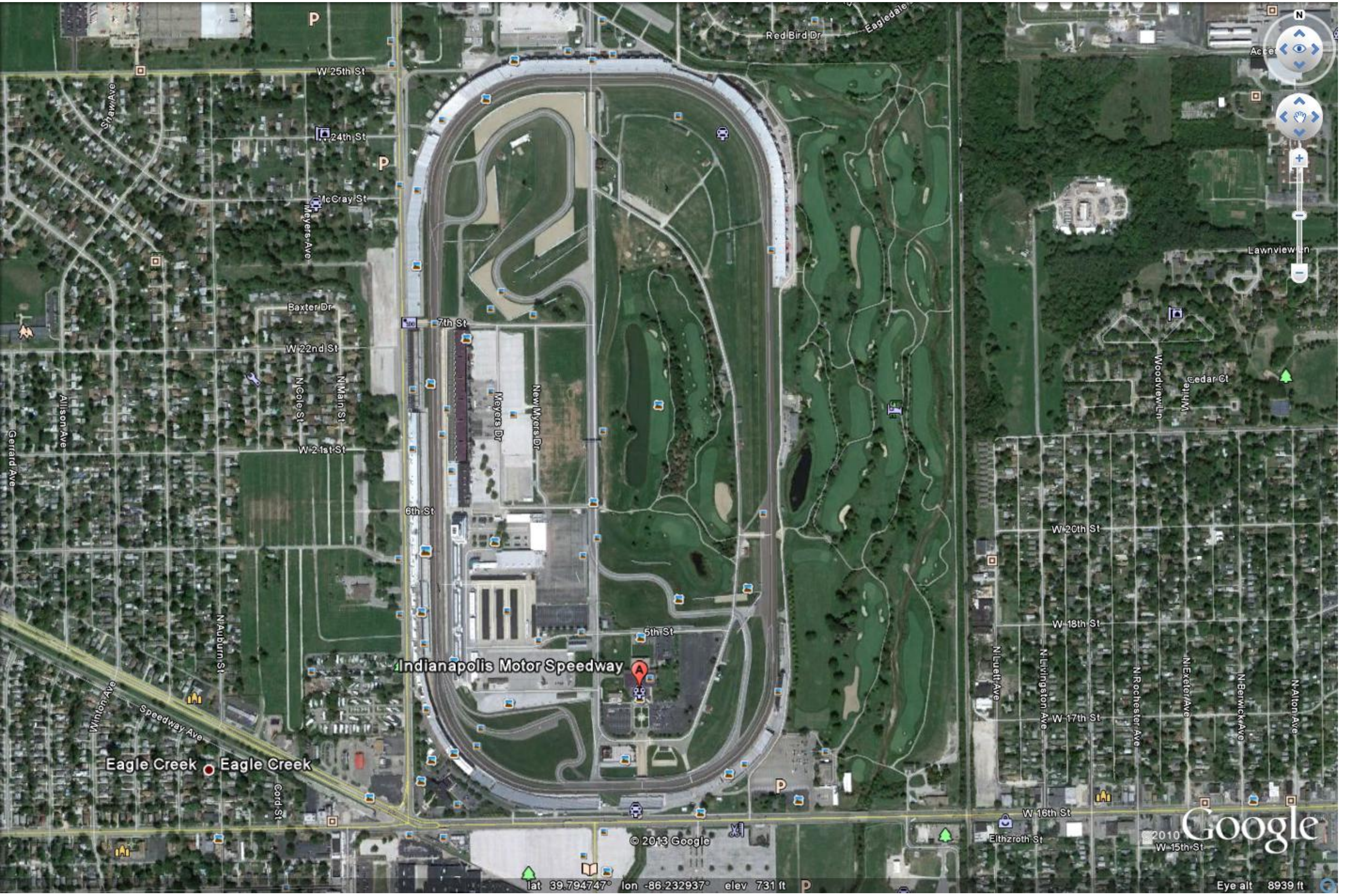

Red arrows are flow measurement points
Purple arrows are ammonia measurement points
RAS
Influent Flow
Screen & Parshall Flume
Grit Removal
Primary Clarifier
UNOX
Final Clarifier
Nitrification Tower
UV
To River
Primary and WAS
WAS
Anaerobic Digestion
Storage - Nitrification - Denitrification - Reactor
Dewatering
Cake to Land Application
Filtrate

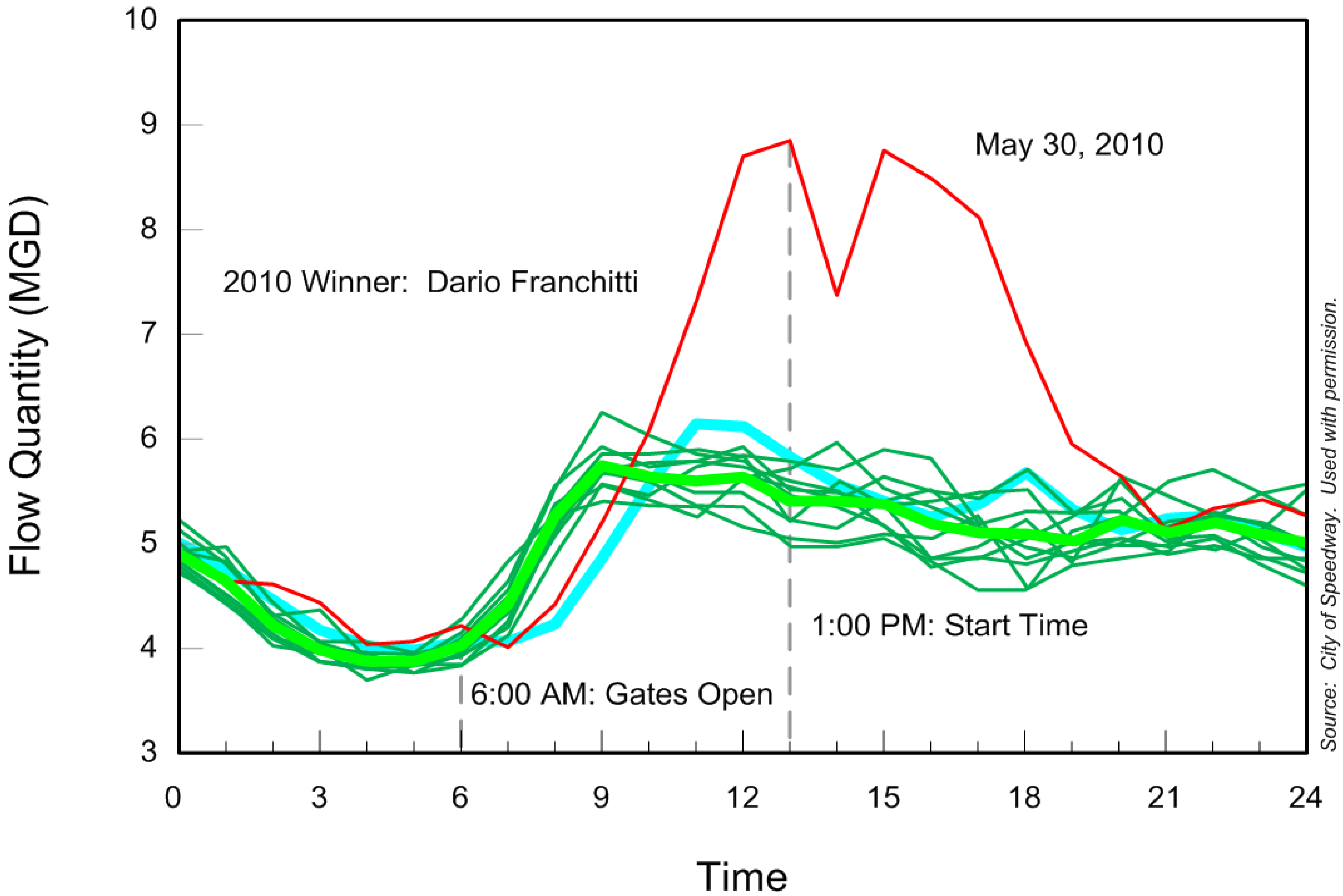
Trouble With Ammonia

- NPDES permit requirement
  - 1.5mg/l summer
  - 1.6 mg/l /winter.
- Between 2008 and 2010, approximately 30 percent of the daily discharges exceeded the permitted ammonia level
- **Why so much ammonia?**

Industrial Discharge

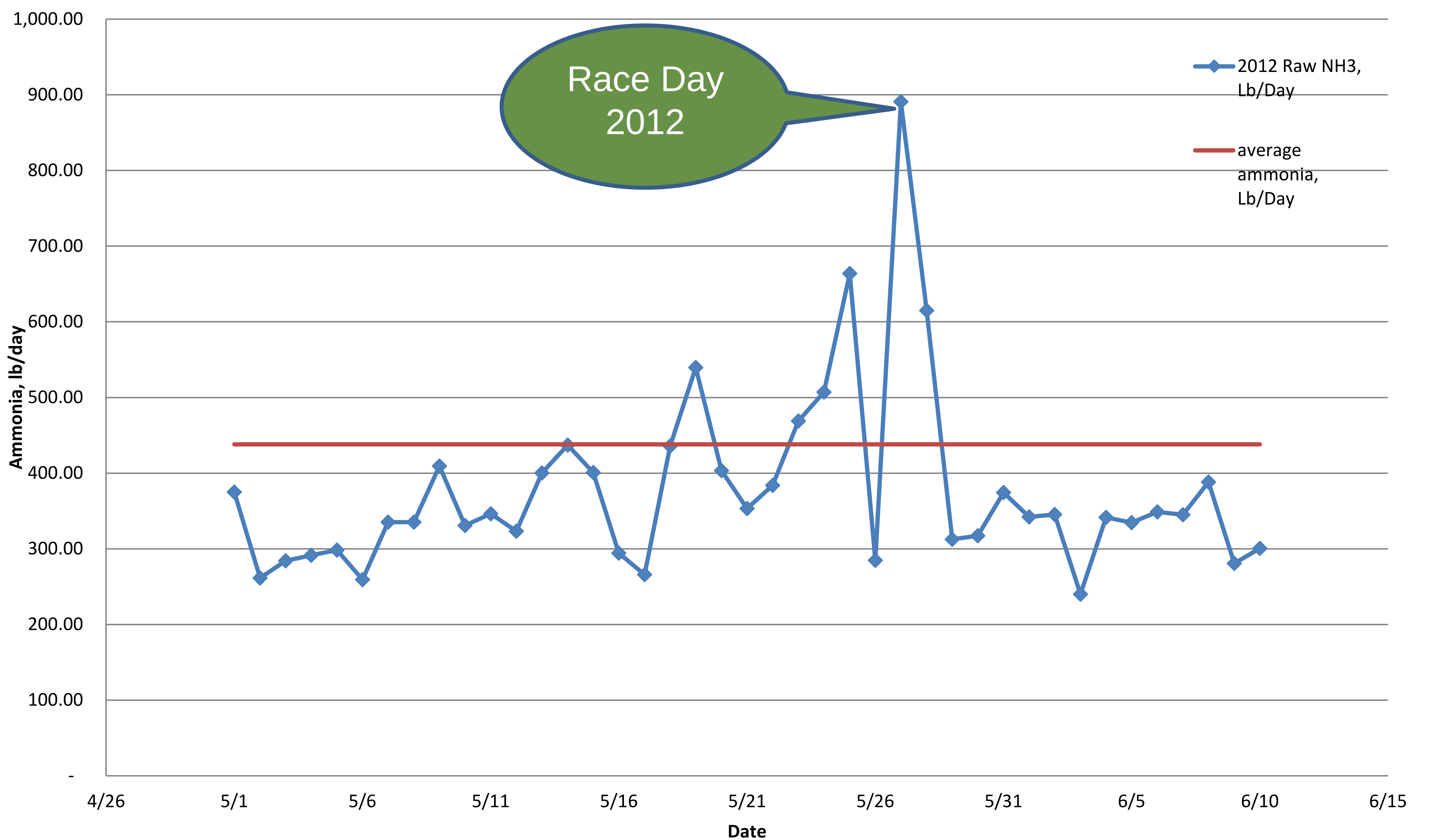
- Septage and biosolids processor discharges filtrate with an average NH3-N concentration between 40-50 mg/l
- Pretreating the filtrate by breakpoint chlorination or chloramination to achieve less than 20 mg/l ammonia
- Monochloramines are rapidly formed through the reaction of chlorine with ammonia. Chloramines, like chlorine, are biocides and kill bacteria by penetrating their cell walls and disrupting their metabolism.
- Research indicates that the addition of monochloramines upstream of (fixed-film) filters will reduce the biological growth on the filters[2].
- What impact if Industry ceases breakpoint chlorination?


Indianapolis Motor Speedway
Eagle Creek
Eagle Creek
W 25th St
24th St
McCray St
Meyers Ave
Shaw Ave
Baxter Dr
7th St
W 22nd St
N Cole St
N Main St
Allison Ave
Gerrard Ave
W 21st St
Meyers Dr
New Myers Dr
6th St
5th St
N Auburn St
Winton Ave
Speedway Ave
Cord St
Red Bird Dr
Eagledale
Lawnview Ln
Cedar Ct
Woodview Ln
White
W 20th St
W 18th St
W 17th St
W 16th St
W 15th St
Elthzroth St
N Luett Ave
N Livingston Ave
N Rochester Ave
N Exeter Ave
N Berwick Ave
N Alton Ave
© 2013 Google
©2010
Google
lat 39.794747° lon -86.232937° elev 731 ft
Eye alt 8939 ft



Pat Stevens & Kevin Enfinger, Water Environment Technology, May 2012 – Sewer Sociology

Raw Influent Ammonia Load



Ammonia Sources

Location	Average Concentration mg/l	Maximum Concentration mg/l	Average Loading lb/d	Maximum Loading lb/d
Raw Sewage	9.92	30.2	460	1,824
SIU stream w/o pretreatment	32	41	23	100
BFP Filtrate recycle	1,023	3,460	386	1,069
Total			869	2,993

Ammonia Removal Processes

- Typically the preliminary treatment and UNOX systems remove 53 percent of the ammonia load.
- The remaining ammonia is oxidized by the existing nitrification towers, which were designed to remove 687 lbs of ammonia/day.
- Insufficient ammonia reduction for peak loads

Alternative Evaluation[3]

- Modify the UNOX process to increase nitrification
- Eliminate anaerobic digestion
- Equalization tank for the filtrate to allow the ammonia load to be distributed over 24 hours instead of the 8 operating hours
- Construct biosolids nitrification denitrification reactor to reduce the ammonia in the recycle stream

Biosolids Nitrification/Denitrifcation

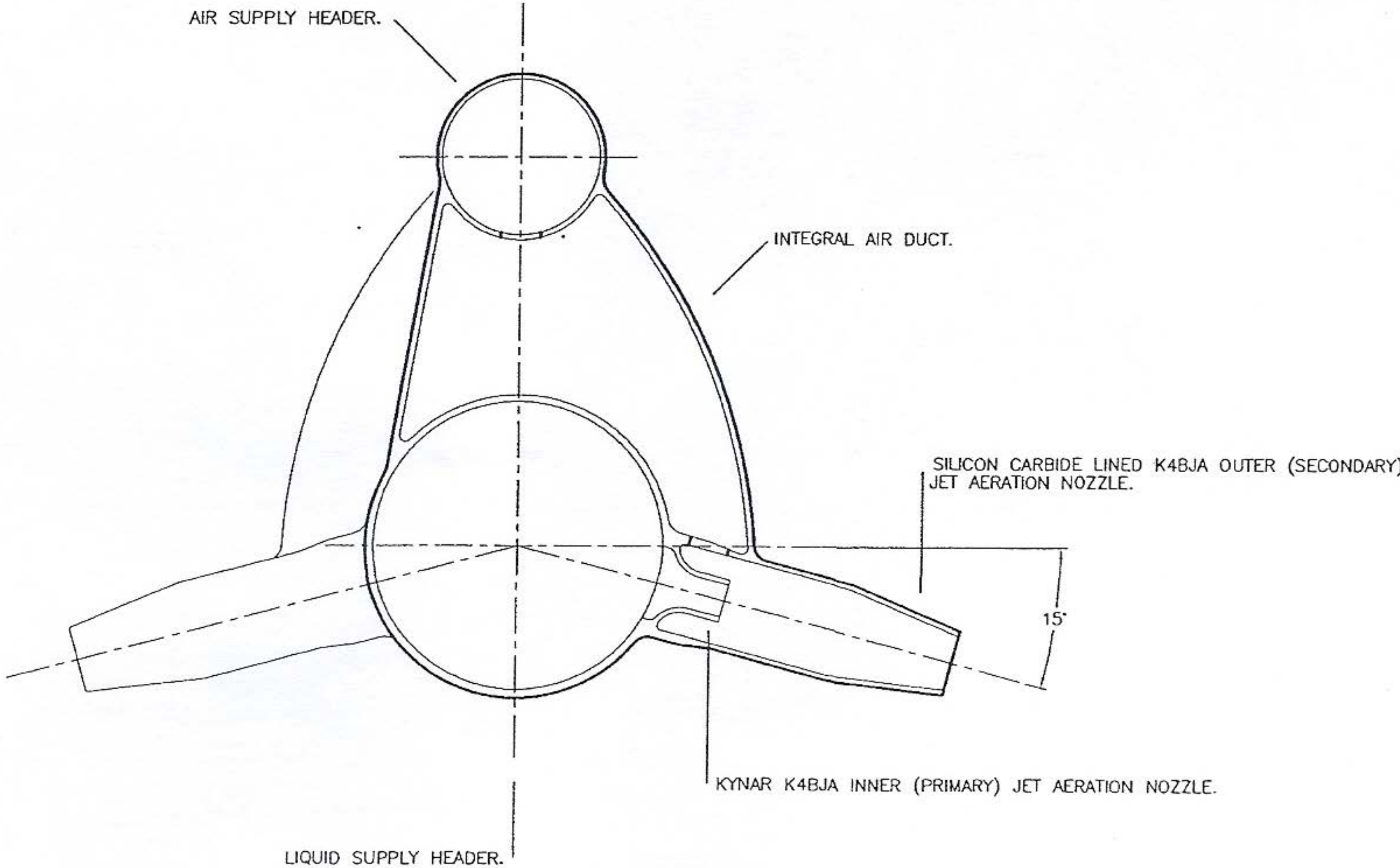
- Research[4] indicated dual digestion process would:
  - increase the volatile solids destruction between 46 and 65 percent;
  - reduce ammonia by 80 percent and
  - improve the dewaterablity of the biosolids.

Dual Digestion

- Estimated to reduce NH_3 from 2,000 mg/L to between 150 and 400 mg/l in the filtrate from the dewatering operations.
- A reduction in the ammonia load to the plant will reduce the peak day ammonia load from the biosolids process by 440 pounds/day of ammonia
- It was also evident that influent ammonia in the raw sewage continues to impact the ability of the plant to oxidize the ammonia sufficiently to meet permit limits during the Indianapolis 500 race.

SNDR

- Storage Nitrification Denitrification Reactor
- Manufacturer: Thermal Process Systems
- Developed for oxidizing NH_3 from ThermAir process (Advanced Thermophilic Biosolids Treatment)
- Transfer O_2 in high solids applications
- First application for an anaerobic biosolid


AIR SUPPLY HEADER.
INTEGRAL AIR DUCT.
SILICON CARBIDE LINED K4BJA OUTER (SECONDARY) JET AERATION NOZZLE.
15°
KYNAR K4BJA INNER (PRIMARY) JET AERATION NOZZLE.
LIQUID SUPPLY HEADER.


EASYAIR X2
Roots

SNDR Temperature

- Nitrifying and denitrifying bacteria are highly temperature dependent
- Ideal range is 90 to 100 F
- >103 too extreme
- Air is added to control temperature

SNDR

- Design is based on:
  - Biological solids
  - Volatile fatty acid oxidation
  - Net nitrification/denitrification oxygen requirements
- Mixing is controlled by jet pump
  - Operates at various speeds depending on oxic or anoxic mode
  - Provides better oxygen transfer during oxic and mixing in anoxic

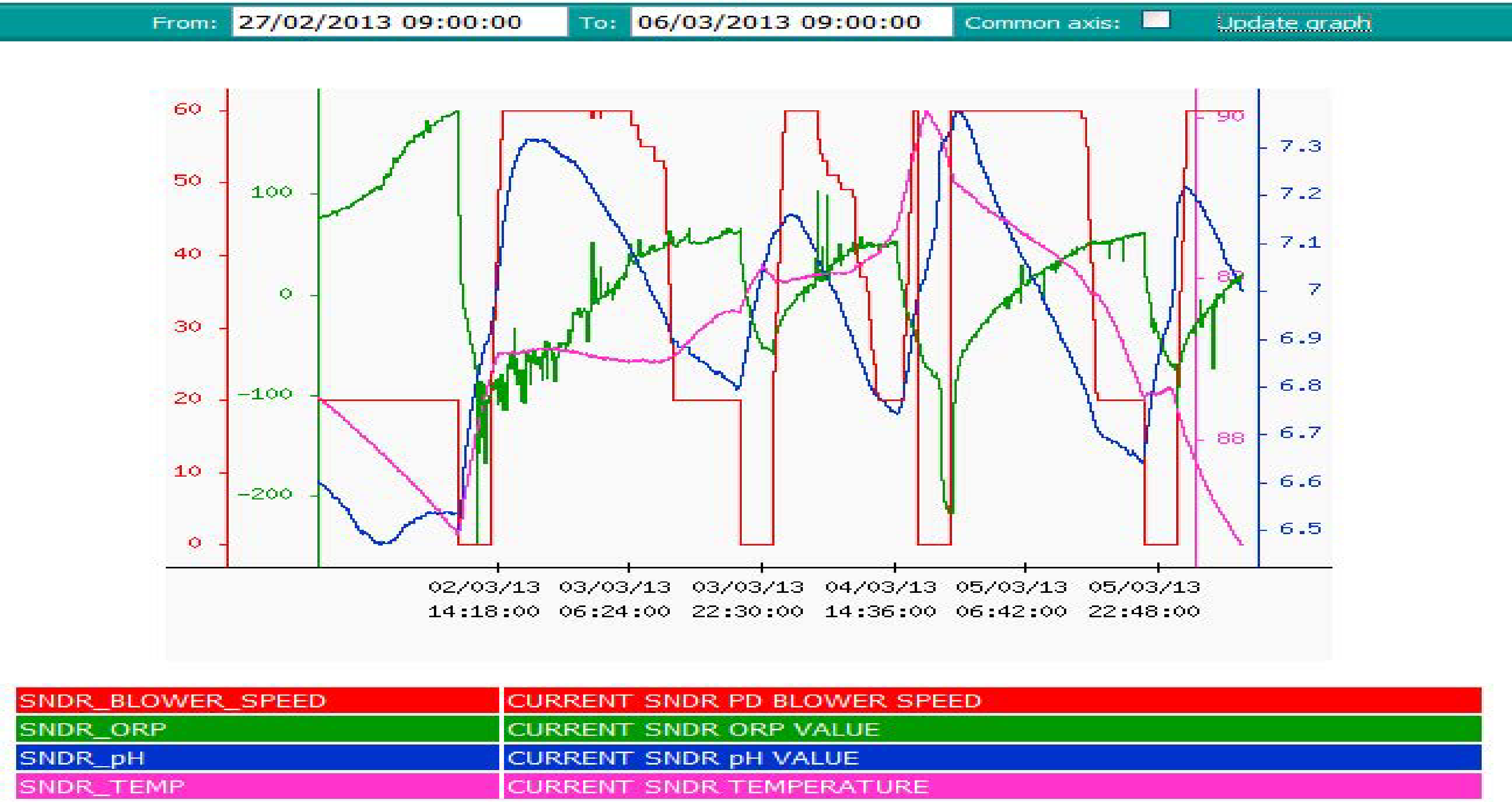
SNDR

- Pump and Blower equipped with VFD
- Typically air on 75% of time
- Process controlled by pH and ORP
- Able to meet the high uptake demand on initial feed cycle and lower oxygen demand in anoxic cycle
- Vary blower and recycle rate independently

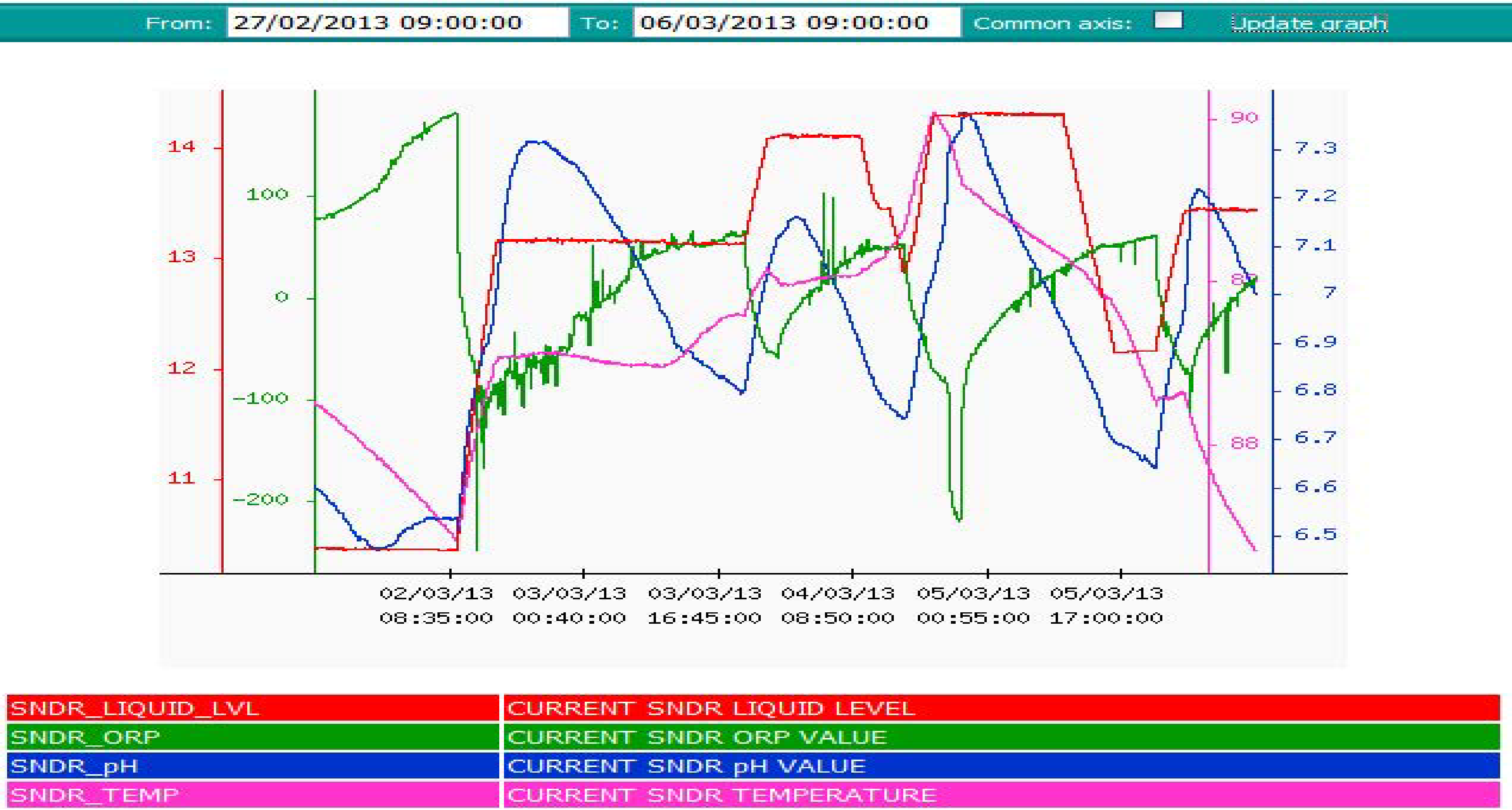
SNDR

- pH is primary control
- Secondary control: foam, temperature & ORP
- During oxic cycle, alkalinity is consumed and pH decreases and ORP increases
- Switch to anaerobic cycle air tourned off, pH increases and ORP decreases

SNDR Bower Speed, ORP, PH, T



SNDR Liquid Level, OPR, pH, Temp

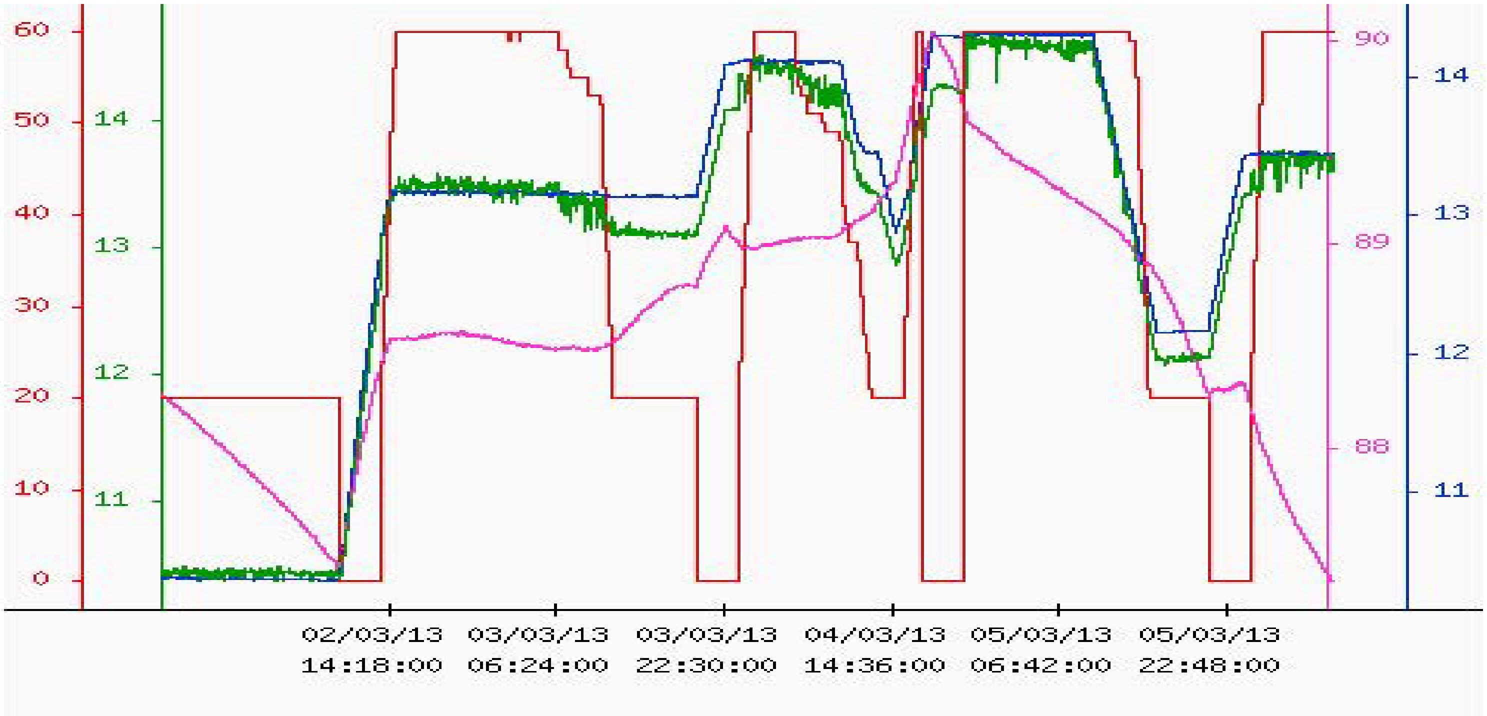


- Oxygen demand is based on CBOD and NOD
- Better process stability when feed cycle is long
- Semi Batch operation – turn blower off before and after a transfer of anaerobic sludge into the SNDR to force a denitrification cycle
- When blower cycled back on use ORP to simultaneously create nitrification and denitrification in the storage tank

- Secondary signals for Temperature, ORP and Foam and Liquid levels
- Liquid and air flows controlled independently to sustain optimum reactor performance
- Hydraulic foam control – nozzles connected to the recirculation pump
- Volume and pressure of flow breaks down the foam

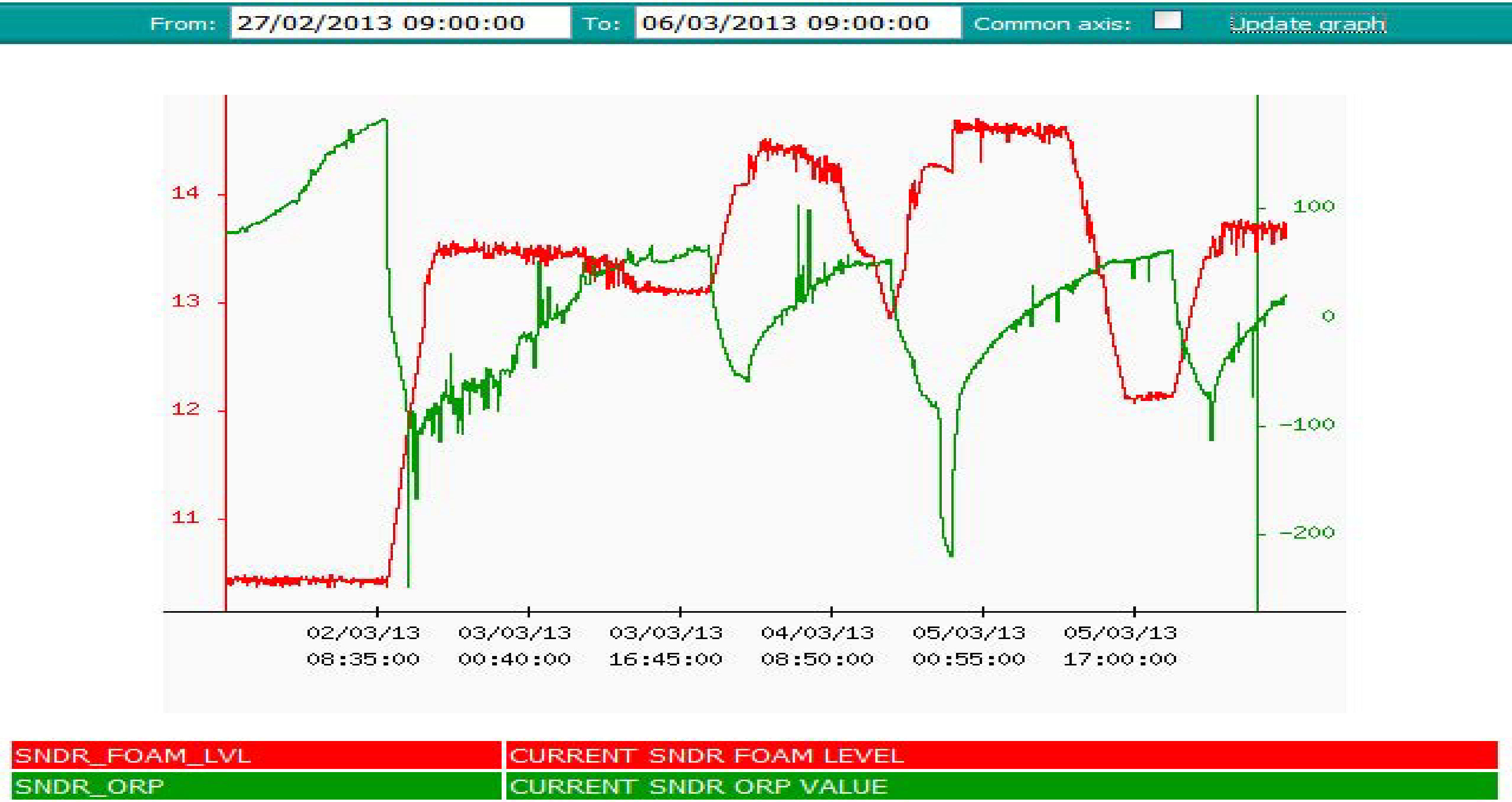
SNDR Blower Speed, Temp, Foam and Liquid Levels

From: 27/02/2013 09:00:00 To: 06/03/2013 09:00:00 Common axis: Update graph

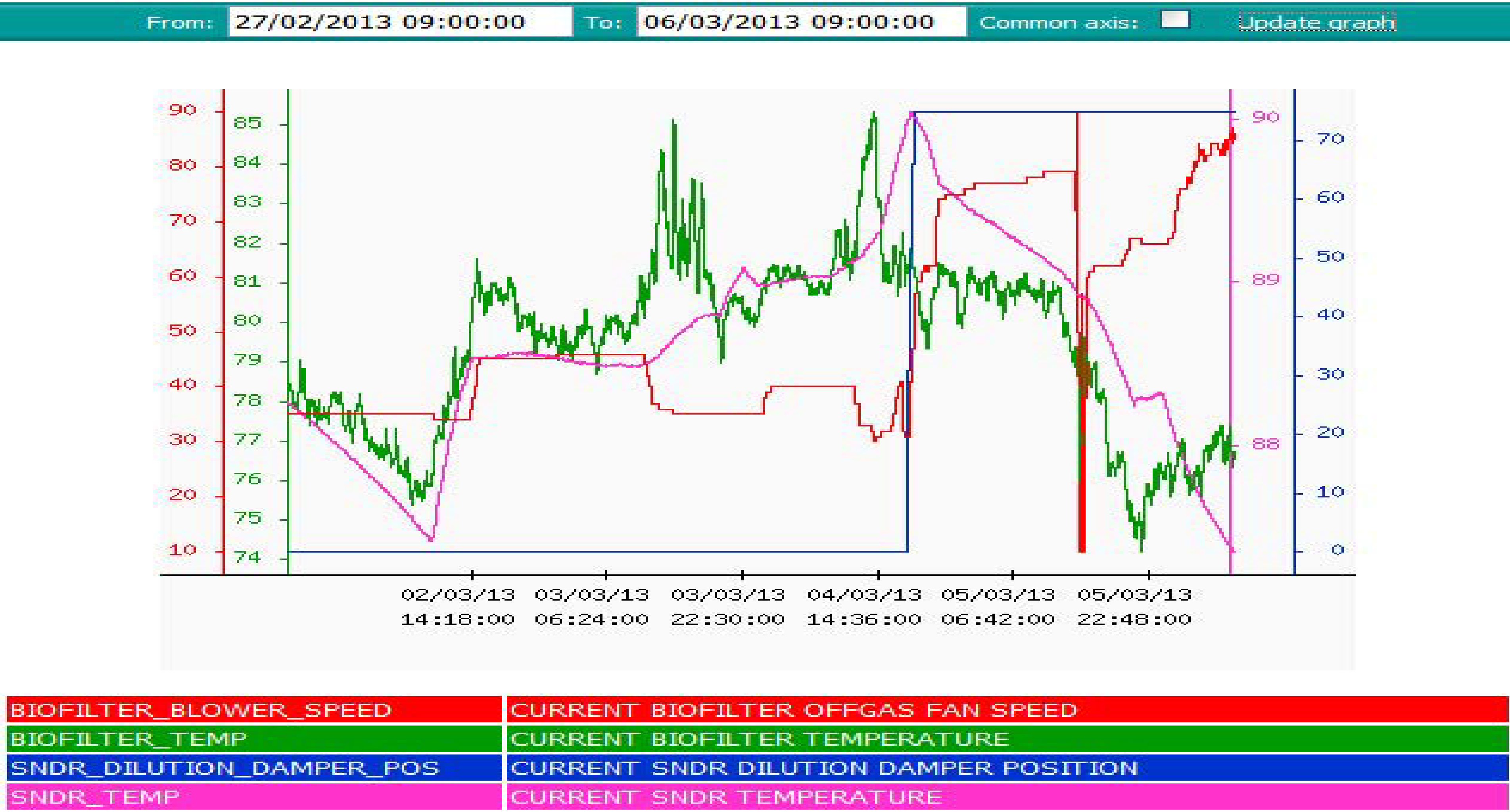


SNDR_BLOWER_SPEED	CURRENT SNDR PD BLOWER SPEED
SNDR_FOAM_LVL	CURRENT SNDR FOAM LEVEL
SNDR_LIQUID_LVL	CURRENT SNDR LIQUID LEVEL
SNDR_TEMP	CURRENT SNDR TEMPERATURE

SNDR Foam and ORP



Biofilter Blower & Temp
SNDR Dilution Damper & Temp



Odor Control

- pH, Temperature and foam control mixing reduces the free ammonia in the head space and maintains it as liquid ammonium (NH_4^+)
- Temperature and free ammonia concentration amenable to biofiltration

Biofilter

- Second strep is adsorption and biolgoical treatment in a fixed film growth bed biofilter
- Mesophillic operation –Temp 80 to 100 F
- Off gas fan pulls air from SNDR through scrubber and then the biofilter
- Two layers of media: inorganic haydite stone – allows growth of bacteria for treatment of H2S and mercaptans
- Upper layer is organic shredded root wood.

Biofilter

Water Panel

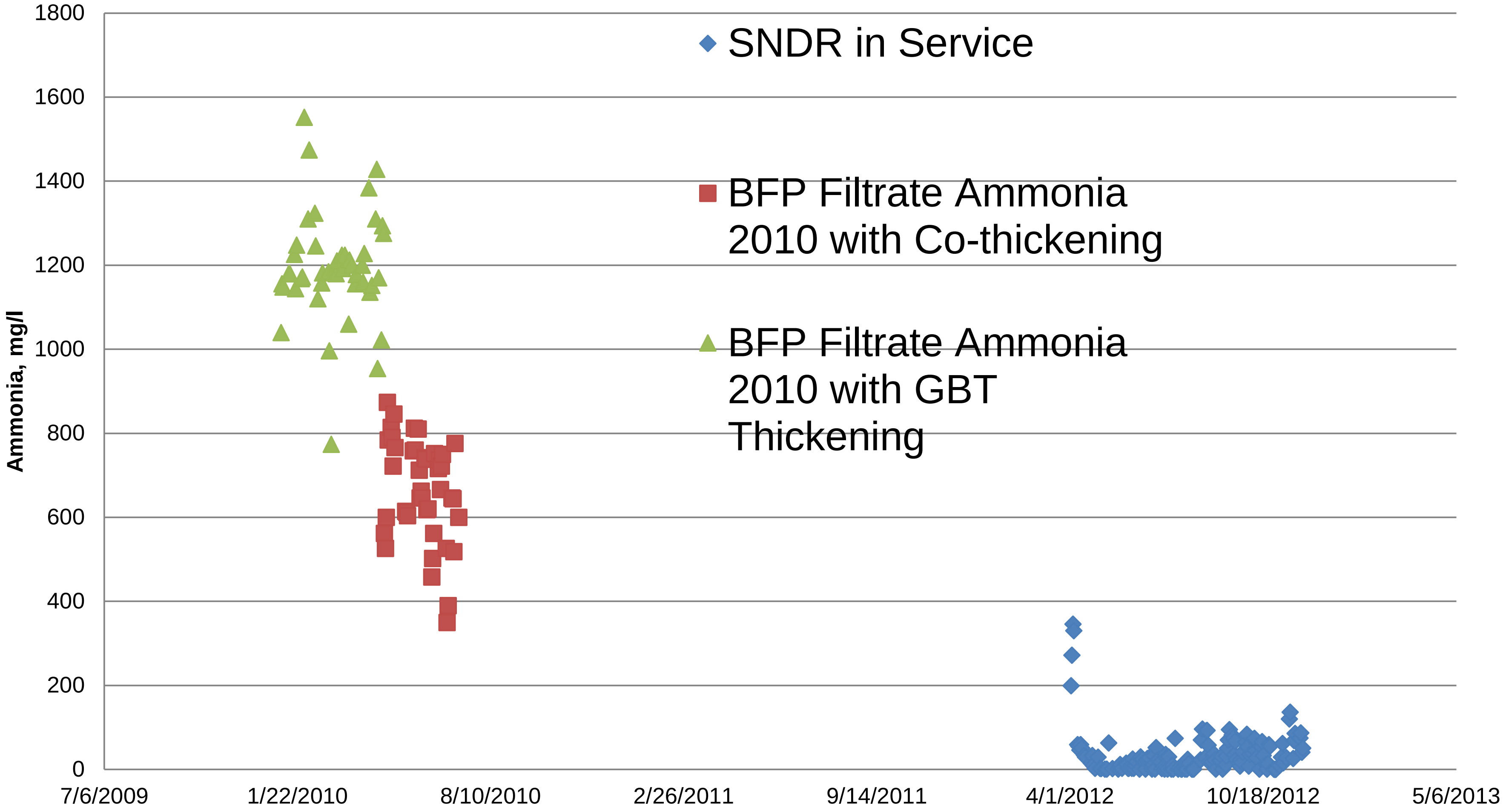
Results

- Better air quality in BFP building – much less H_2S
- Sludge feed to BFP is more consistent due to completely mixed storage tank
- Sludge easier to dewater

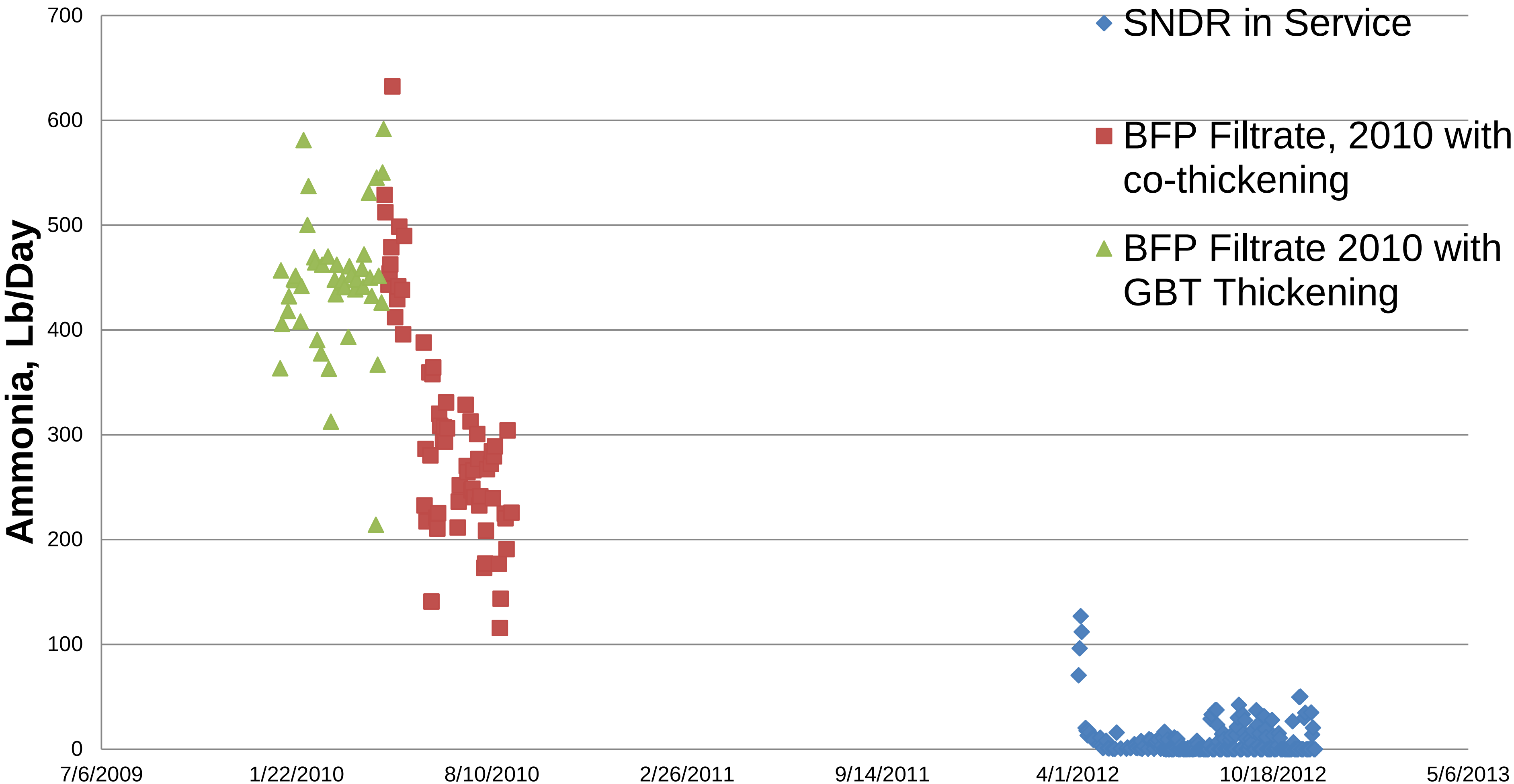
Industrial Discharge

- UNOX system increased ammonia removal
- Nitrification Tower ammonia removal stayed about the same
- Industry is paying the surcharge for ammonia discharge – which is less expensive for their operation than breakpoint chlorination was

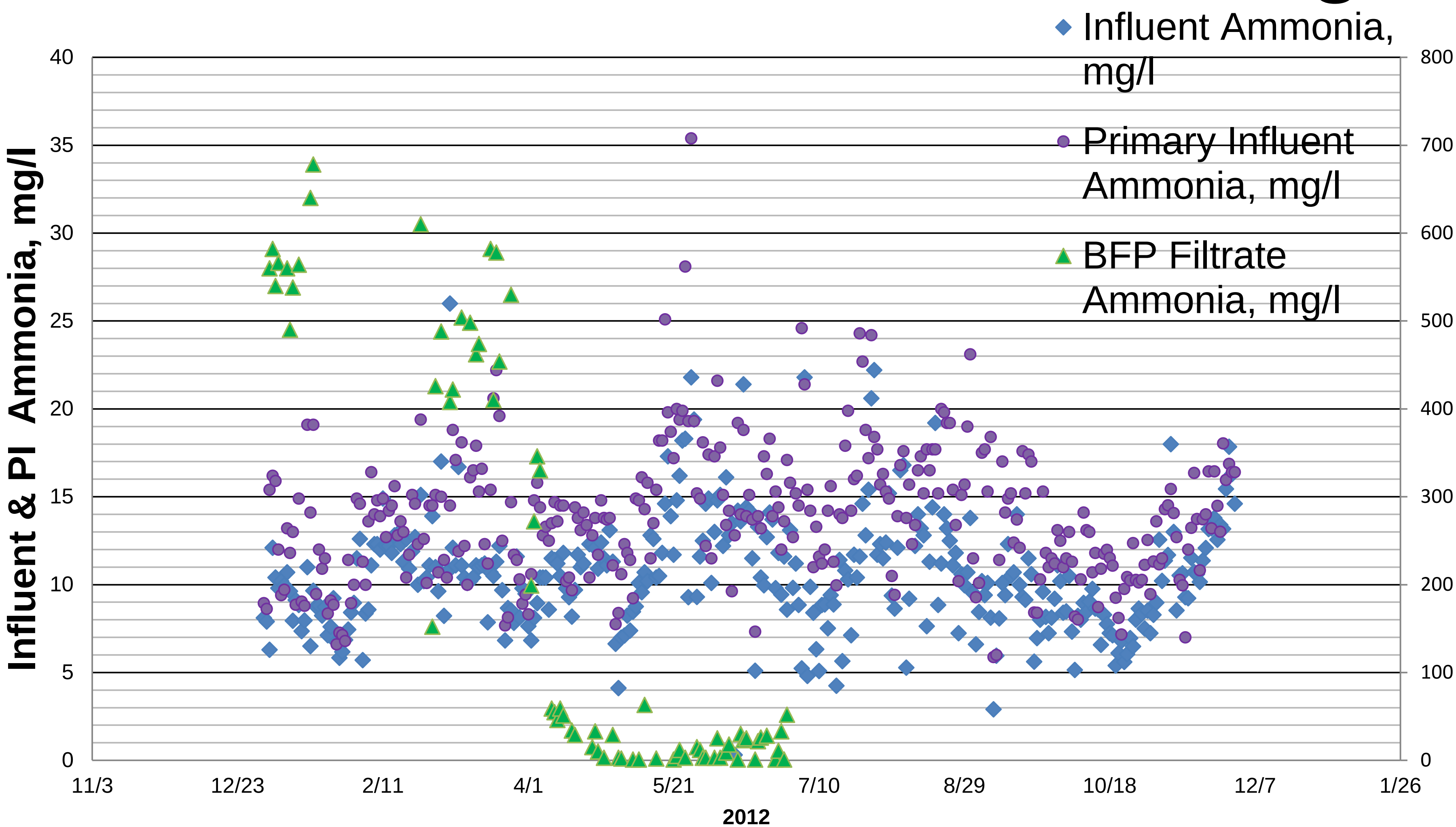
Filtrate Ammonia, mg/l



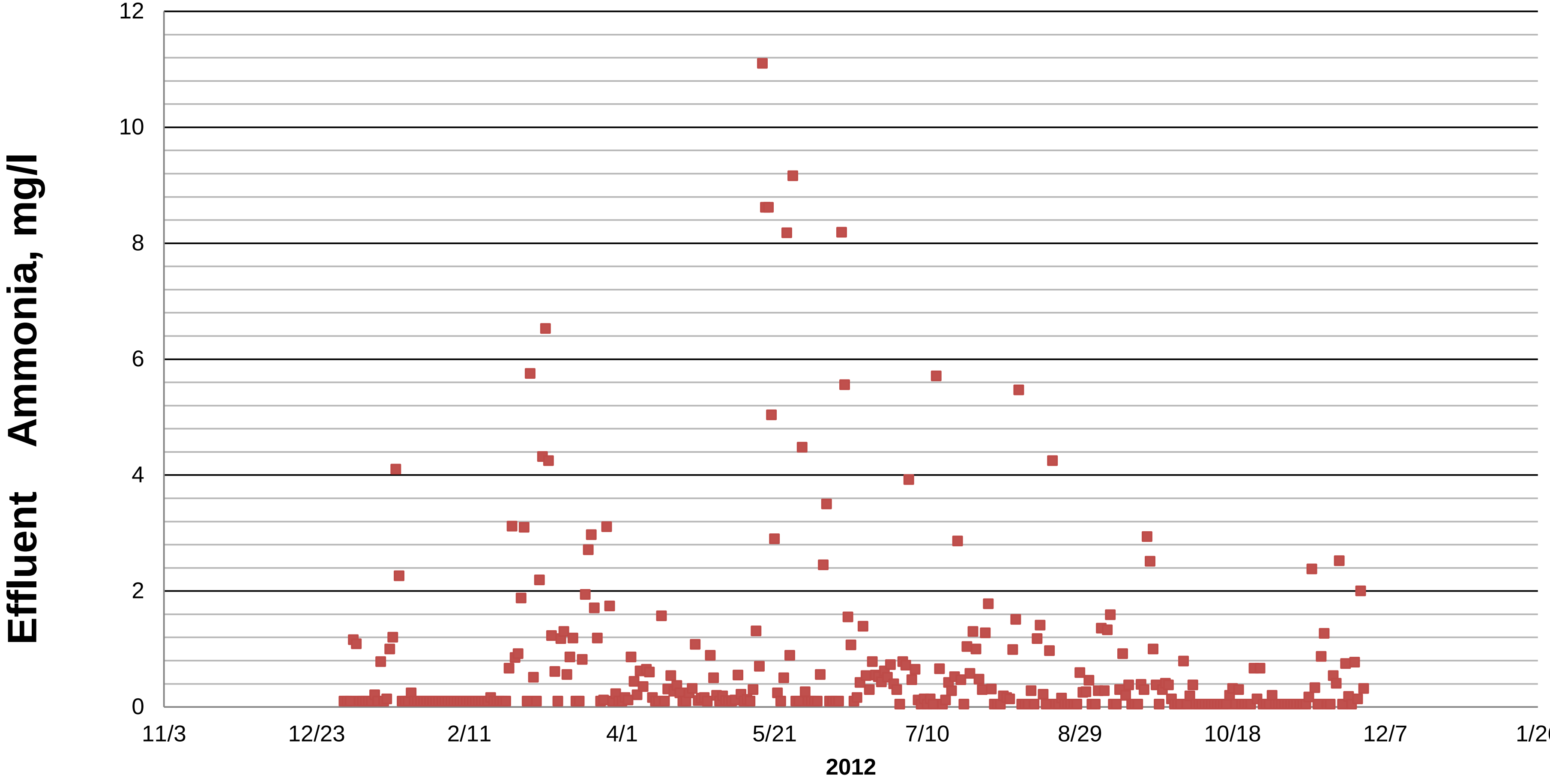
Ammonia Loading from Filtrate



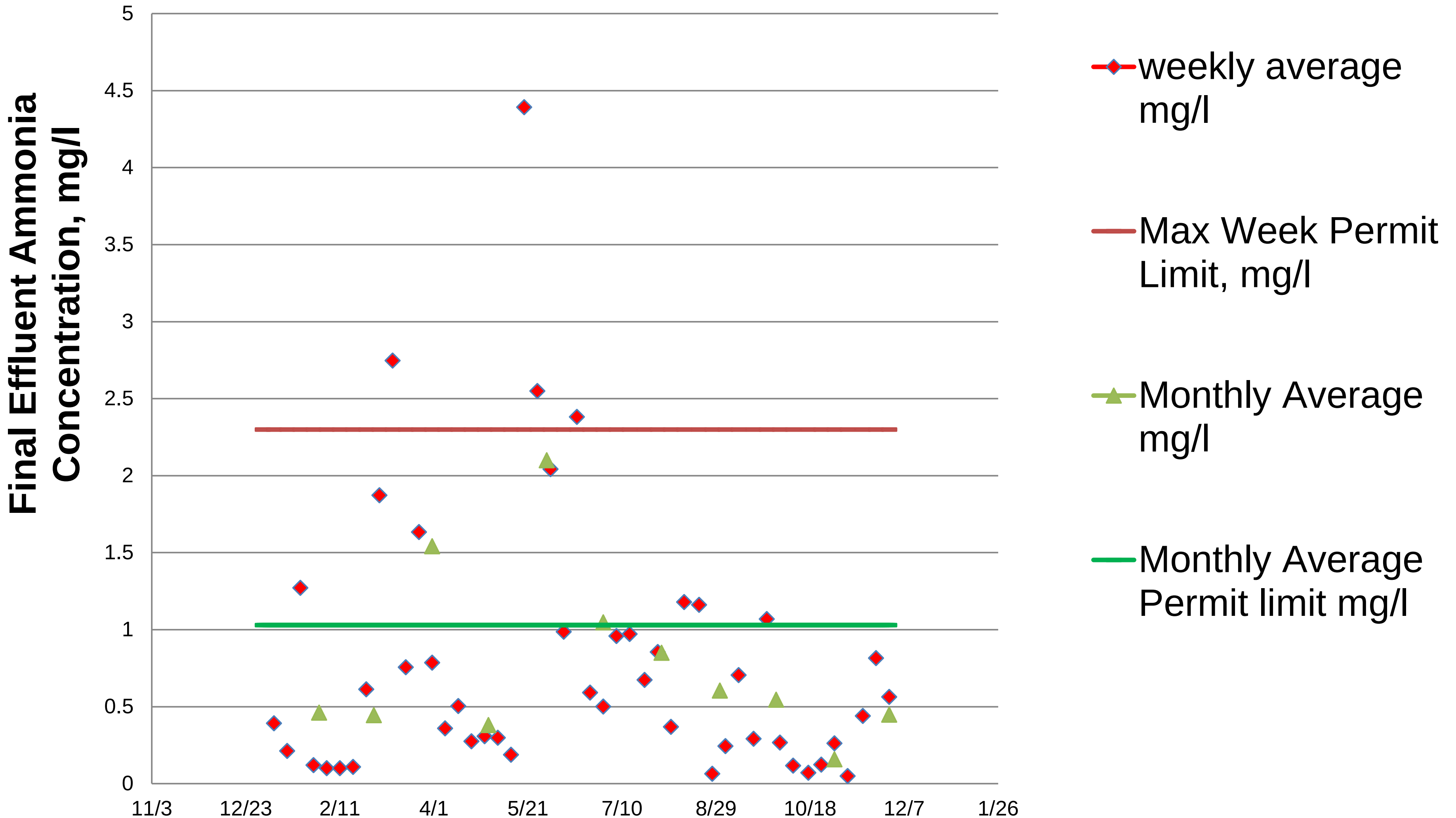
Ammonia, Raw, PI, Filtrate, mg/l



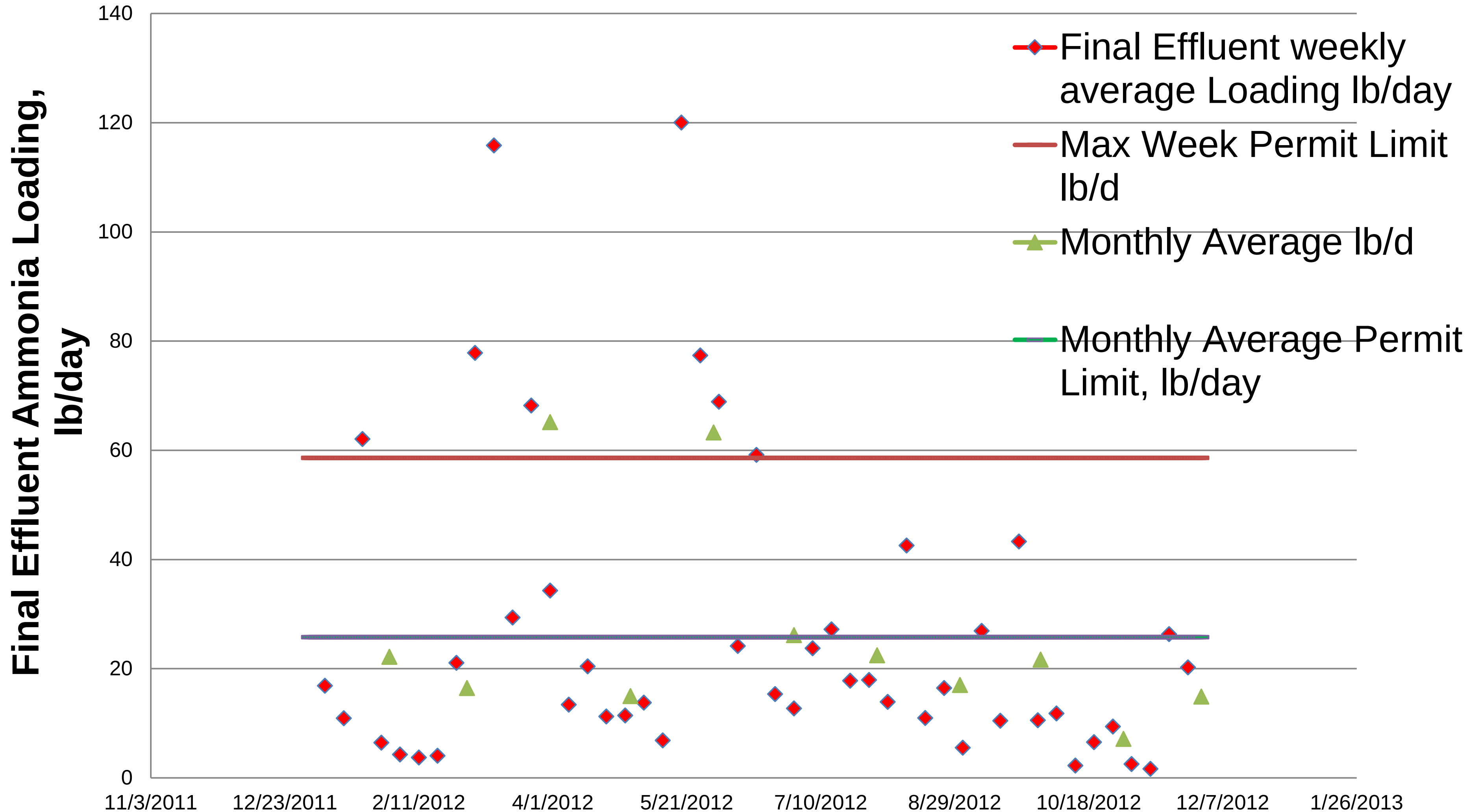
Effluent Ammonia, mg/l



Effluent NH3, mg/l



Effluent Ammonia Loading



Plant Operations May - November

Parameter	Prior to SNDR 2011	SNDR in Operation 2012
Flow, M Gallons total over period	1,111.8	834.4
Total BOD Loading Lbs (influent load)	1,289,395	1,137,989
Total Ammonia Loading Lbs (influent load)	79,767	71,357

Plant Operations May - November

Parameter	Prior to SNDR 2011	SNDR in Operation 2012
Biosolids to BFP, Gallons, total	6,175,400	4,733,900
% Solids BFP feed	1.8	2.1
Dry Tons produced, total	402	447

Plant Operations May - November

Parameter	Prior to SNDR 2011	SNDR in Operation 2012
% Solids BFP Cake Average before BFP optimization	16.7	16.7
% Solids BFP Cake Average after BFP Optimization	16.8	19.8
TSS, filtrate, mg/l average, before BFP Optimization	66.6	331.9
TSS, filtrate, mg/l average, after BFP Optimization	88.9	80.4

Plant Operations May - November

Parameter	Prior to SNDR 2011	SNDR in Operation 2012
NH3, filtrate, average mg/l	489.2	29.6
TVSS Primary and WAS, % total volatile solids	69.8%	67.1%
TVSS Digested Biosolids, % total volatile solids	53.9%	51.1%

References

1. Van Overmeiren, Frank; Pratt, Julia; Frazier, Elizabeth; <u>Speedway Pride Brochure</u>, Town of Speedway web site.
2. 1999 EPA Guidance Manual: Alternative Disinfectants and Oxidants
3. Commonwealth Engineers, 2009, Preliminary Engineering Report
4. Kumar, Nitin; Novac, John; Murthy, Sudhir; <u>Sequential Anaerobic-Aeration Digestion for Enhanced Volatile Solids Reduction and Nitrogen Removal</u>, 2006 WEF, Residuals and Biosolids Management Conference
5. TPS literature
6. Stevens, Pat; Efinger, Kevin, Water Environment Technology, May 2012

Questions

- Cindy Fort
  cfort@structurepoint.com

- Norm Berry
  nberry@speedwayutilities.org