A New Low – Achieving 3 mg/L Total Nitrogen with Bardenpho

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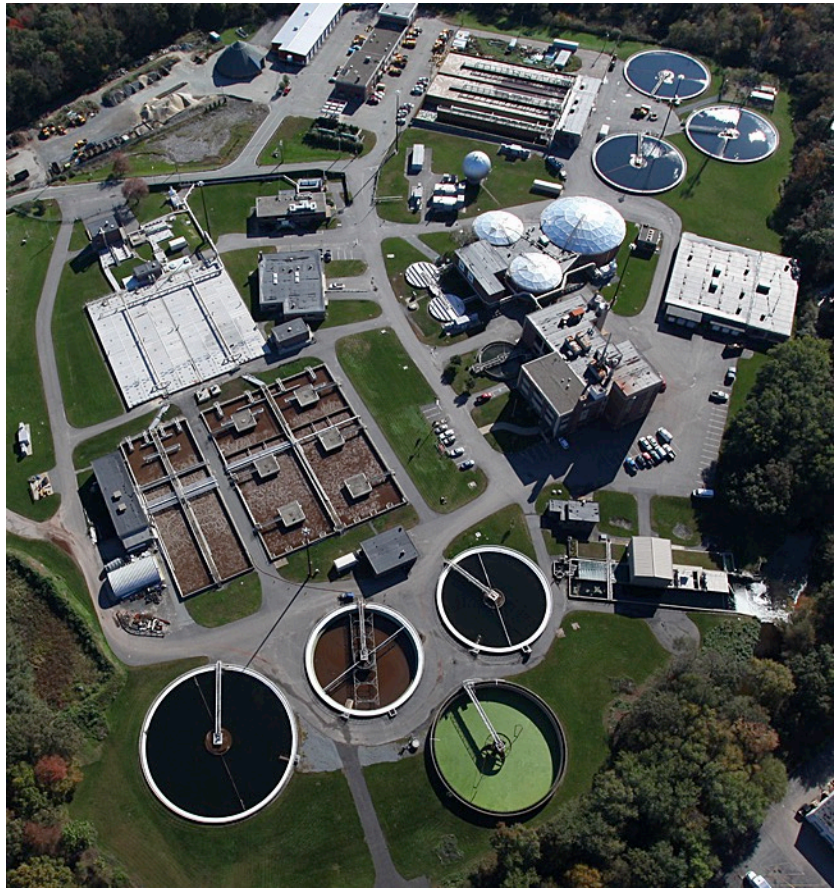
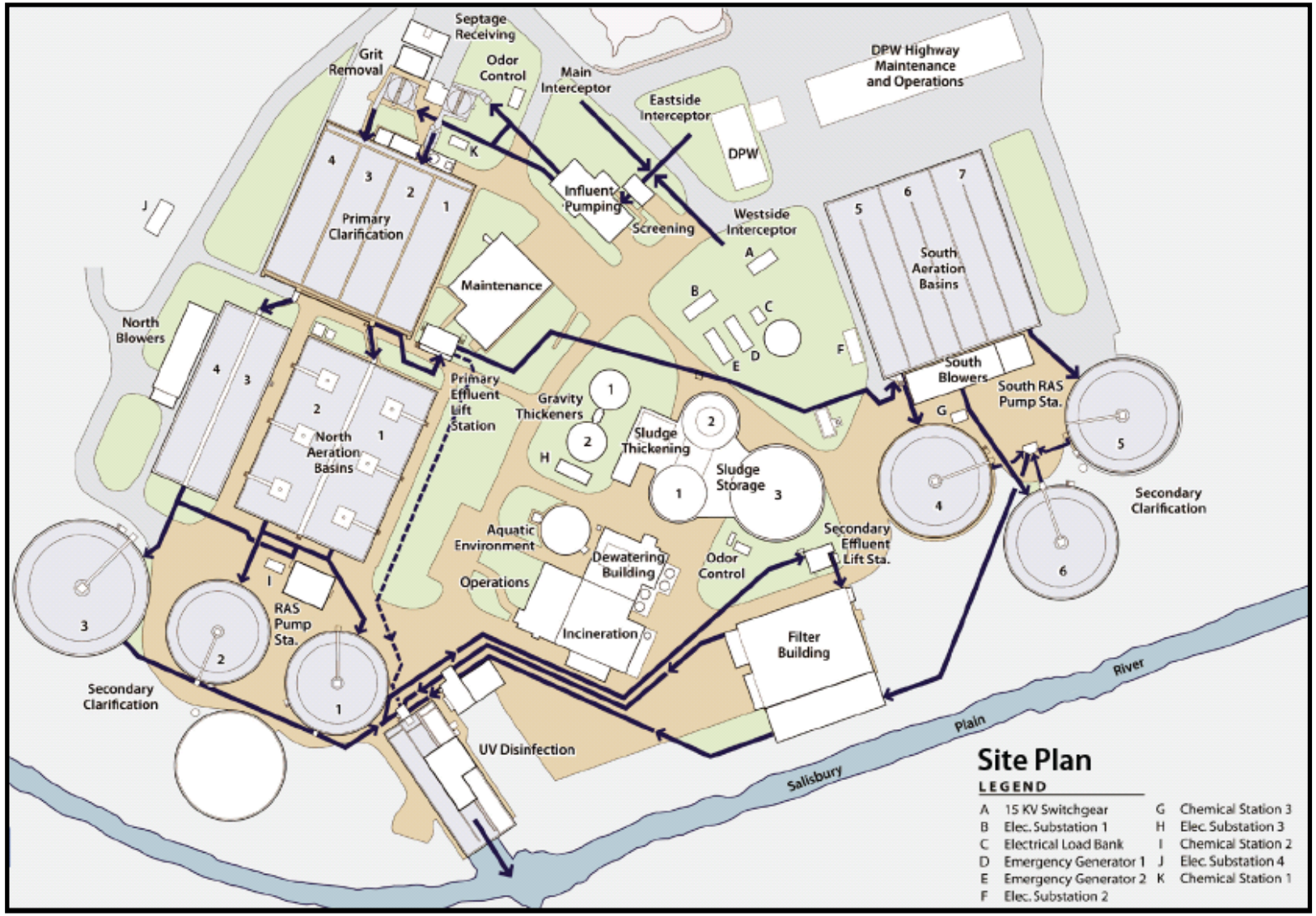
NEWEA
WORKING FOR WATER QUALITY

Brockton AWRF

- City Population <100,000
- Activated Sludge Late 1960s
- Expansion Early 1980s (2-stage process)
  - 18 mgd Average Annual Flow
  - 36 mgd Max Day
  - 60 mgd Peak
- Upgrade in mid 2000s (nutrient removal)
  - Expansion to 20.5 mgd
  - N removal to 5.5 mg/L TN
  - Chemical P removal to 0.2 mg/L



Brockton AWRF



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Biological Process Criteria

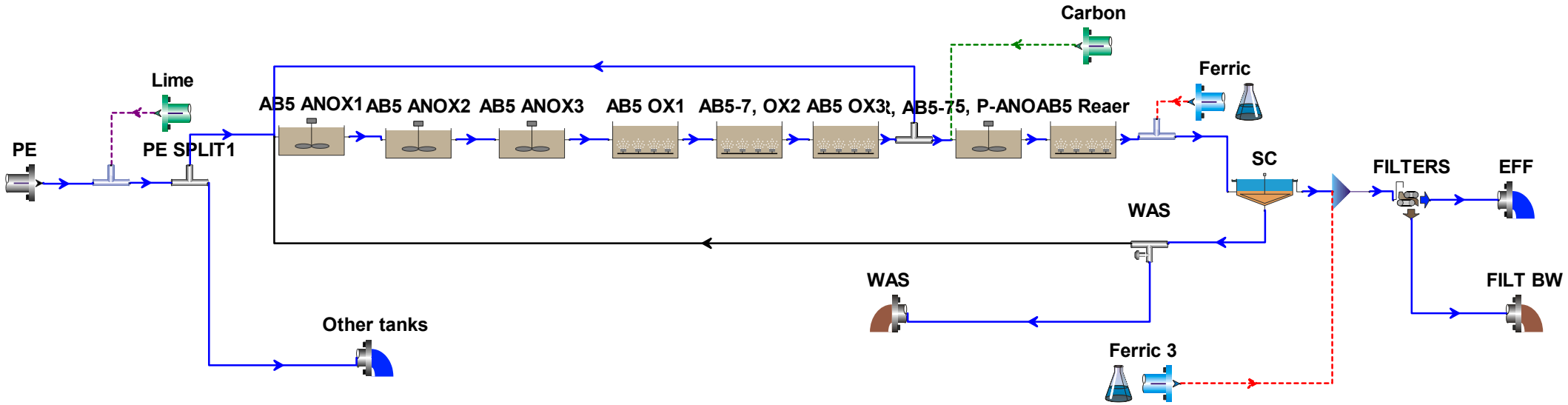
	Bioreactors 1, 2	Bioreactors 3, 4	Bioreactors 5, 6, 7
Wastewater temperature (min. month)	11°C	11°C	11°C
Design aerobic SRT	9.8 days	9.8 days	9.8 days
Anoxic Volume/ Basin	0.38 MG	0.23 MG	0.35 MG
Aerobic Volume/Basin	1.26 MG	0.74 MG	1.12 MG
Total Volume/ Basin	1.64 MG	0.97 MG	1.47 MG
Internal recycle rate	300 %	300 %	320 %
Design MLSS conc,	3,740 mg/L	4,500 mg/L	4,500 mg/L
	Secondary Clarifiers 1, 2	Secondary Clarifier 3	Secondary Clarifiers 4, 5, 6
Diameter	110 ft	150 ft	130 ft
Surface Area, each	9,500 ft^2	17,670 ft^2	13,300 ft^2
Average RAS Ratio	75%	75%	75%

NPDES Limits

	Average Monthly	Average Weekly	Maximum Daily
CBOD5 (5/1 – 10/31)	5 mg/L	8 mg/L	15 mg/L
CBOD5 (11/1 – 4/30)	15 mg/L	25 mg/L	30 mg/L
TSS (5/1 – 10/31)	5 mg/L	8 mg/L	15 mg/L
TSS (11/1 – 4/30)	15 mg/L	25 mg/L	30 mg/L
Total phosphorus (4/1 – 10/31)	0.101 mg/L	--	--
Total phosphorus (9/1 – 3/31)	1.0 mg/L	--	--
Ammonia-nitrogen (6/1 – 10/31)	1 mg/L	1 mg/L	1.5 mg/L
Ammonia-nitrogen (11/1 – 11/30)	6.3 mg/L	--	--
Ammonia-nitrogen (12/1 – 4/30)	9.5 mg/L	--	--
Ammonia-nitrogen (5/1 – 5/31)	3.2 mg/L	--	--
Total nitrogen (5/1 – 10/31)	450 lbs/day (seasonal average)		

Process Modeling

- Conclusion: 4-stage Bardenpho followed by effluent filters can achieve 3 mg/L TN



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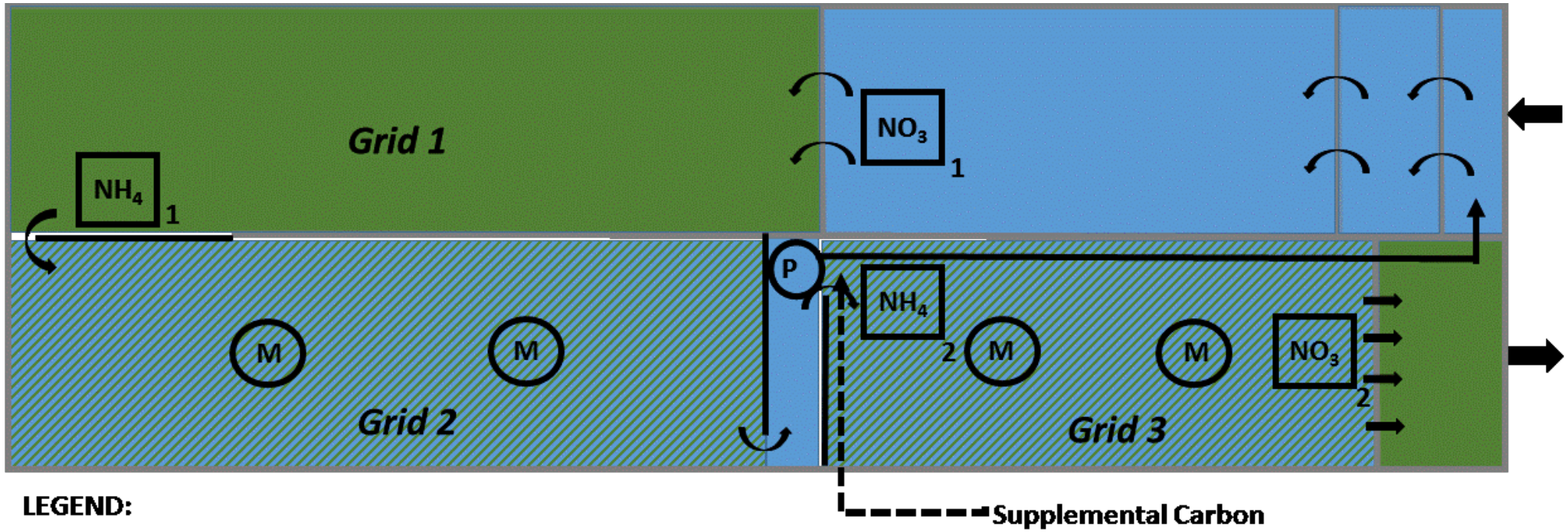
Pilot Basin Layout



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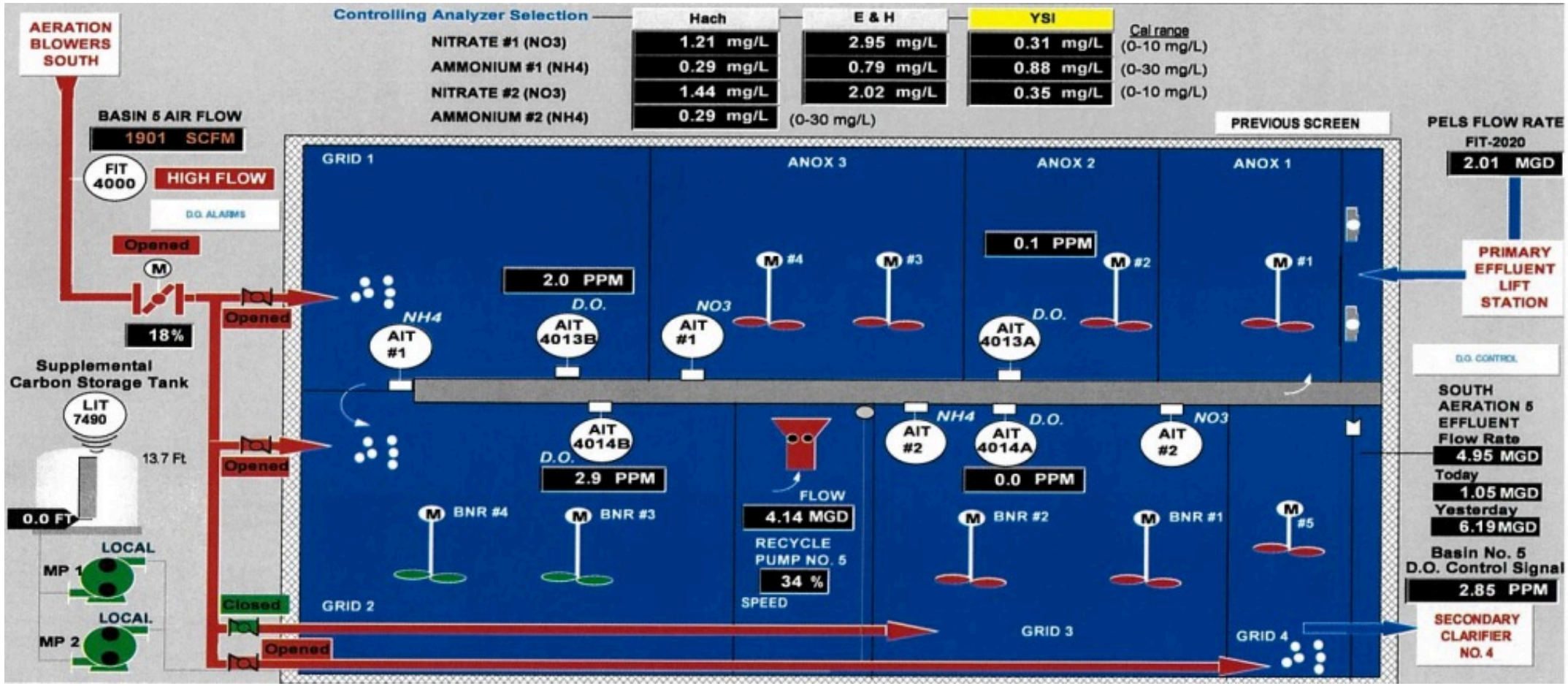
Installed Systems

Process Analyzers

Analyzer/Parameter	Location	Process Optimization Purpose
Nitrate, Location 1	Effluent end of the pre-anoxic zone (cell 3)	Adjustment of internal recycle pump rate to optimize denitrification capacity
Ammonium, Location 1	Effluent end of grid 1	Monitoring nitrification status at end of grid 1 to optimize swing zone mode
Ammonium, Location 2	Influent end of grid 3	Monitoring nitrification status at transition between grids 2 and 3
Nitrate, Location 2	Effluent end of post-anoxic zone	Monitoring of denitrification status at end of post-anoxic zone; adjustment of supplemental carbon dose

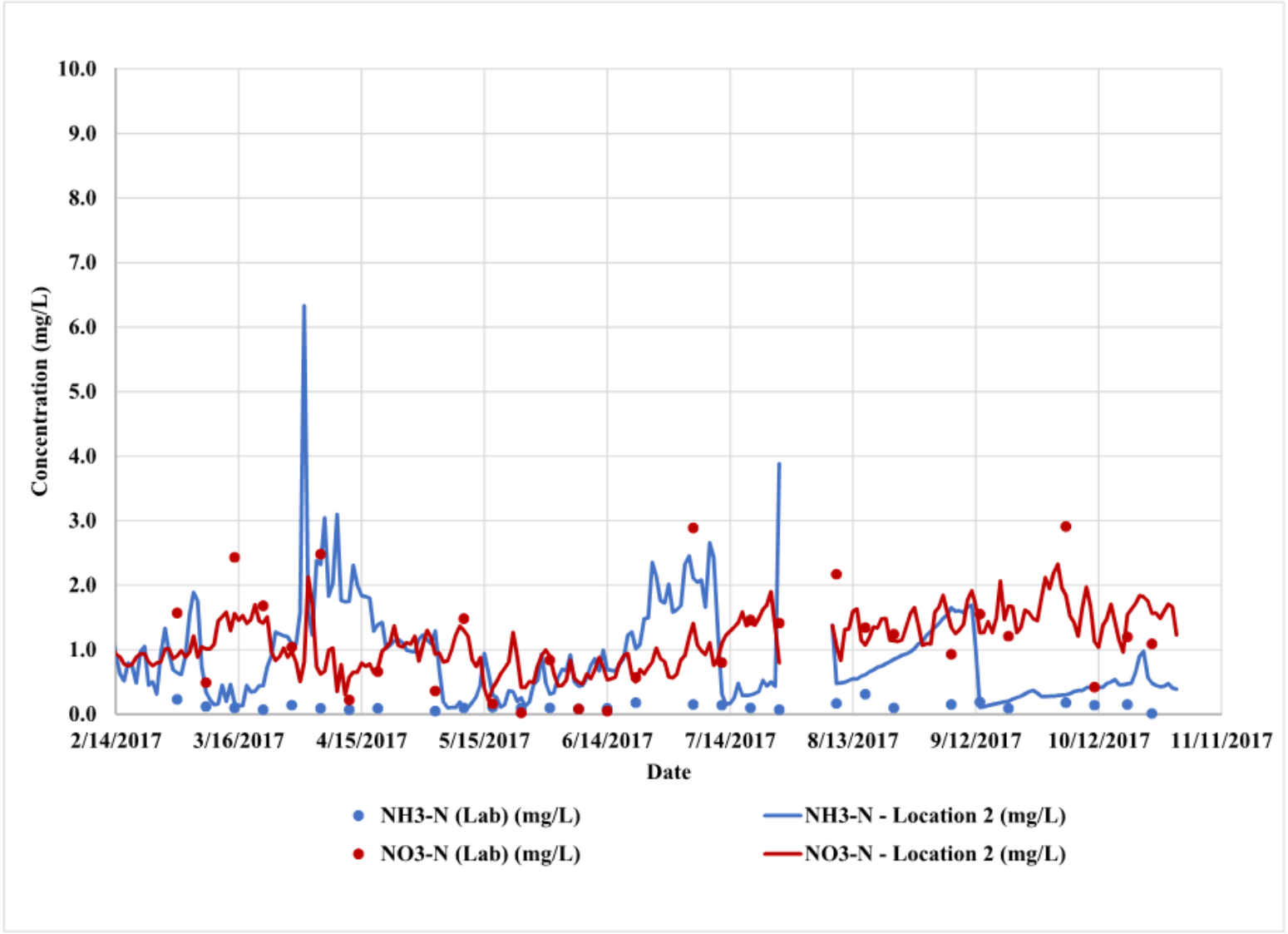
Monitoring and Control



Nitrogen Removal Performance

Parameter	Average	Maximum
NH_3-N	0.12 mg/L	0.31 mg/L
NO_2-N	0.011 mg/L	0.020 mg/L
NO_3-N	1.16 mg/L	2.91 mg/L
TIN	1.29 mg/L	3.1 mg/L

Lab Data vs. Online Monitoring



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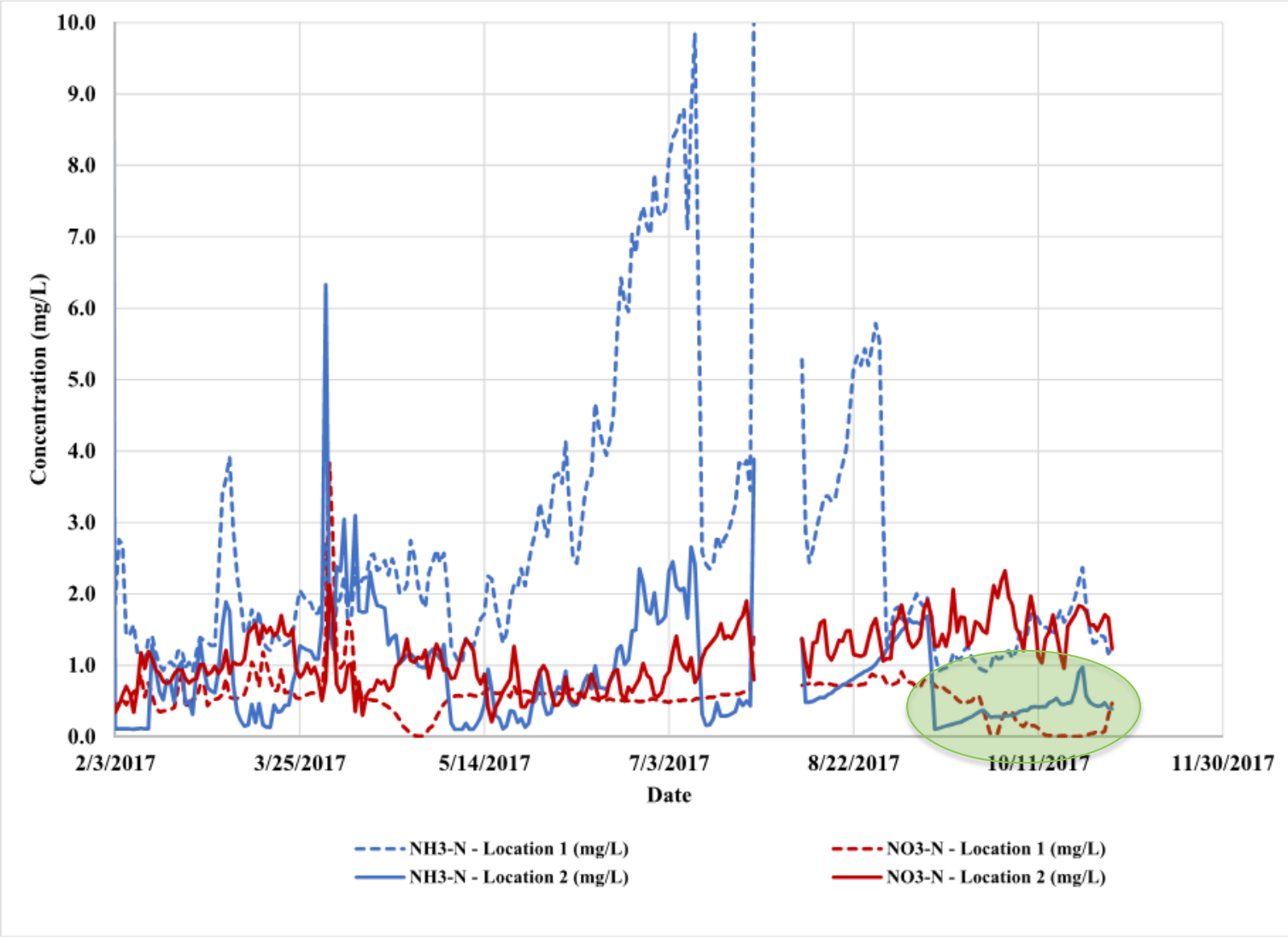
Optimization Opportunities with On-Line Monitoring



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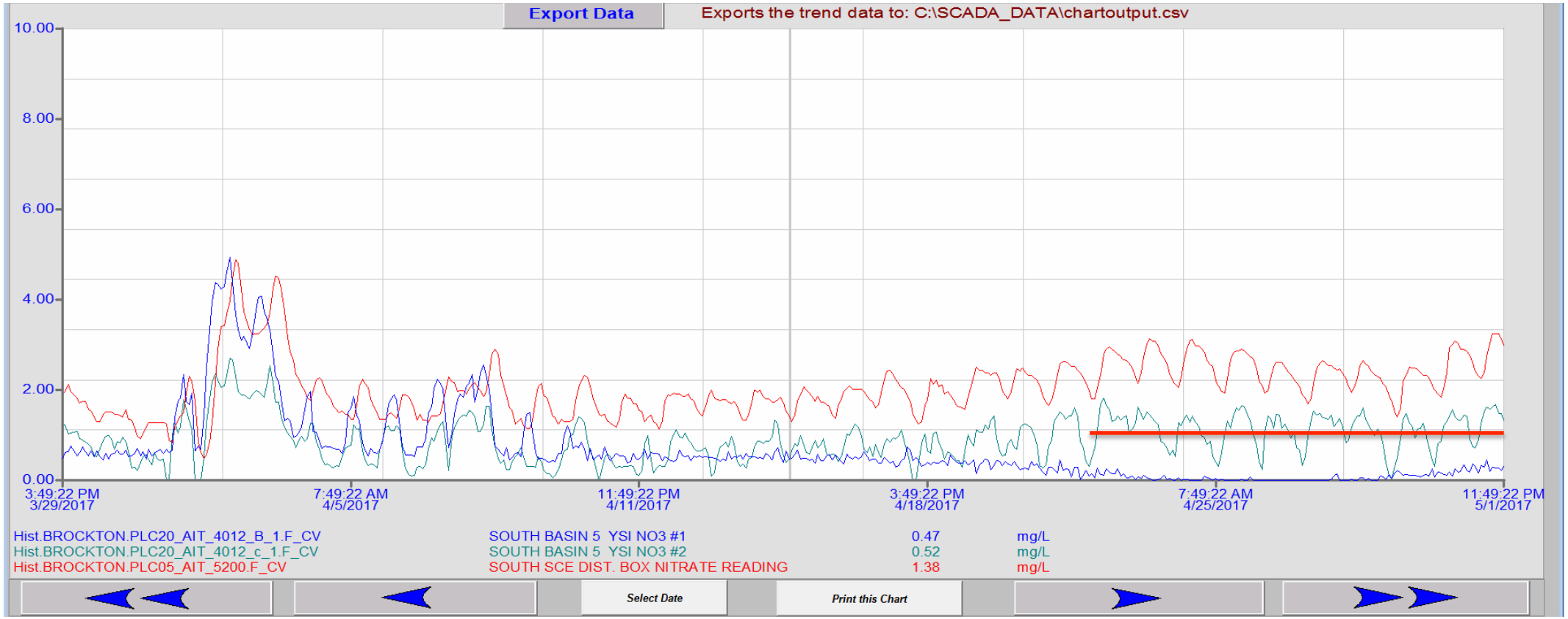

Conclusions

- Pilot basin has been operational for about 2 years (two summers)
- Operation to date indicates that 3 mg/L TN concentration can be achieved
- Supplemental carbon and further optimization expected to further improve effluent TN
- Continued demonstrated success would enable the City of Brockton to avoid construction of a tertiary denitrification facility

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Water Partnership with CDM Smith

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