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Sustainability & TMDL Compliance Using Integrated Fixed Film Activated Sludge (IFAS) Process in Cocoa Beach, FL

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BACKGROUND

- The USEPA established Total Maximum Daily Loads (TMDL's) for nutrients and dissolved oxygen (DO) in the Indian River Lagoon and Banana River Lagoon.

- The permitted annual discharges from Cocoa Beach's 6.0 MGD wastewater treatment facility were reduced to 4,022# and 1,063# for total nitrogen (TN) and total phosphorous (TP), respectively.

- This represents a nutrient load reduction requirement of approximately 300% for the City's utility which already beneficially reclaims over 90% of the available effluent.

GOAL

- The City's goal was to identify the lowest cost solution which would meet the mandated effluent goals, and reduce energy consumption, without increasing maintenance or staffing requirements.

- Plant modifications must be constructed within the existing site boundaries and existing treatment processes must remain on line during construction while meeting current permitted discharge.

- The existing treatment capacity of 6.0 MGD had to be maintained while enhancing nutrient removal capabilities to achieve TN and TP levels below 3 mg/l and 1 mg/l, respectively.

- A project budget of approximately $20M was established for all design and construction related activities.

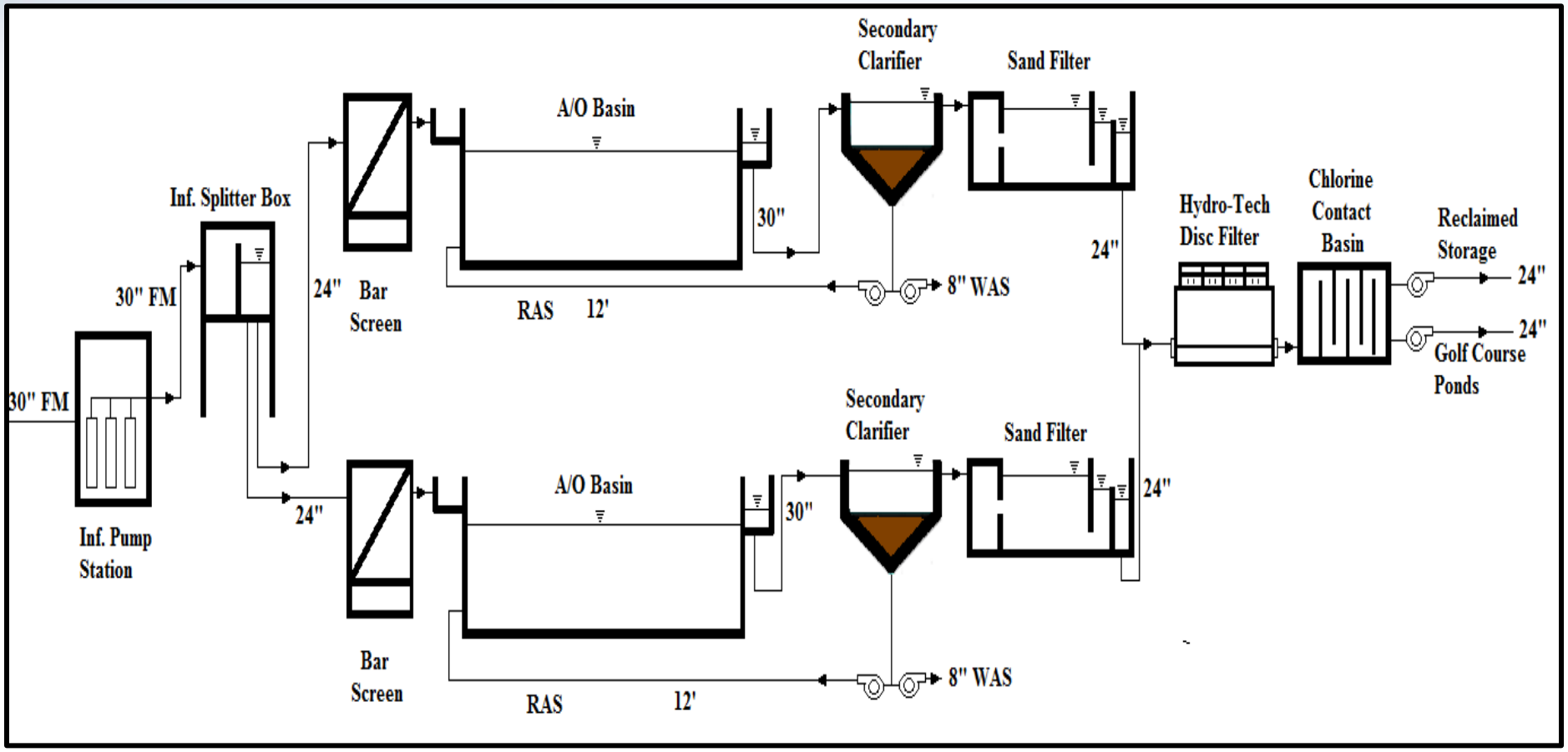
CHALLENGES

- Conventional treatment technology and storage techniques would not meet the stated goals.
- City staff and their consultants determined that a combination of innovative wastewater treatment technologies in conjunction with aquifer storage and recovery (ASR) were necessary.
- It was determined that two (2) processes were available which could reliably achieve AWT quality effluent within the existing site footprint.
- The two (2) options were a membrane bioreactor (MBR), or an IFAS moving bed bioreactor (MBBR).

Process Selection

- Both options were evaluated and it was determined that either could achieve the stated effluent goals.
- The cost to construct a 6.0 MGD MBR system was estimated to cost approximately $7 – $9/gallon for a total project cost of $42M to $54M.
- The estimated cost for the IFAS system was approximately $3 – $4/gallon for a total treatment cost of $18 to $24M.
- The City elected to pursue construction of an IFAS process, the AnoxKaldnes Hybrid Biofilm Activated Sludge (Hybas™) process was selected.
- The actual bid amount and corresponding final construction cost for the treatment facility was $15.14M.

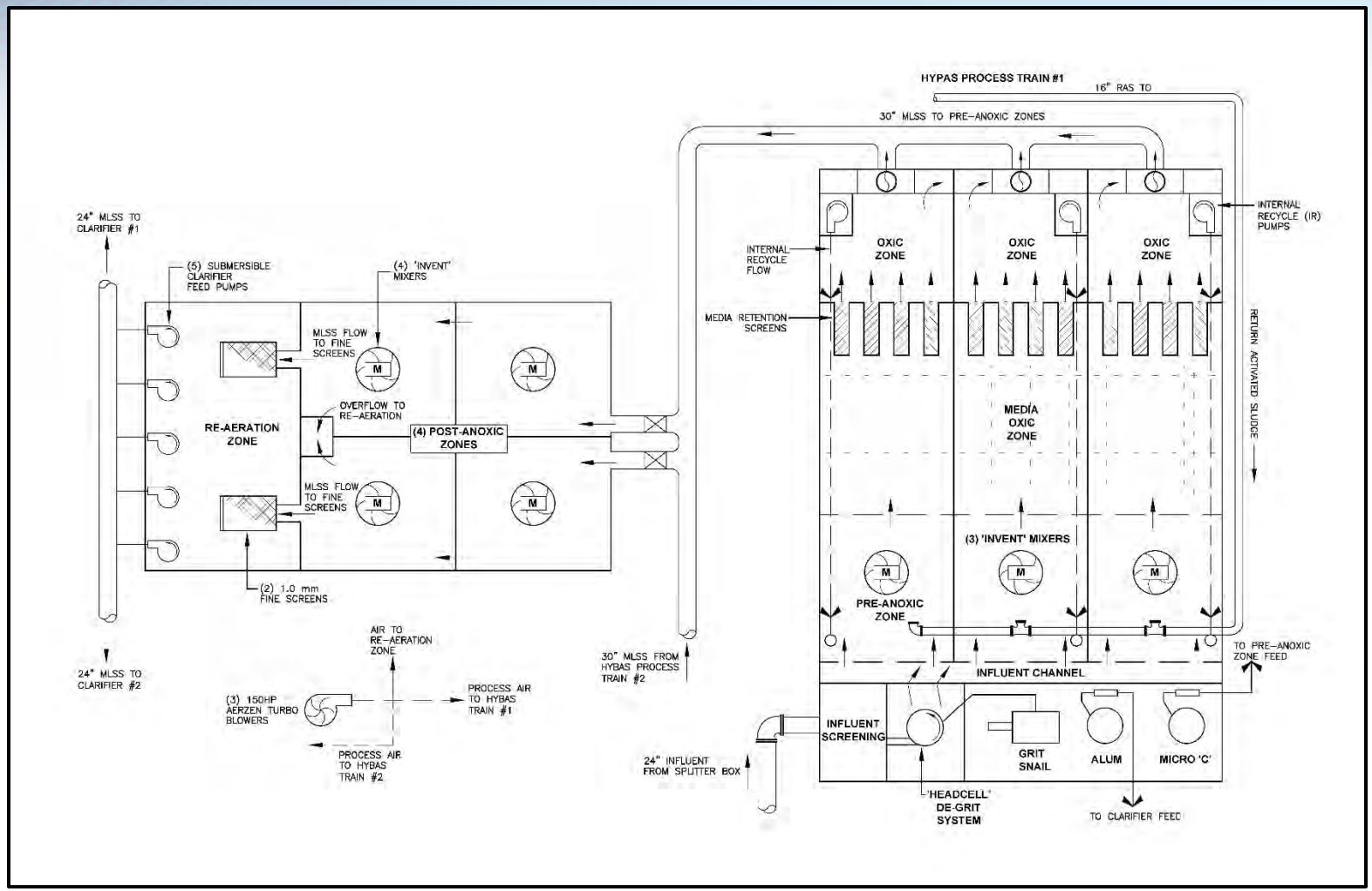
Pre-Construction A/O Process Schematic Diagram



Pre-Construction Effluent Characteristics

Month	Flow (mgd)	$cBOD_5$ (mg/l)	TSS (mg/L)	TN (mg/L)	TP (mg/L)
1/1/11	3.27	2.00	0.70	11.10	1.70
2/11/11	3.21	2.19	1.33		
3/11/11	3.41	2.32	0.65		
4/11/11	3.43	2.90	0.53	9.60	1.21
5/11/11	3.06	2.12	0.70		
6/11/11	3.15	2.23	0.73		
7/11/11	3.49	2.23	0.71		
8/11/11	3.48	2.50	0.56		
9/11/11	3.64	2.15	0.57		
10/11/11	4.77	3.40	3.33	6.19	0.73
11/11/11	4.01	3.15	1.15	7.18	1.00
12/11/11	3.57	5.650	1.60	9.15	1.67
Annual Avg	**3.54**	**2.73**	**1.05**	**8.64**	**1.26**

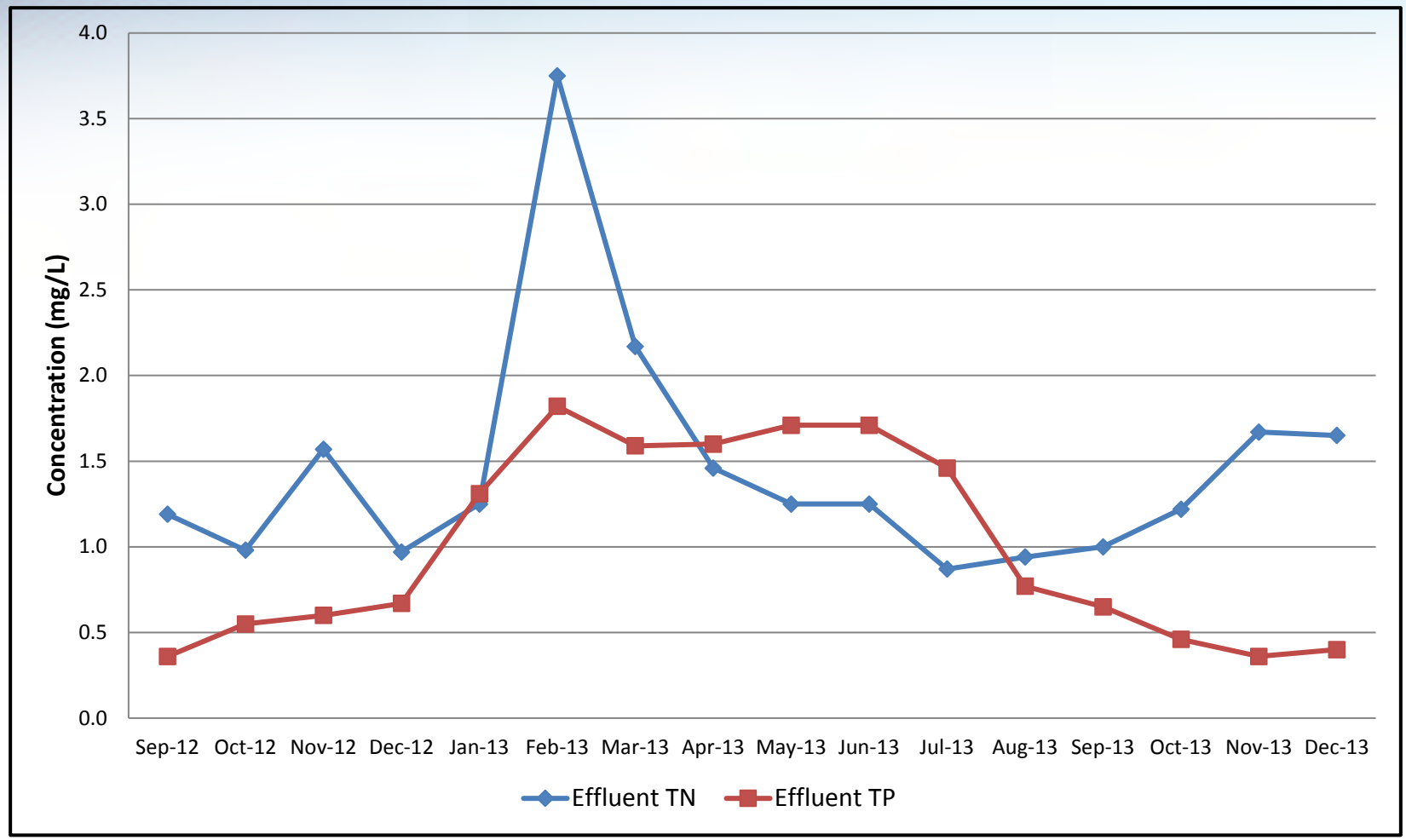
Post-Construction Hybas Process Schematic



Proposed Design Parameters for New Process

Process Parameters	Units	Value
MLSS Concentration @ Design Conditions	mg/L	3,000
IMLR @ Design Conditions	%	400
Total SRT @ Design Conditions	Day	4
F/M Ratio @ Design Conditions	lb BOD/lb TSS/day	0.15
RAS @ Design Conditions	%	50-100
Media Percent Fill in Hybas Basins	%	27
Media Protected Surface Areak	ft_2/ft_3	244
Minimum Design Temp	°C	18

Effluent, TN, and TP Concentrations



TN Reduction

- Provisions were included in the Cocoa Beach process design for feeding a supplemental carbon source (Micro-C 2000) for denitrification
- It was observed that addition was unnecessary to achieve the target effluent TN concentrations for the past 18 months of operation
- This is most likely due to endogenous denitrification in the post-anoxic basins and within the sludge blanket in the secondary clarifiers
- It is thought to be caused by the following mechanisms:
  - (1) hydrolysis and fermentation of particulate matters entrapped in the MLSS
  - (2) endogenous respiration of biomass within the sludge blanket due to decay process

Sustainability and Efficiency

- A stated goal of the project was sustainability and efficiency.
- Upon project completion, the plant saw a decrease in: nutrient mass, sludge residuals and unit energy conservation.
- The Hybas process effectively reduced effluent nitrogen from an average of 8.64 mg/l in 2011 to 1.62 mg/l in 2013. This is an 81% reduction in effluent TN values.
- Phosphorous control commenced after completion of process train #2. The baseline value for total effluent phosphorous (TP) was approximately 1.6 mg/l, the effluent values for TP were 0.46, 0.36 and 0.40 mg/l in September, October and November.

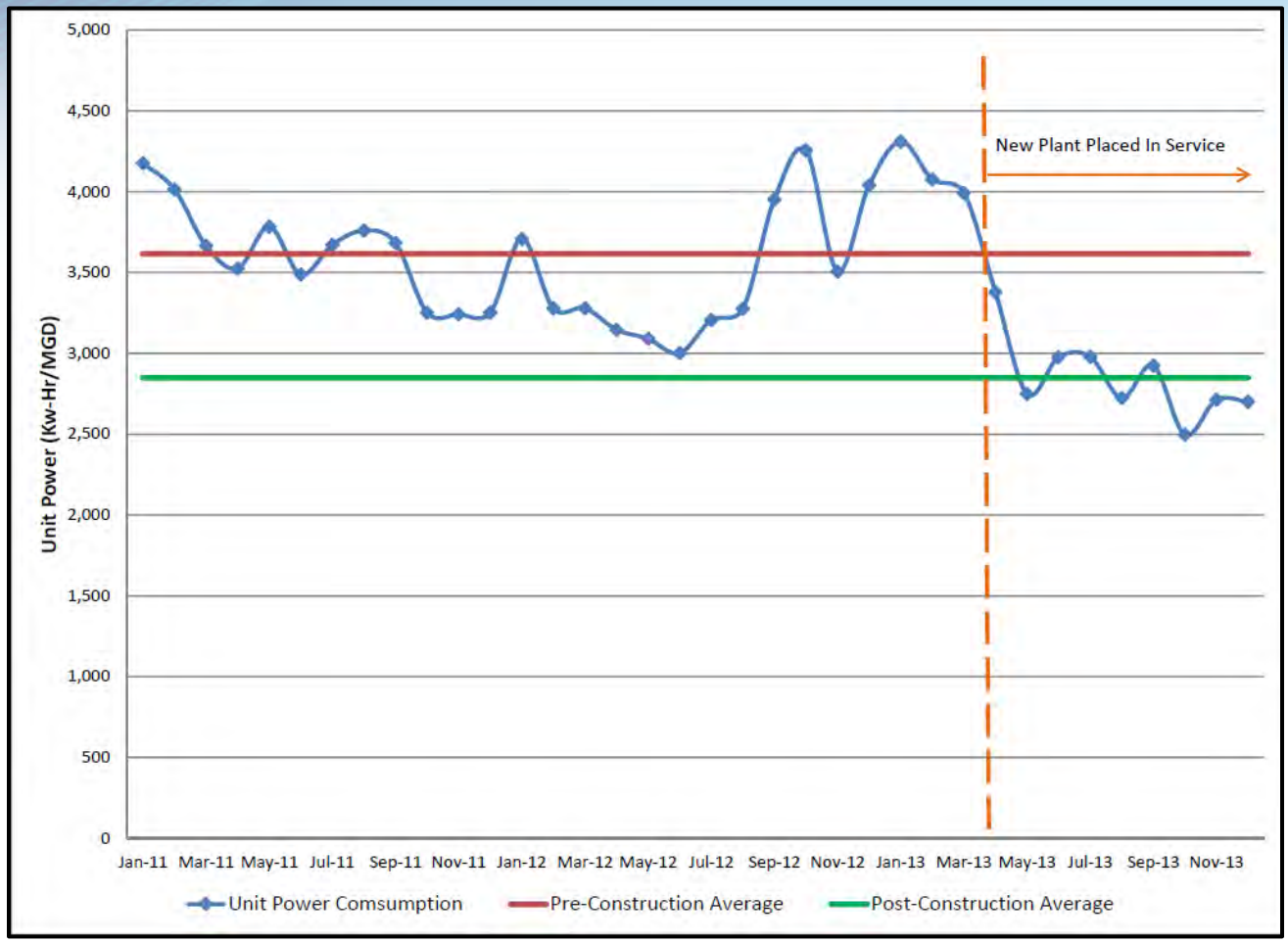
Biosolid Residuals (Sludge) Production

- 1.0mm fine screening of all MLSS was incorporated into the process design in order to reduce the inorganic content in the MLSS and minimize the potential for fouling the media retention screens.
- Total sludge production was noticeably reduced.
- In 2011, prior to the plant upgrades, the facility produced 424 dry tons of sludge, 0.33 dry tons per million gallons of flow (0.33 dry tons/MG).
- In 2013, the facility produced 461 dry tons of sludge, 0.29 dry tons/MG. The result is a 12% net reduction in solids production.

Energy Conservation

- Energy conservation was a primary goal which served as a basis for the biological process and equipment selection.
- The Hybas process reduced the footprint of the oxic treatment zones necessary to achieve complete nitrification and BOD reduction. This reduced area also corresponded to reduced aeration requirements.
- 'Invent' hyperboloid mixing and aeration equipment was also selected because of improved efficiency and reduced power requirements.
- Variable frequency drives (VFD's) and intelligent control systems were specified for all motors greater than 5 HP in order to reduce energy consumption.
- In terms of connected horsepower, the total load assigned to blowers, mixers and pumps was reduced by 220 HP.

Unit Power Consumption vs Time



- 21% decrease in unit power consumption

Conclusions

- IFAS is an excellent technology for upgrading existing CAS systems within the existing tankage for maintaining nitrification at higher flow rates/loads or upgrading a CAS plant to meet new nitrification or total nitrogen removal requirements.

- IFAS technology achieves extremely low NH_3-N and NO_3-N concentrations in secondary effluent. A total of 0.5 mg/L of total inorganic nitrogen (TIN) is achievable for IFAS technology.

- Process and equipment selection resulted in reduced sludge production, lower nutrients and reduced power consumption.

- Sludge production was reduced by 12%, TN and TP were reduced by 81% and 32%, respectively and power consumption was reduced by 21%.

- The experience at Cocoa Beach demonstrates that enhanced sustainability can actually reduce operating expenses!