Feasibility of Traditional and Emerging Technologies for Treatment and Resource Recovery from Recycle Streams at the Water Reclamation Plants of Metropolitan Water Reclamation District of Greater Chicago

Presented by

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7. Pro-Corp, LLC and Ostara Inc. for screening recycle streams and analyzing data for cost opinions

OUTLINE

- Identification of Recycle Streams at Stickney, Calumet and Egan WRPs
- Sampling Locations - Raw Sewage and Recycle Streams
- Sampling Plan
- Estimation of Flow and Characteristics Data of Recycle Streams
- Loadings at Plant Headworks
- Impact on Treatment at SWRP
- Treatment Options and Screening of Technologies
- Feasible Technologies for District WRPs

Identification of Recycle Streams at Calumet, Egan and Stickney WRPs

Centrate

East side lagoon 9 supernatant overflow plus runoff from drying cells

West side lagoon 17 supernatant overflow,

Gravity tank supernatant overflow

(Digester feed tank overflow and Gravity concentration feed tank overflow seldom)

Centrate

GBT filtrate

Grit Classifier Recycle

Filter Backwash

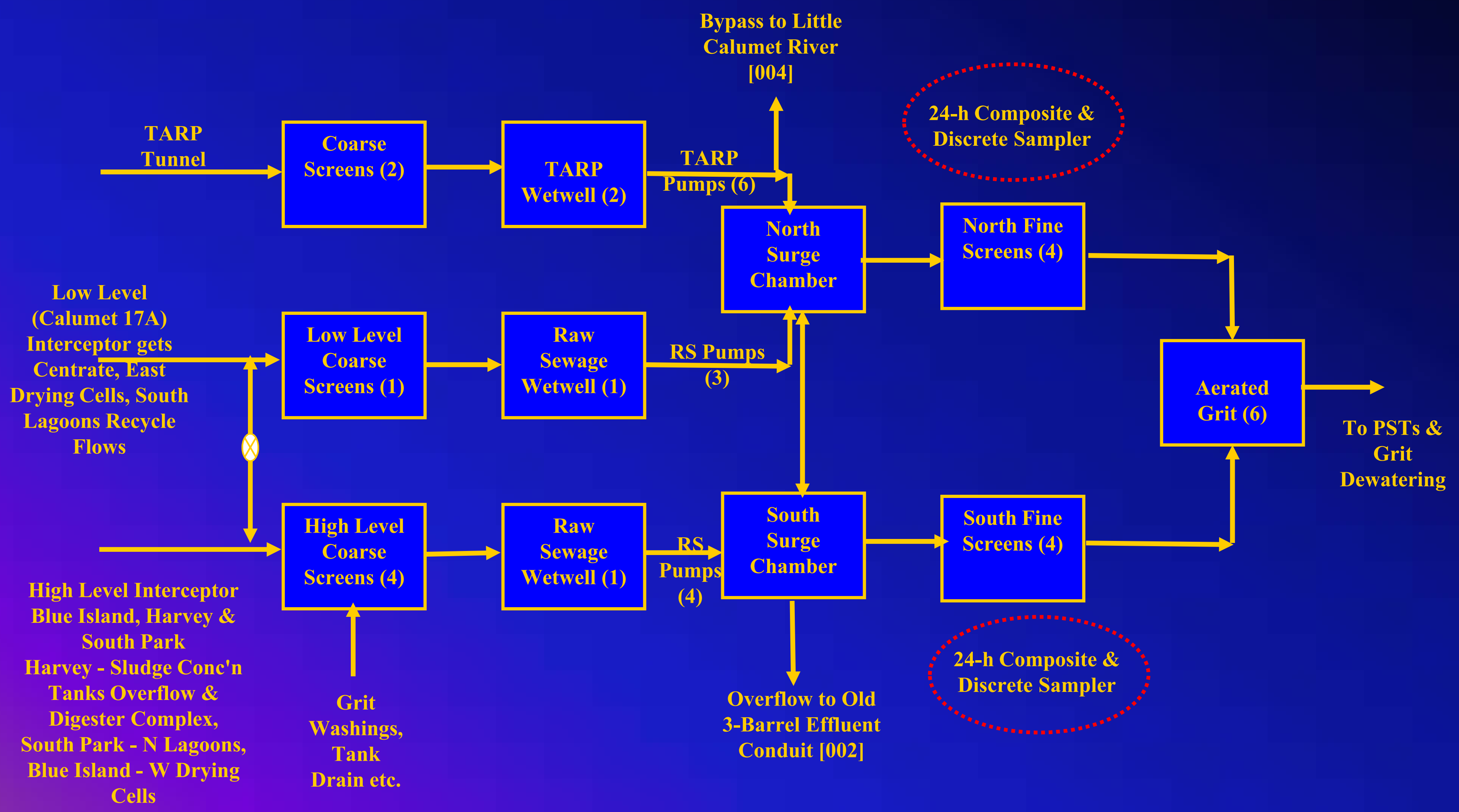
Pre-centrifuge centrate

Post-centrifuge centrate

Gravity Concentration tank supernatant overflow

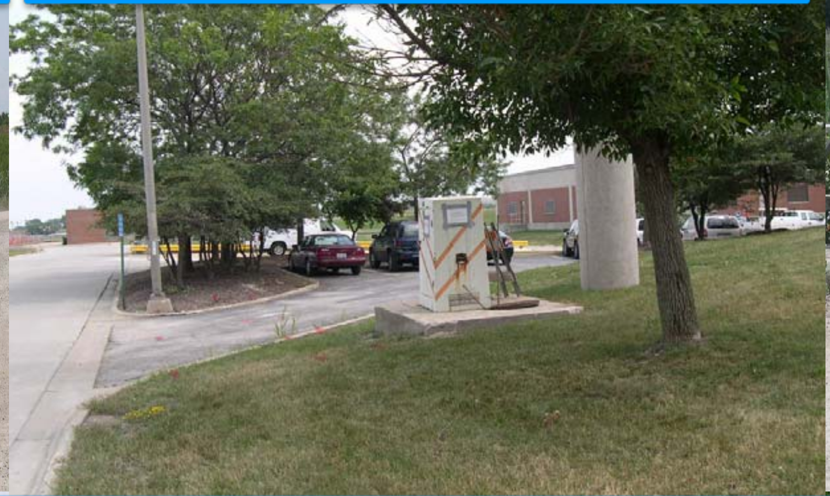
(Lagoon supernatant via main screen seldom)

Details of Plant Headworks and Recycle Streams at Calumet WRP



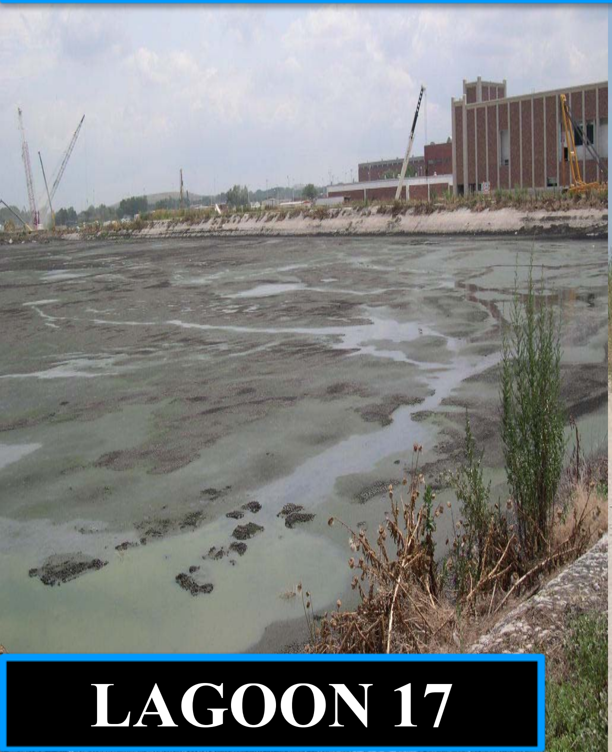
CENTRATE

GRAVITY OVERFLOW

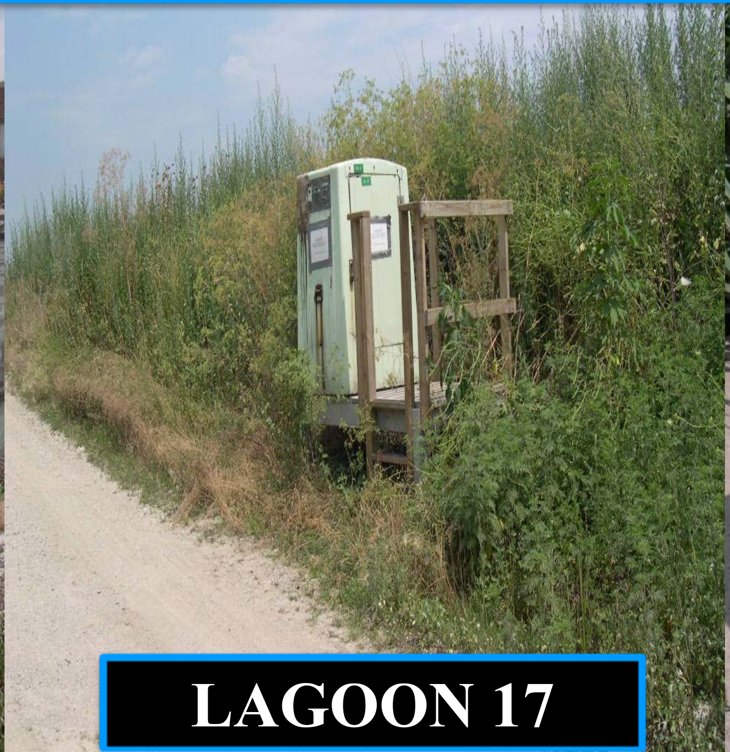


LAGOON 9

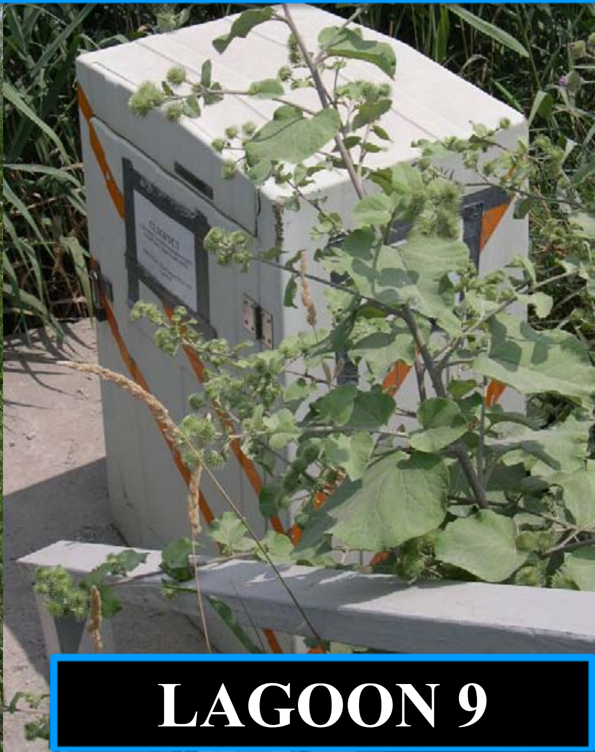
SAMPLING LOCATIONS AT CALUMET WRP



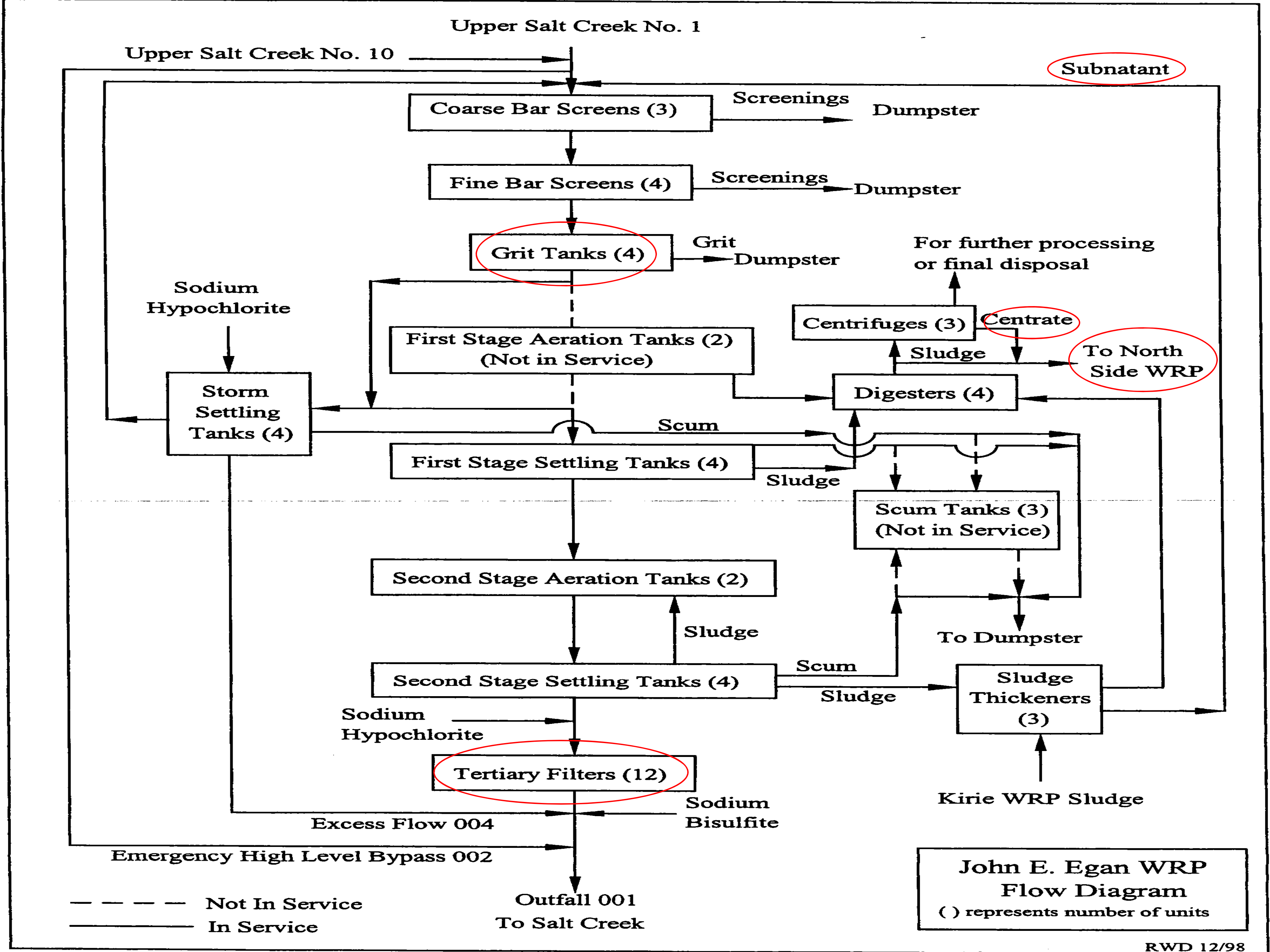
LAGOON 17



LAGOON 17



LAGOON 9

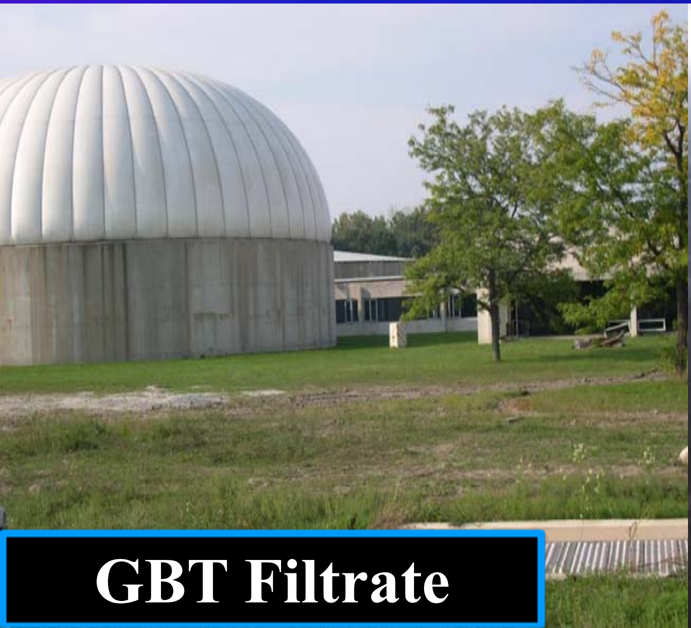


Upper Salt Creek No. 1
Upper Salt Creek No. 10
Subnatant
Coarse Bar Screens (3)
Screenings
Dumpster
Fine Bar Screens (4)
Screenings
Dumpster
Grit Tanks (4)
Grit
Dumpster
For further processing
or final disposal
Sodium
Hypochlorite
Centrifuges (3)
Centrate
First Stage Aeration Tanks (2)
(Not in Service)
Sludge
To North
Side WRP
Storm
Settling
Tanks (4)
Digesters (4)
Scum
First Stage Settling Tanks (4)
Sludge
Scum Tanks (3)
(Not in Service)
Second Stage Aeration Tanks (2)
Sludge
To Dumpster
Scum
Second Stage Settling Tanks (4)
Sludge
Sludge
Thickeners
(3)
Sodium
Hypochlorite
Tertiary Filters (12)
Kirie WRP Sludge
Sodium
Bisulfite
Excess Flow 004
Emergency High Level Bypass 002
Not In Service
In Service
Outfall 001
To Salt Creek
John E. Egan WRP
Flow Diagram
( ) represents number of units
RWD 12/98



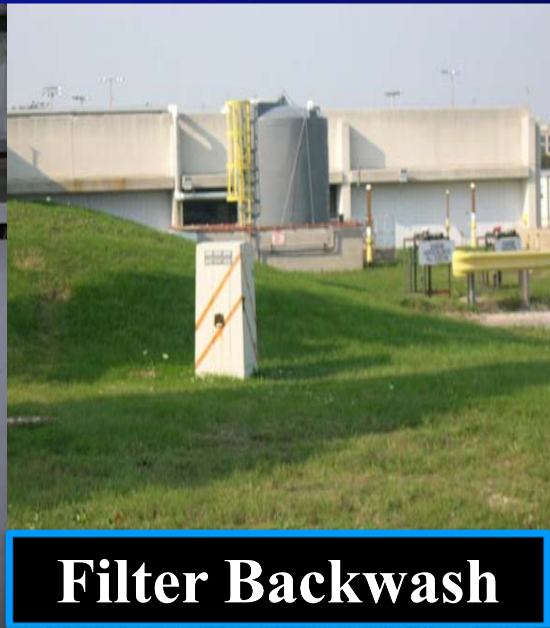
Grit Classifier

SAMPLING LOCATIONS AT EGAN WRP



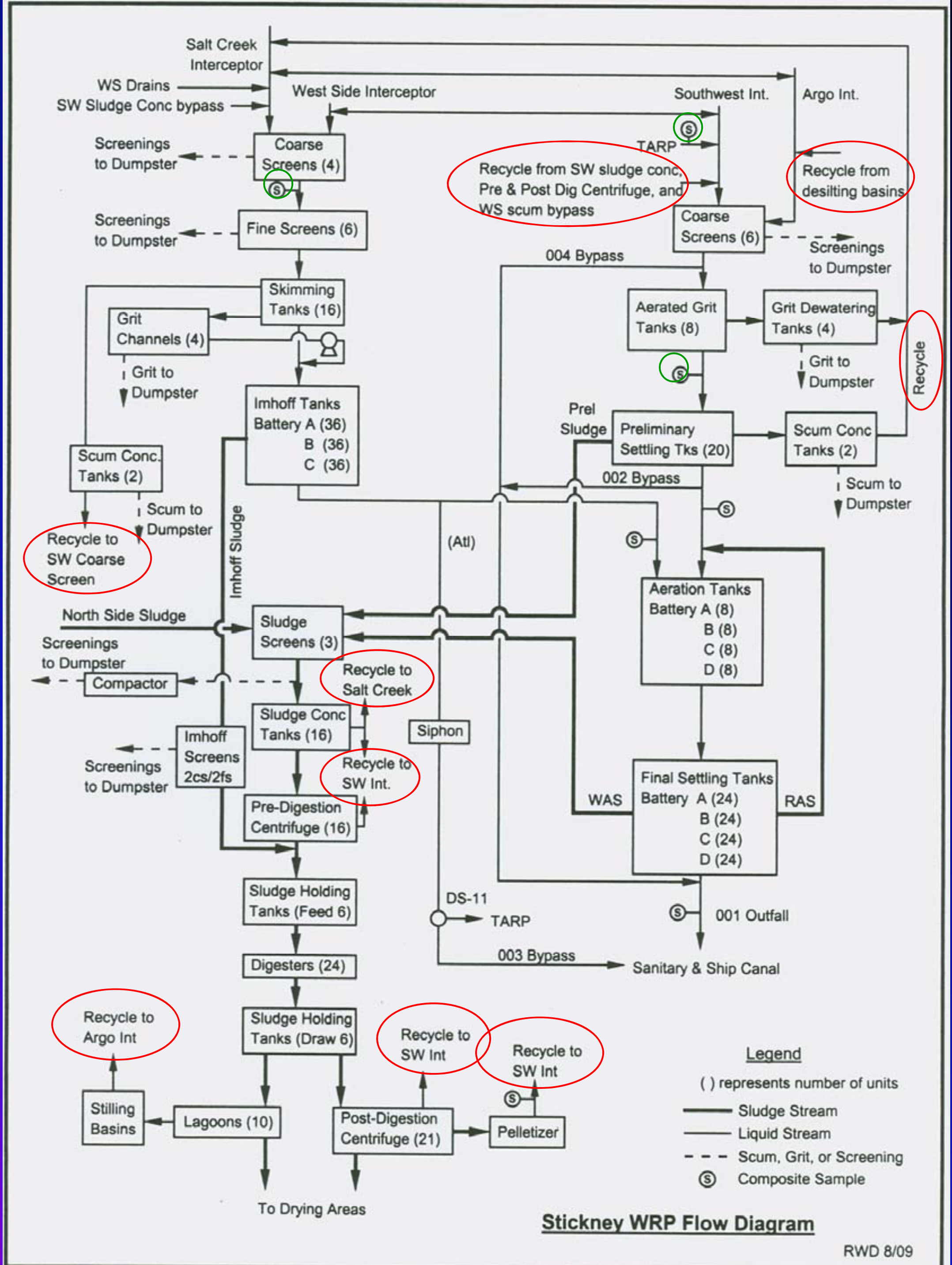
GBT Filtrate

Centrate



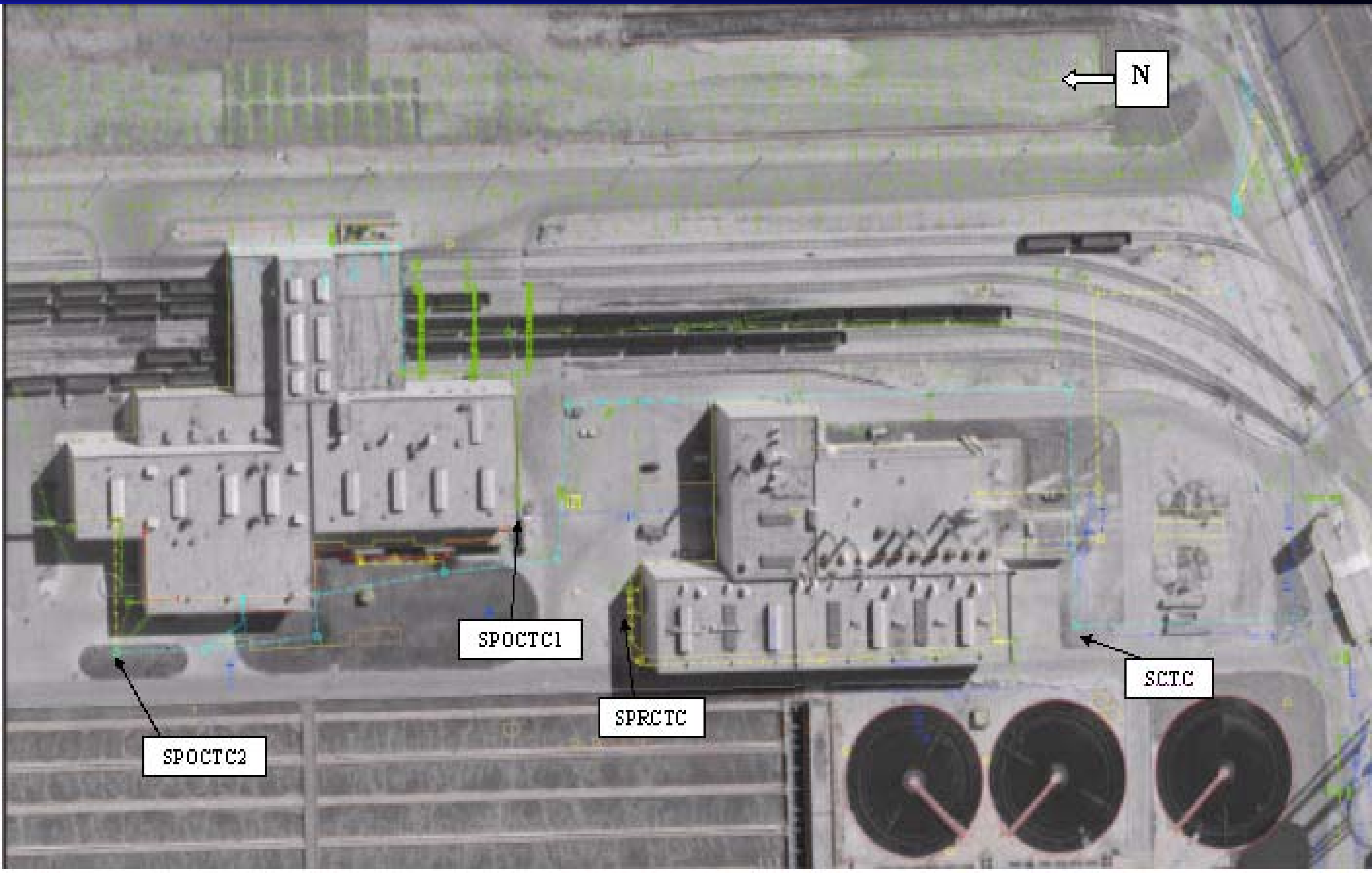
Filter Backwash

STICKNEY WRP



SAMPLING LOCATIONS AT STICKNEY WRP

SAMPLING LOCATIONS AT PRE AND POST-CENTRIFUGE FACILITIES AT STICKNEY WRP



SPOCTC1 OLD POST CENTRIFIUGES

SCTC COMPOSITE CENTRATE


HYDROGEN
GAS ALARM


CONCENTRATION BUILDING
BUILDING NO. 102
CAUTION
HOT WORK PERMIT REQUIRED IN THIS AREA
HAVE PORTABLE GAS DETECTION EQUIPMENT WITH YOU WHEN FIXED SYSTEM IS NOT WORKING
FIRE HYDRANT VALVE

SAMPLING PLAN

- TIME COMPOSITES COLLECTED EVERY 15-MINUTE APART OVER 24-HOUR PERIOD TO MAKE APPROXIMATELY 2 GALLONS AT EACH STATION

- STICKNEY AND CALUMET WRP - ONCE A WEEK (7/30/08-7/29/09)

- EGAN WRP - TWICE A WEEK (8/11/09-9/3/09)

CHARACTERISTICS OF RECYCLE STREAMS AND RAW SEWAGE AT CALUMET WRP (7/30/08-7/29/09)

Parameter	Raw Sewage	Centrate	Gravity Supernatant	Lagoon 9 (East)	Lagoon 17 (West)	Combined Recycle
Flow, MGD	307	0.6	4.0	0.45	0.45	5.5
BOD_5, mg/L	113	139	158	50	118	143
SS, mg/L	148	768	493	99	653	504
NH_3-N, mg/L	10	286	7	80	308	68
TKN, mg/L	21	495	33	128	487	128
Tot P, mg/L	5	32	17	11	53	21

CHARACTERISTICS OF RECYCLE STREAMS AND RAW SEWAGE AT EGAN WRP (8/11/09-9/3/09)

Parameter	Raw Sewage	Centrate	Filter Backwash	GBT Filtrate	Grit Classifier	Combined Recycle
Flow, MGD	24	0.25	1.8	1	0.12	3.17
BOD_5, mg/L	267	80	13	393	265	148
SS, mg/L	344	695	59	998	286	414
NH_3-N, mg/L	17	277	2	4	17	25
TKN, mg/L	37	289	7	58	35	46
Tot P, mg/L	9	23	5	32	9	15

1. **Centrate is pumped to Northside WRP**
2. **Combined recycle concentrations include centrate input**

CHARACTERISTICS OF RECYCLE STREAMS AND RAW SEWAGE AT STICKNEY WRP (7/30/08-7/29/09)

Parameter, MGD or mg/L	Raw Sewage SW+WS	Post centrifuge centrate New	Post centrifuge centrate Old	Pre-centrifuge centrate	Centrate composite	Gravity Concentration Tanks Overflow	Combined Recycle
Flow	804	1.4	1.4	10.9	13.7	13	26.7
BOD_5	192	79	127	853	1,085	371	677
SS	322	336	452	929	1,307	731	978
NH_3-N	15	291	481	20	174	15	83
TKN	30	332	564	120	266	65	151
Tot P	6	36	54	45	56	23	37

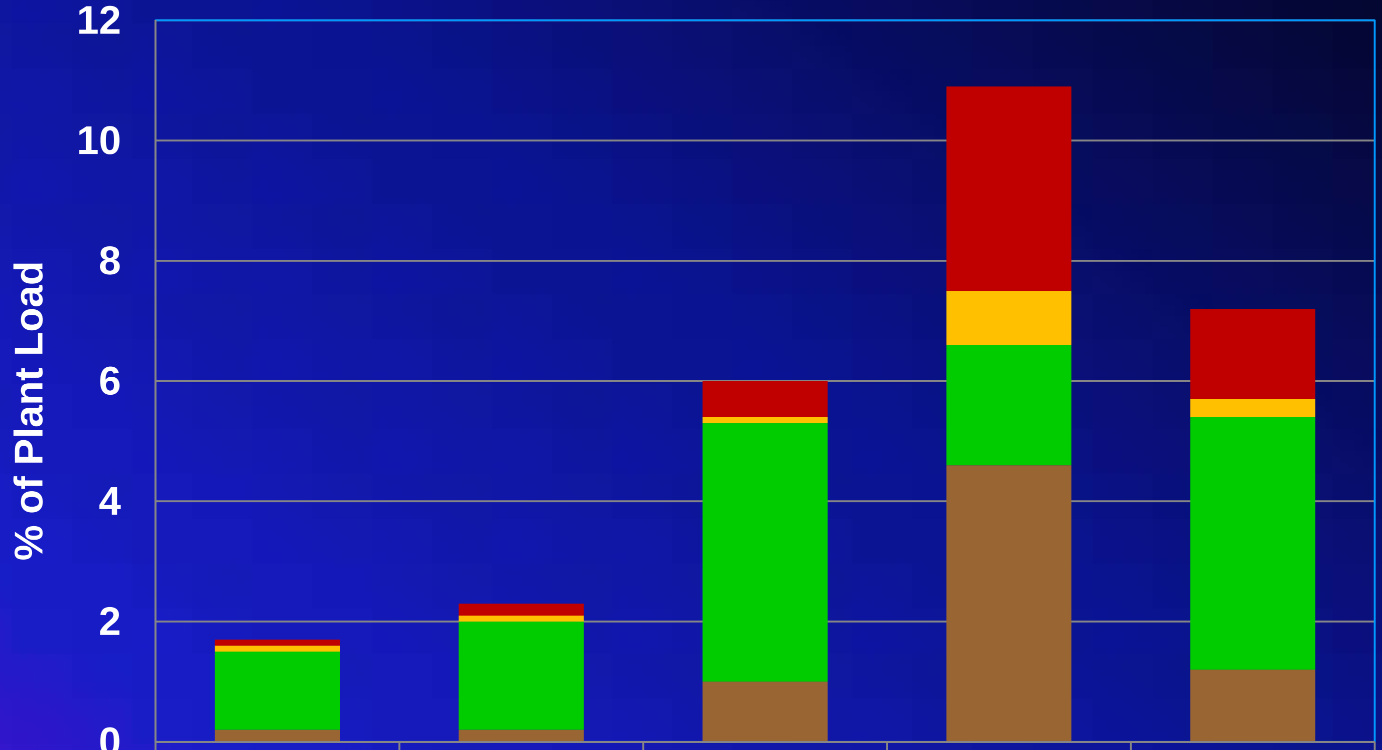
COMPARISON OF FLOW AND CHARACTERISITCS OF CENTRATE STREAMS AT VARIOUS PLANTS

WWTP	Flow, m^3/d	Centrt Flow, m^3/d	%	NH_4-N, mg/L	sCOD	TP, mg Per L	pH	Alkalinity, mg/L as $CaCO_3$	sCOD/NH_4	Authors
Wards Island, NY, USA	**937,500**	**19,125**	**2.04**	**886**	**431**	**79**	**7.7**	**2,943**	**0.50**	**Katehis et al. (1998)**
Hunts Point, NY, USA	**750,000**	**14,250**	**1.9**	**1,312**	**793**	**112**	**7.9**	**5,265**	**0.60**	**Katehis et al. (1998)**
26th Ward, NY, USA	**318,750**	**7,125**	**2.2**	**801**	**494**	**84**	**7.8**	**3,144**	**0.62**	**Katehis et al. (1998)**
Bowery Bay, NY, USA	**562,500**	**5,250**	**0.9**	**672**	**371**	**116**	**7.5**	**2,100**	**0.55**	**Katehis et al. (1998)**
Kohlfurth, Germany	**103,680**	**300**	**0.3**	**628**	**1,760**	**-**	**-**	**-**	**2.8**	**Kolish and Rolfs (2000)**
Calumet WRP	**1,160,460**	**2,268**	**0.2**	**286**	**260**	**32**	**7.9**	**1,529**	**0.91**	**Patel (2010)**
Egan WRP	**91,098**	**945**	**1**	**277**	**201**	**17**	**7.6**	**228**	**0.73**	**Patel (2010)**
Stickney WRP	**3,039,120**	**10,433**	**0.3**	**386**	**300**	**11**	**7.9**	**494**	**0.78**	**Patel (2010)**

RECYCLE CONTRIBUTION TO INFLUENT FLOW AT CALUMET WRP (7/30/08-7/29/09)

Flow, MGD	307
BOD_5	289,323
SS	378,936
TKN	53,768
Tot P	13,314

Loadings in lbs/day

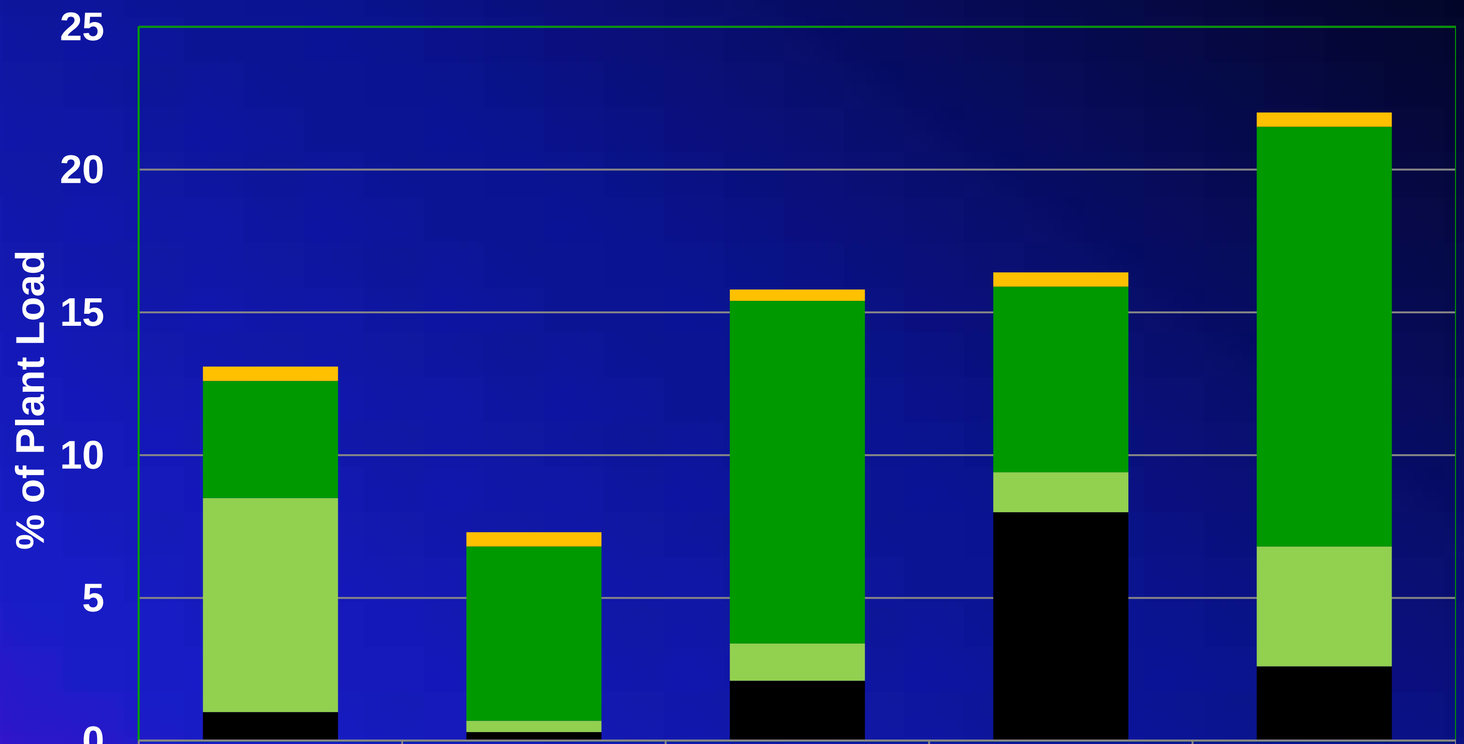


	% Flow	BOD5	SS	TKN	Tot P
Lagoon 17 (West)	0.1	0.2	0.6	3.4	1.5
Lagoon 9 (East)	0.1	0.1	0.1	0.9	0.3
Supernatant	1.3	1.8	4.3	2	4.2
Centrate	0.2	0.2	1	4.6	1.2

RECYCLE CONTRIBUTION TO INFLUENT FLOW AT EGAN WRP (8/11/09-9/3/09)

Flow, MGD	24.1
BOD_5	53,573
SS	69,142
TKN	7,477
Tot P	1,809

Loadings in lbs/day

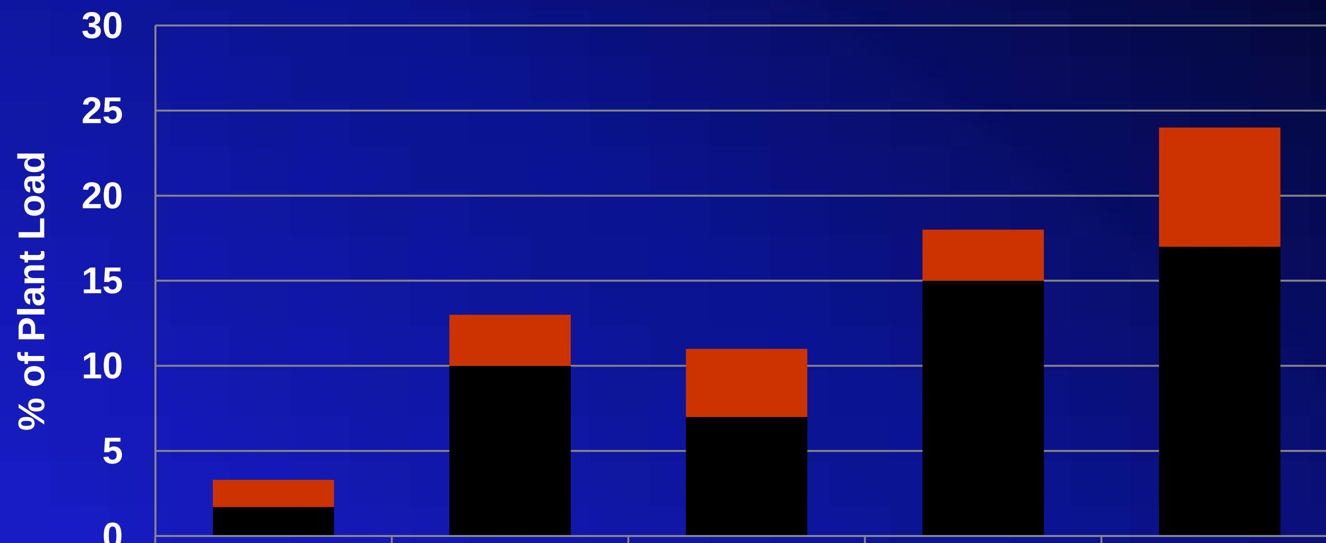


	% Flow	BOD5	SS	TKN	Tot P
Grit Classifier Recycle	0.5	0.5	0.4	0.5	0.5
GBT Filtrate	4.1	6.1	12	6.5	14.7
Filter Backwash	7.5	0.4	1.3	1.4	4.2
Centrate	1	0.3	2.1	8	2.6

RECYCLE CONTRIBUTION TO INFLUENT FLOW AT STICKNEY WRP (7/30/08-7/29/09)

Flow, MGD	804
BOD_5	1,289,469
SS	2,157,382
TKN	202,401
Tot P	36,861

Loadings in lbs/day



	% Flow	BOD5	SS	TKN	Tot P
Gravity Concentration Tanks Overflow	1.6	3	4	3	7
Centrate composite	1.7	10	7	15	17

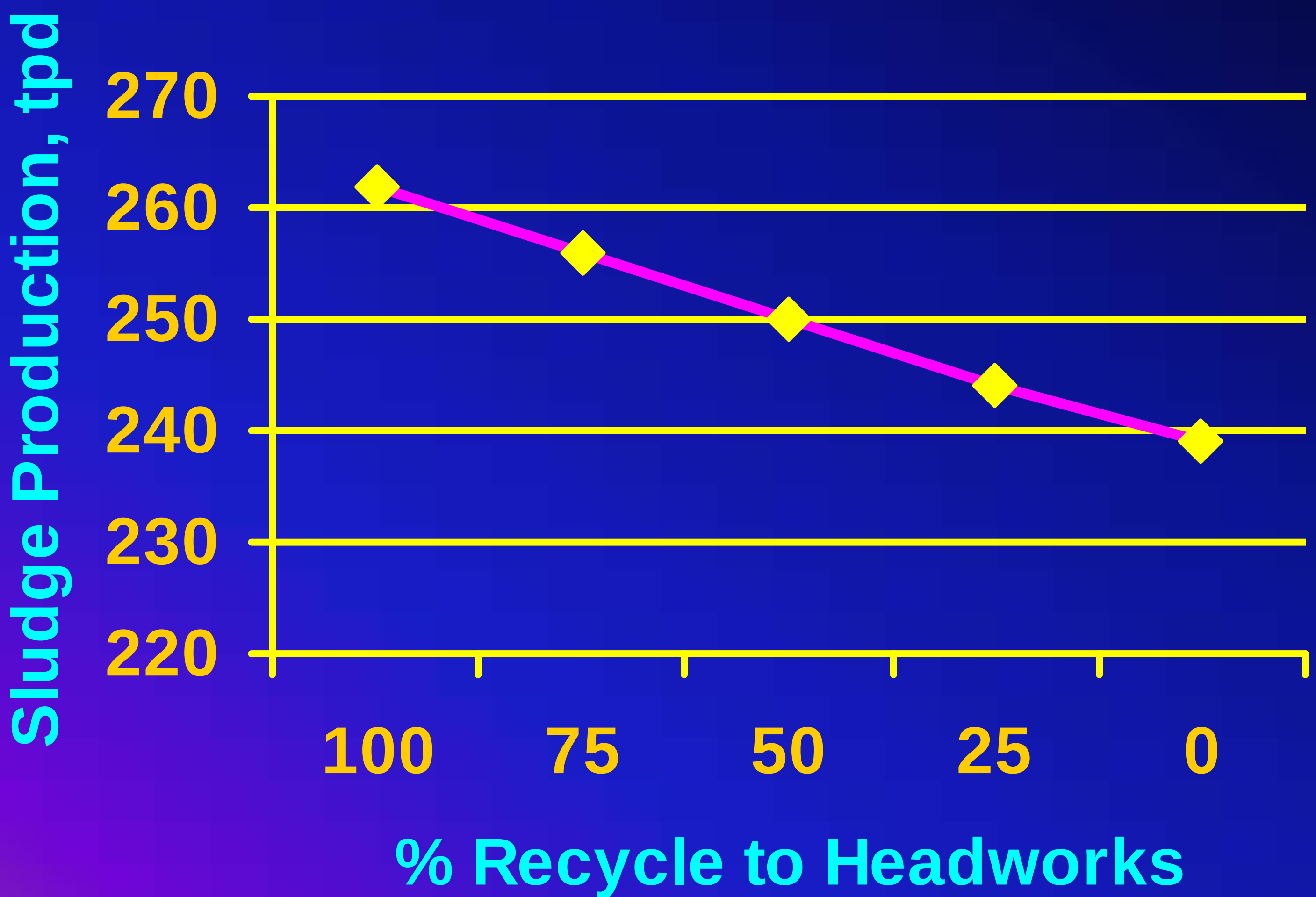
STICKNEY WRP GPS-X MODEL

- Black & Veach 2000 GPS-X – No recycle lines
- Modifications – recycle lines to headworks or final outfall via sidestream treatment unit
- Baseline data correspond to study period with plant and LIMS data and calibrated throughout the process train based on 100% recycle to headworks
- Added a DO controller to evaluate potential energy savings due to aeration
- Each scenario consisted of three 100-day simulations to assure stability

STICKNEY GPS-X BASELINE MODEL: 100% RECYCLE TO HEADWORKS

Parameter	WS Influent		SW Influent + TARP		All Recycle		Final Effluent	
Flow, MGD	431		340		26		772	
SS, mg/L (tpd)	150	(270)	530	(809)	988	(108)	4.8	(15.5)
$CBOD_5$, mg/l (tpd)	77	(139)	169	(258)	332	(36)	1.5	(4.9)
TKN, mg/L (tpd)	19	(34)	47	(71)	156	(17)	0.9	(3.0)
TP, mg/L (tpd)	4	(6)	9	(14)	37	(4)	0.8	(1.2)
NH_3-N, mg/L (tpd)	10	(18)	19	(29)	94	(10)	0.1	(0.2)

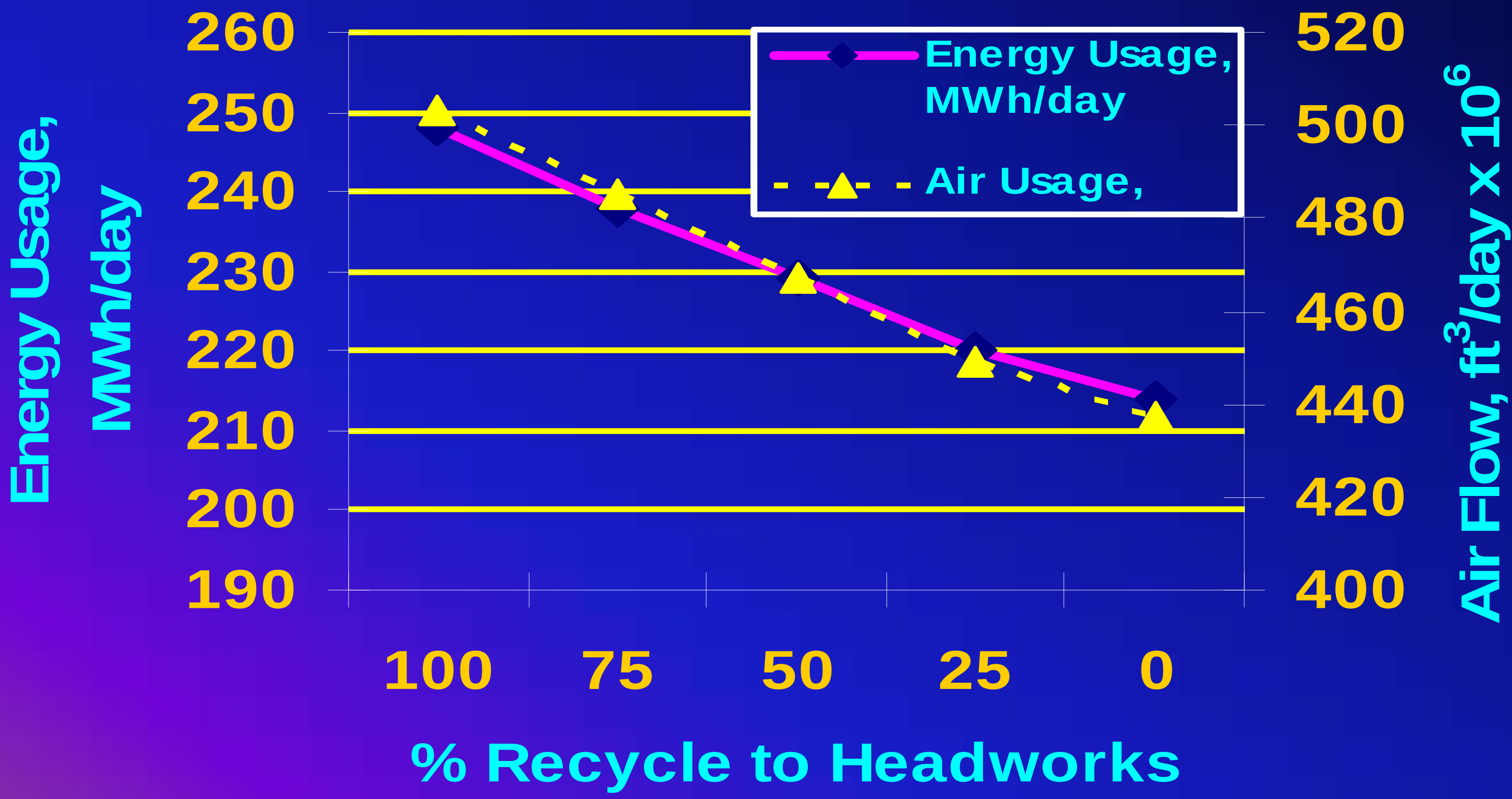
Stickney GPS-X Model: Sludge Production as a Function of Percent Recycle to Headworks



Stickney GPS-X Model: Air and Energy Usage as a Function of Percent Recycle to Headworks

Normal plant operation : 496 X 10^6 cft/day & aeration energy 368 MWH/day

DO control set point of 4.5 mg/L. Results in ~15% savings



THE OPTIONS

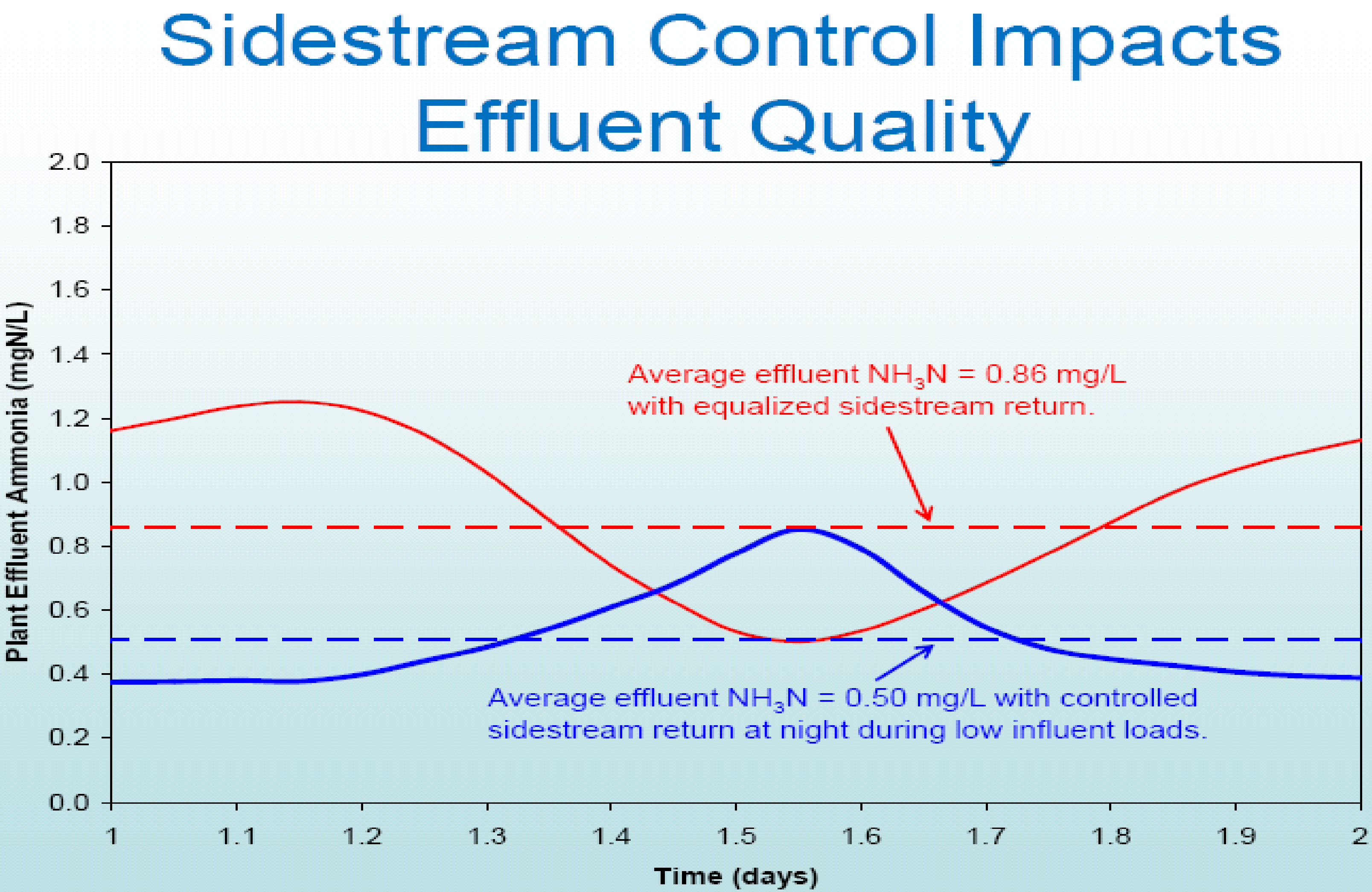
1. Maintain Present Operation

2. Recirculate But Equalize the Flows

3. Use As a Liquid Fertilizer

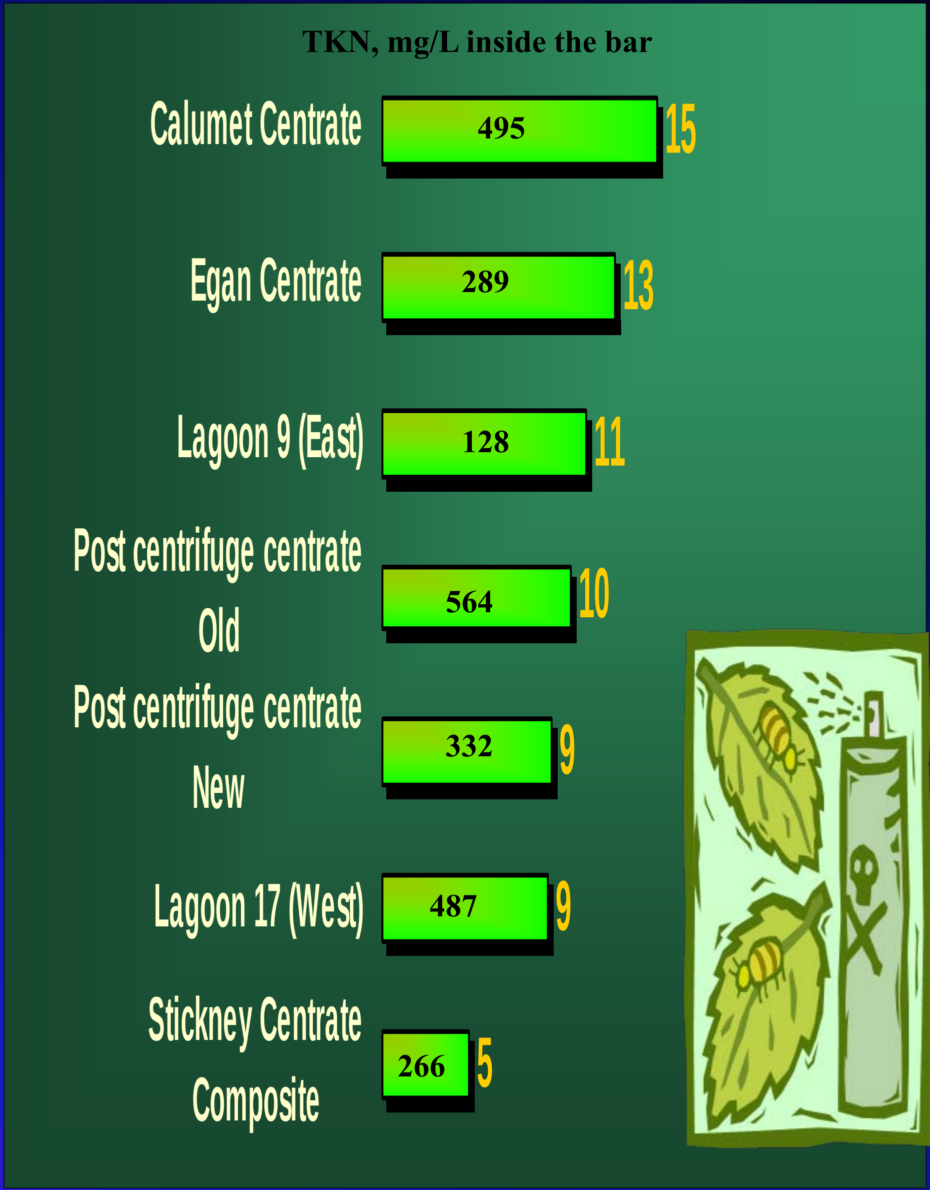
4. Remove or Recover Nutrients

OPTION 2: CONCEPTUAL REPRESENTATION OF RECYCLE FLOW EQUALIZATION



OPTION 3: LIQUID FERTILIZER (N:P :: >5 to 1)

- A total of 18 MGD (37% flow) from 7 streams out of 13
- Benefits to the Environment
  - Conserve water/phosphate reserves
  - Recycle materials locally
  - Avoid greenhouse gas emissions (~8 tons CO_2e per ton fertilizer produced)
  - Environmental Sustainability
- Drawbacks
  - Transport based on volume required
  - Heavy metals



OPTION 3: AN OFFICIAL SEAL OF APPROVAL FOR LIQUID FERTILIZER

OPTION 4A: TREAT TO REMOVE NUTRIENTS. WHY?

OPTION 4B: TREAT TO RECOVER NUTRIENTS. WHY?

Option 4A: Why to Treat Recycle Streams?

1. Stringent Regulatory Limitations
   - **TP (Water Quality)**
   - **TN (Water Quality)**
   - **Nitrate (SDWA)**
   - **NH_3-N (NPDES for Aquatic Toxicity)**
   - **Bottle-necks in Permit (Daily Max, Wkly Avg. etc.)**
2. Sustainable Treatment for Nutrient Removal & Entire Plant
   - **Requires less energy (reduction in C footprint)**
   - **Increases Process Capacity at Low Temperatures**
3. Common Treatment for Multiple Plants
   - **More TP and TN @ SWRP from NSWRP/EWRP**
   - **Less Capital & OM Costs**
   - **Reliable Operations @ One Location than Two Small-scale Operations**
4. Adjustment in Plant Operations
   - **Variable Thickening and Dewatering Process Schedule**
   - **Impact if Only One Shift or Certain Days (HPWRP, CWRP)**
   - **Increased use of BNR**
   - **Major Plant Upgrade (e.g. Master Plan)**

Option 4B: Why to Recover Nutrients?
FACTS AND PERSPECTIVE ON P

–Phosphorus Supply Challenges

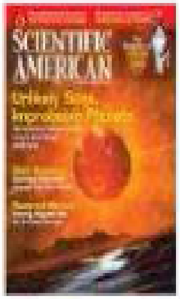
–Nutrient Recovery from a global perspective (7 billion humans and 63 billion live stock)

–1.5% mining of rock phosphate can be reduced if P recovery around the world (Shu et. al. 2006)

–"We may be able to substitute nuclear power for coal, and plastics for wood, and yeast for meat, friendliness for isolation – but for phosphorus there is neither substitute nor replacement" Isaac Asimov

–Conserve phosphate reserves, recycle P locally, reduce GHGs and environmentally sustainable

Phosphorus is an "Emerging Issue"



From the June 2009 Scientific American Magazine | 28 comments

Phosphorus Famine: The Threat to Our Food Supply

This underappreciated resource--a key component of fertilizers--is still decades from running out. But we must act now to conserve it, or future agriculture could collapse

By David A. Vaccari

From The Times

June 23, 2008

Scientists warn of lack of vital phosphorus as biofuels raise demand

Leo Lewis, Asia Business Correspondent

NEWS SCAN

Scientific American – November 2009

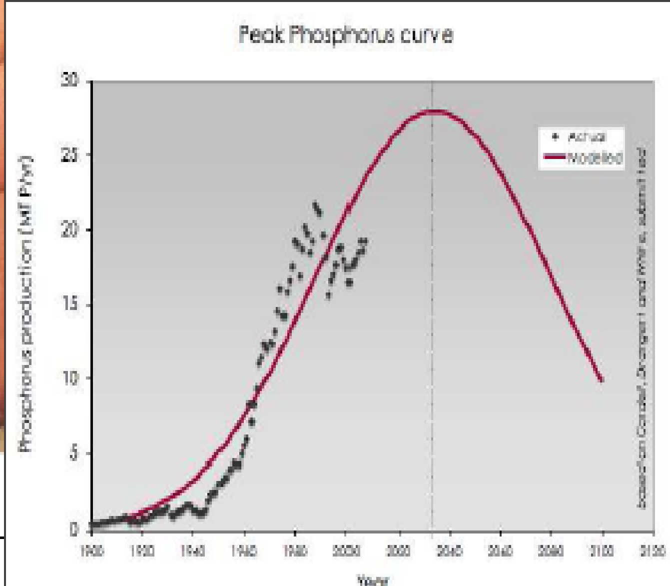
Technology

Sewage's Cash Crop

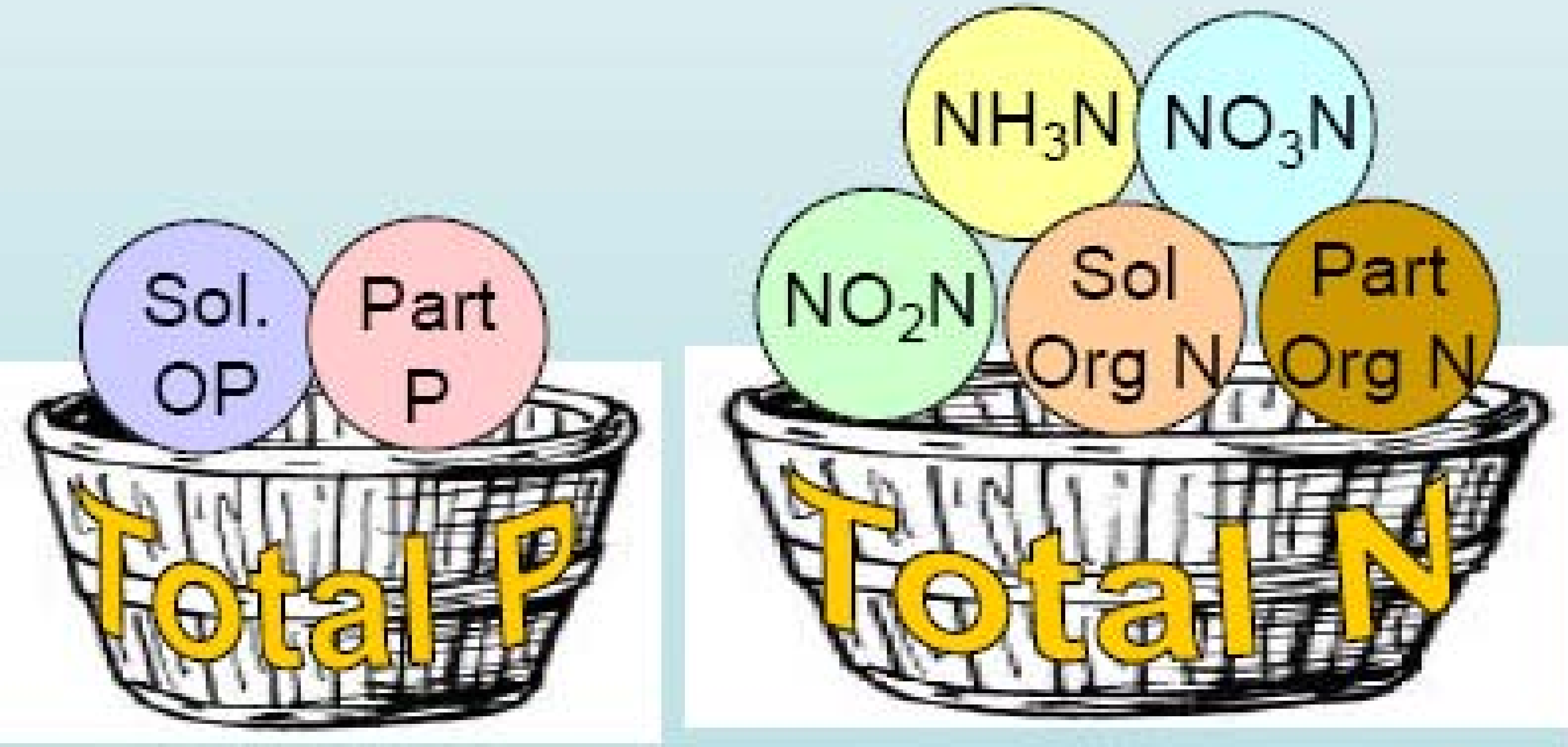
How flushing the toilet can lead to phosphorus for fertilizers BY KATHERINE TWEED

Tucked away in Oregon's Willamette Valley, three massive metal cones could help address the world's dwindling supply of phosphorus, the crucial ingredient of fertilizers that has made modern agriculture possible. The cones make consistently high-quality, slow-release fertilizer pellets from phosphorus recovered at the Durham Advance Wastewater Treatment Facility, less than 10 miles from downtown Portland. By generating about one ton

WASTEWATER WONDER: Ostara's Crystal Green, a slow-release fertilizer, incorporates phosphorus retrieved from sewage streams.



Treatment Technologies for Options 4A and 4B



TREATMENT TECHNOLOGIES

Biological

- CND
- AND : Bioaugmentation w/ and w/o RAS (In-Nitri, BABE, BAR etc.)
- Nitritation/Denitritation and Deammonification (SHARON, ANNAMOX, SBR, STRASS,MAUREEN, OLAND, CANON etc.
- Algae Based (stabilization/oxidation ponds, Algaewheel®, Algal Turf Scrubber® Technology, Algae farms)

Physicochemical

- Ammonia Stripping (ARP via Steam, Hot Air, & CAST Vacuum Distillation)
- IE
- MAP based technologies (Metal Salts, Ostara, Pro-Corp)

SCREENING OF TECHNOLOGIES

•CND: Alkalinity deficiency 25, 88, 82% at CWRP, EWRP and SWRP, respectively, impact on aeration cost, ammonia toxicity etc.

•Bioaugmentation: pH, temp, TDS/osmotic pressure changes in main treatment so augmented nitrifiers predated

•Nitritation/Denitritation/Deammonification: Many premature and emerging technologies - not suitable for full-scale of District plants

•Algae Based: Settling and possible SS violation, premature for full-scale, polymer costs

•Air Stripping: 2000:1 Air to NH_3 ratio, pH ~11, ~55C air temp – pH and temp control, scaling etc.

•Steam Stripping: Heat exchanger & stripper fouling, 300 - 500 to 1 steam to liquid ratio, high temp maintenance and associated energy cost

•IE: Pretreatment such as filtration needed, salt deposits within resin bed, piping etc.

NITRIFICATION, NITRITATION-DENITRITATION AND DEAMMONIFICATION FUNDAMENTALS

- CND: Alkalinity – 7.14 g/g NH_4
  : O_2 – 4.57 g/g NH_4
  : C – 3 to 4.5 g COD/g of NO_3

Nitritation/Denitritation:
: O_2 – 25% less wrt CND
: C – 40% less so 40% less biomass

- Deammonification:
  : O_2 – 62% less wrt CND
  : C – 100% less so much reduced biomass
  : Reduced CO_2 and N_2O

SINGLE REACTOR FOR HIGH ACTIVITY AMMONIA REMOVAL OVER NITRITE

Features:

• At 25-40 C the nitrifying bacteria have a higher growth rate than the nitrafying bacteria.

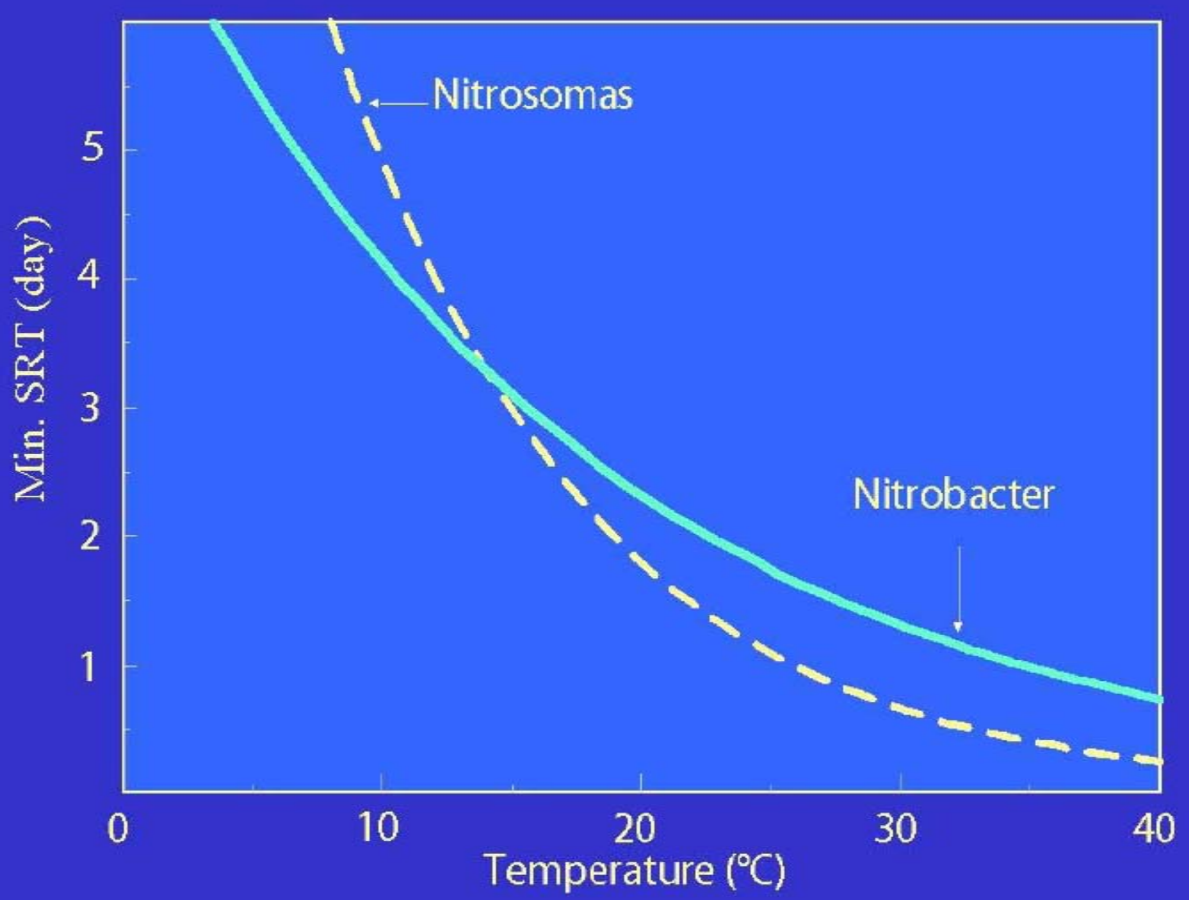
•pH 6.6 to 7.2 for AOBs and DO 0.3 to 2 mg/L

•SRT=HRT

• At a 1 day SRT/HRT the reactor acts as a selector converting ammonia to nitrite

• The process then allows for denitrification via nitrite.

BIOLOGICAL GROWTH RATE – SRT_{MIN} AS A FUNCTION OF TEMPERATURE



SHARON PLANTS

Location	Capacity(pe)	Nitrogen (lbs N/day)	Operation
Utrecht, Netherlands	400,000	2000	1997
Rotterdam-Dokhaven	470,000	1900	1999
Zwolle	200,000	900	2003
Beverwijk	320,000	2,600	2003
Groningen-Garmerwolde	300,000	5,300	2004
Den Haag-Houtrust	430,000	2,900	2004
New York-Wards Island	250 MGD	12,700	2008
Geneva, Switzerland	115 MGD	3,600	2009

WARDS ISLAND, NEW YORK SHARON PLANT

Goals:

- **To reduce TN discharge from the Wards Island facility into the East River/Long Island Sound/NY Harbor**
- **To reduce TN discharge associated with the solids handling at multiple NYC-DEP facilities**
- **To utilize a highly efficient process for cost savings associated with TN**

WARDS ISLAND, NEW YORK – 250 MGD

Solids from 3 Plants

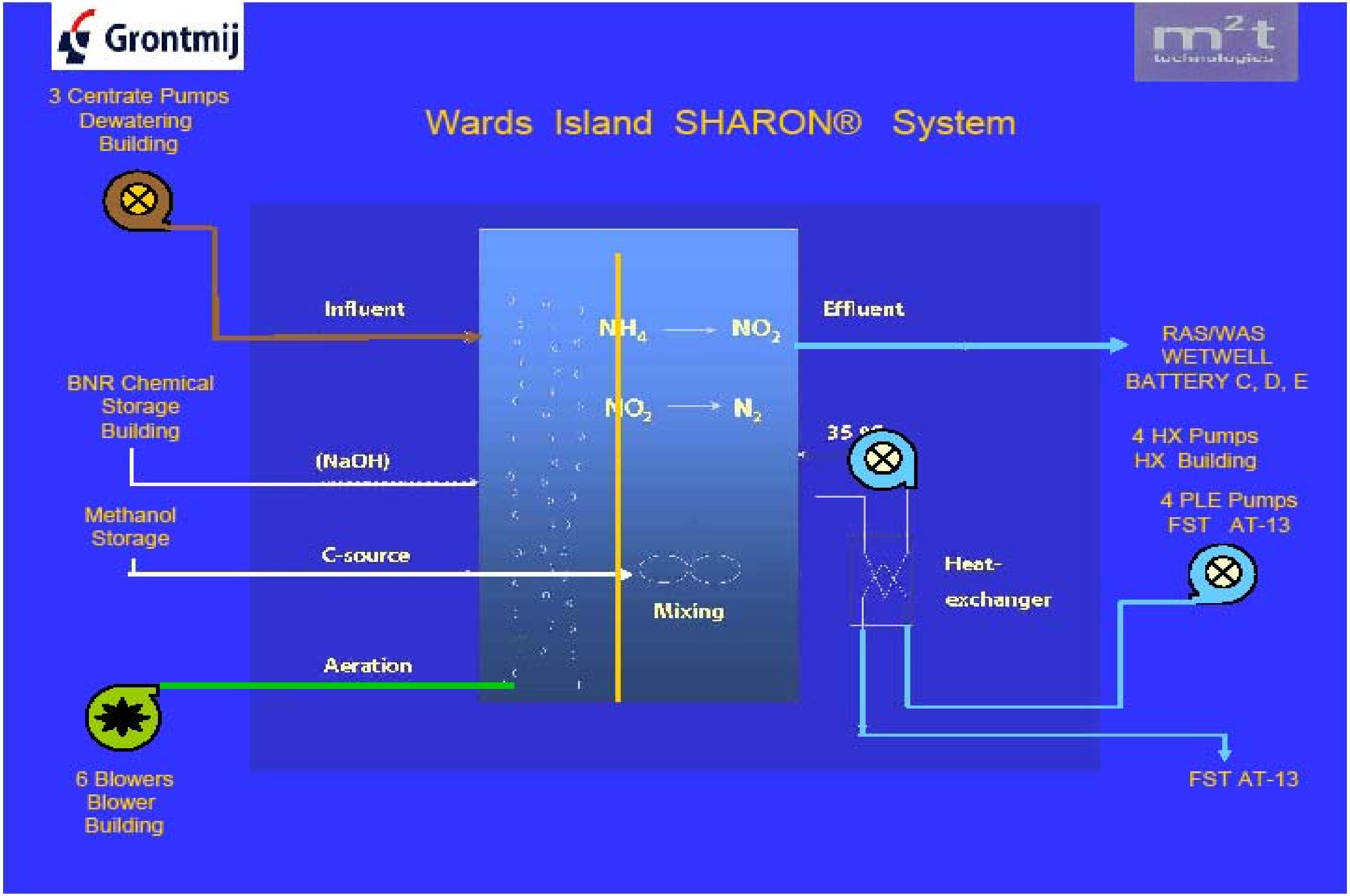
First in the USA and the largest in the world

Two Parallel SHARON Reactor Trains :

Design / Peak Flow : 1.85 / 2.31 MGD
NH_3 : 700 mg/l
10,800 lbs./day
(~30% N-Load)
TSS : 600 mg/L
COD : 950 mg/L
Temp. : 28 – 32 C
N-Removal : >95%

Benefits:

- Removes 25-35% of ammonia load to main stream nitrification tanks. Over 2.5 tpd TN removed.
- Reduces oxygen required for nitrification by 25%. Lowering both capital and M&O costs.
- Reduces methanol required for denitrification by 40%. Lowering both capital and M&O costs.
- Reduces the size of main stream reactors, especially associated with respect to denitrification processing.



Courtesy of Mr. Keith Beckmann, P.E., Chief - Process Planning of NYCEP, NEW YORK

ANaerobic AMMonium OXidation Process

•Observation of simultaneous removal of NH_4-N and production of N_2 in the Netherlands in 1986 led to ANAMMOX technology

•A derivative of SHARON process - ANAMMOX bacteria/autotrophic bacteria accomplish N-removal during nitrification & denitrification

•NH_4-N is used as an electron donor in lieu of organic carbon source such as methanol

•50 % of NH_3-N is oxidized to NO_2-N in a SHARON reactor and equal ratio of NH_4-N to NO_2-N liquor is sent to the second ANAMMOX reactor, where the ANAMMOX bacteria reduce nitrite to N_2

•Both processes can take place in a single reactor where two guilds of bacteria form compact granules (Kartal et. al. 2010)

Enriched culture of anaerobic ammonium oxidizing bacteria
(Radboud University Nijmegen) Kinestetika 20:44, 15 August 2007 (UTC)

ANAMMOX Process Benefits (STOWA)

- 62% Reduction in O2 wrt conventional nitrification to nitrate

- No organic carbon needed for denitrification

- Reduced biomass production

- Operating costs reduction by 90% compared to CND (van Loosdrecht, 2004)

- Reduction in GHG gases by 95% possible because of the consumption of CO_2 and a lack of production of nitrous oxide (N_2O)

- N_2 gas can partially mix the contents which can reduce the mixing energy needs

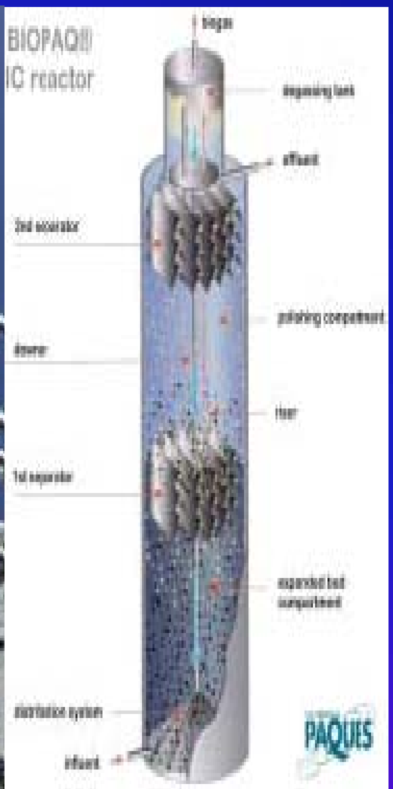
- Sustainable process wrt economic and operational perspectives

ANAMMOX Process Full-scale Applications and Challenges

- The DCWASA, City of Baltimore and the NYCDEP spent considerable effort on this technology, DCWASA under design stage for sidestream

- As of 2010, 20 installations in Europe and 2 in design in the US

- A full-scale test for raw sewage to begin in Strass Austria and pilot-scale at HRSD



- Very slow growth rate of ANAMMOX bacteria need 100 to 200 days after initial seeding to reach full capacity and produce low sludge production. Due to slow growth rate, sludge retention is very important and typical SRT is 1.5 to 2 days

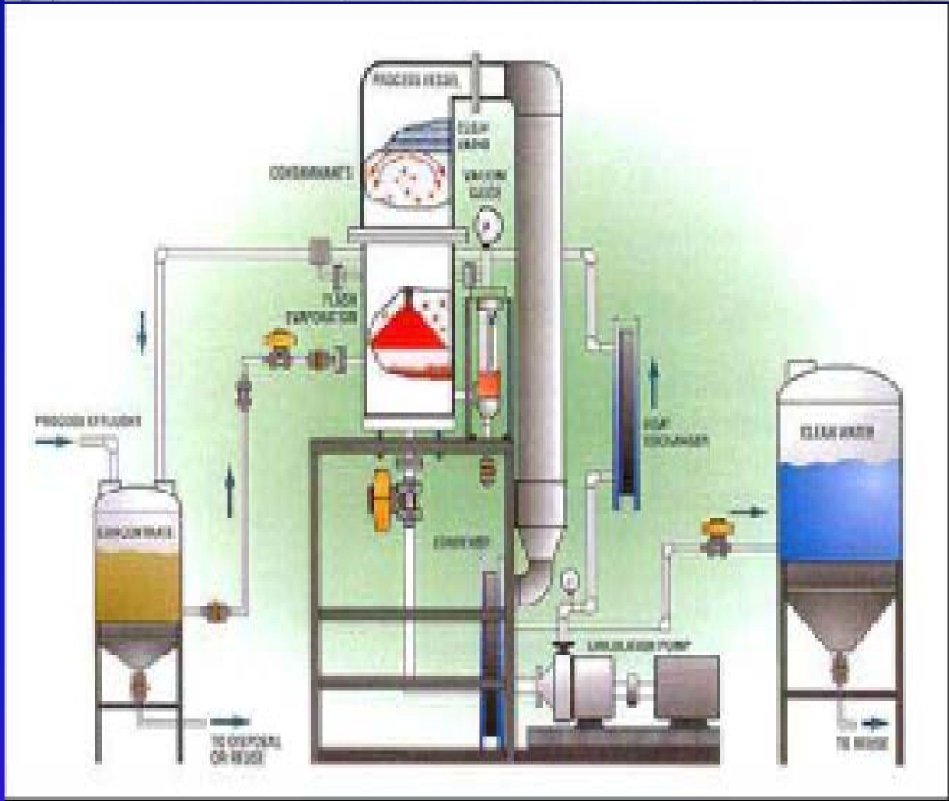
- Higher nitrite concentration for extended period of time is detrimental to ANAMMOX bacteria

- Challenge is to make it suitable for the treatment of wastewater with lower nitrogen concentrations and low temperatures.

Controlled Atmosphere Separation Technology Vacuum Distillation (CASTion)

- CASTion – A subsidiary of ThermoEnergy
- Proprietary tech for recovery of chemicals and water in many industries including WRPs
- Up to 40% NH_3 recovery as NH_4SO_4
- Flash Vacuum Distillation
  - Atomizer
  - Low Vacuum
- Continuous or batch
- Physical principles
  - Uses partial pressures to separate materials
  - Uses sensible heat of wastewater to increase efficiency
- Combined with other technologies (IE, MBR etc) depending on application

Key Variables : pH (10 to 12), feed temp (90 to 120 F, pressure –ve 26 to 29", process time 6 to 12 min, recirculation rate 15 to 30 turnovers



CASTion PILOT-SCALE RESULTS

- Midsized Aberdeen, WA filtrate: 80% of initial NH_3 of 550 ppm in 7 min at 11.5 pH and T 100 to 120 F
- NYCDEP 26th Ward centrate pilot tests: 80% of initial NH_3 of 815 ppm in 3 min at >12 pH and T 90 F
- Also maintained <100 ppm effluent NH_3 from the initial 550 ppm for 28 min at 11.2 to 11.4 pH and T 100 F
- 1.2 MGD centrate CASTion project at 26th Ward plant to begin Qtr 2, 2010.
- City of Tacoma, WA is to start on-site pilot tests for $50,000 (Off-site tests for $3 to 4000)

Benefits and Drawbacks / Limitations :

- + Potential for substantial reduction in methanol requirement for BNR because it returns alkalinity and COD for BNR
- - Filters, IE pretreatment, pH and temp increase make it costly depending upon centrate quality

STRUVITE – A BUILDING BLOCK FOR MAP BASED TECHNOLOGIES

SEWER PIPES FROM EPHESUS (FOUNDED 300 B.C.)

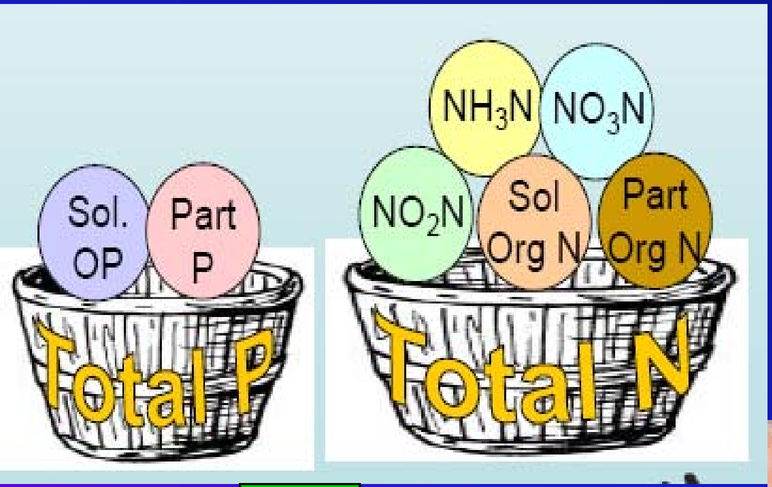
$$NH_3 + PO_4 + Mg + 6\ H_2O \longrightarrow \downarrow NH_3PO_4Mg * 6\ H_2O$$

- pH dependent, pH pushes the reaction. $CO_2\uparrow$ = pH $\uparrow$ = struvite$\downarrow$
- Removes equi-molar ammonia and phosphorus
- AKA: Struvite, MAGamp, MAP
- Mg limiting element

1 kg of struvite can be recovered from 100 m^3 wastewater & applied on 2.6 ha arable land (Shu L. et. al.)

MAP Based Technologies for P Recovery from Resource Streams

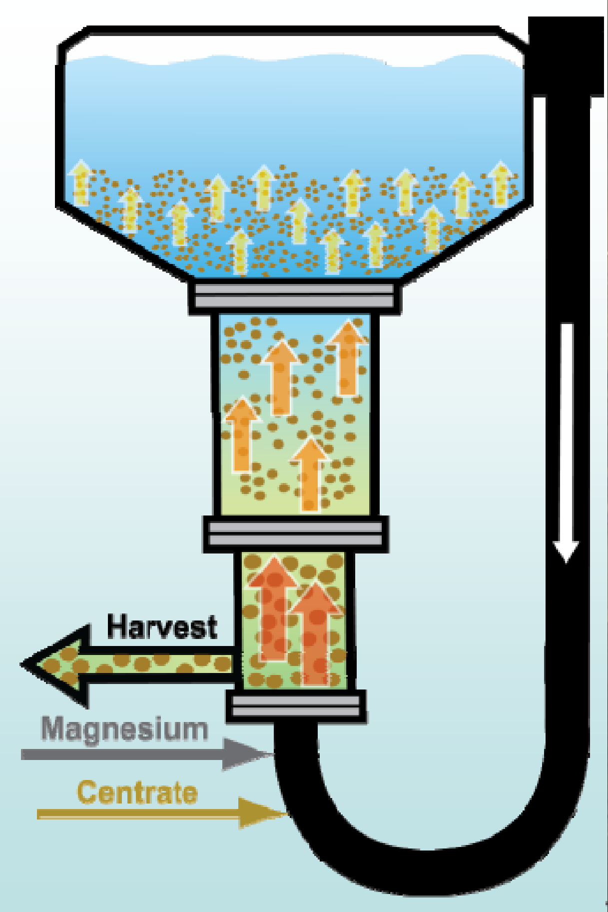
OSTARA & PROCORP, LLC



Pilot-scale Prills

Full-scale Prills

PEARL™ Process Operation



OSTARA NUTRIENT RECOVERY TECHNOLOGIES INC.

PREFERRED APPLICATION

- Plant size >5 MGD
- Plant processes:
    - Anaerobic zone (Bio–P)
    - Anoxic zone for denitrification/biological selectors
    - Anaerobic digestion & dewatering
- PEARL™ process feed stream desired characteristics:
    - PO_4–P >75 mg/L, and > 140 lbs/day for 90% + P removal
    - TSS <1000 mg/L
- Struvite and/or vivianite formation challenges
- <10 Year Payback / Instant Net Savings
- At present, not feasible at District plants but may become feasible with Bio-P treatment

OSTARA TREATMENT AT DISTRICT WRPS

- NOT FEASIBLE DUE TO LOW P
- BIO-P IS A MUST
- IN ORDER TO REALIZE CASH FLOW, NEEDS AT LEAST 2 TO 3 TIMES HIGHER P IN CENTRATE

Estimated P-Recovery at Stickney, Egan and Calumet WRPs : Pro-Corp LLC

Recycle	Fertilizer, tpd	NH_3, lbs/day	TP, lbs/day
SWRP Pre-Centrate	6	740	1600
SWRP Pre & Post Centrate	11	1500	2700
EWRPCentrate + Filtrate	0.33	46	83
CWRP Centrate	0.2	26	48
CWRP Lagoon 9 (Not enough P)	---	---	----
Lagoon 17	0.4	48	87

If Iron is not added at EWRP, more P will be available, potentially up to 75% of TP

A SUMMARY OF TREATMENT TECHNOLOGIES FOR FURTHER CONSIDERATION AT DISTRICT WRPS

- SHARON-ANNAMOX process for SWRP

- Consider CASTion based on cost economics if excess recovered by-product can be sold in Chicago markets

- Consider MAP Based Technology if Bio-P is implemented : Ostara or ProCorp LLC

- Keep eye on Algalwheel success

THE NEXT STEP

- Need for data on flow and characteristics of recycle streams
- Due to limited supply of P, P-resource recovery from recycle streams in future may become more attractive
- Identify and evaluate feasibility of select technology (e.g. SHARON-ANAMMOX at SWRP) at a pilot-scale

THANKS FOR YOUR ATTENTION

- Questions and/or Comments Now?
- Later? kamlesh.patel@mwrd.org
- 708-588-3735

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