

EFFECTIVE HIGH PERFORMANCE LAGOONS - HOW LOW CAN YOURS GO . . .



Wisconsin Wastewater Operators Association
2017 Annual Conference

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OVERVIEW

- BACKGROUND and OBJECTIVES
- CHALLENGES
- STRATEGIC TOOLS

OVERVIEW

- **BACKGROUND and OBJECTIVES**
 - LAGOONS in GENERAL
- **CHALLENGES**
 - GENERAL
 - CODE / PERMITS
 - OPERATIONS
- **STRATEGIC TOOLS**
 - EFFLUENT PARAMETERS and TREATMENT
 - OPERATIONS
 - WPDES

BACKGROUND

- **GENERAL**

- ~ 60% of TREATMENT SYSTEMS USE LAGOONS (usEPA)
- ~ SAME BIOLOGY as with CONVENTIONAL MECHANICAL

- **TYPES**

- AERATED → DO / O₂
- ANAEROBIC → no DO
- STABILIZATION → MULTIPLE MECHANISMS

- **TODAY'S FOCUS**

- ✓ • CONVENTIONAL and HIGH PERFORMANCE AERATED TYPES

BACKGROUND

+ **PROS / STRENGTHS**

- + HRT and FLOW RATES
- + DAMPEN / BUFFER SLUG LOADS and HIGH FLOWS
- ✓ + MINIMAL OPERATIONS TIME - RELATIVELY 'HANDS OFF'
- + OPERATIONAL FLEXIBILITY with 'FILL and DRAW' TYPES
- + GOOD MATCH for SMALLER COMMUNITIES with SPACE

- **CONS / CHALLENGES**

- CONSISTENTLY MEETING VERY LOW LIMITS
- LESS PROCESS CONTROL
 - VARIABILITY e.g. daily DO
- DILUTE BIOLOGY and
- SEASONAL WEATHER
 - CHANGE OVER

CHALLENGES

- GENERAL
- CODE / PERMITS
- OPERATIONS

CHALLENGES

- **GENERAL**

- DILUTE BIOLOGY and
- SEASONAL WEATHER - TEMPERATURE
- DAILY CHANGES - SUNLIGHT
- LESS CONTROL (PROCESS / ENVIRONMENT)
- CONSISTENCY / RELIABILITY
- i.e. 'RISK'

CHALLENGES

- **CODE**

- ✓ • NR 110.24 → GENERALLY OVERSIZED fⁿ (DILUTE BIOLOGY and COLD TEMPERATURE)
- NR 212 III TMDL / WASTE LOAD ALLOCATIONS
- NR 217 PHOSPHOROUS - STANDARDS and LIMITS

NR 110.24 Lagoons. (1) DESIGN REPORT. A design report shall be submitted in accordance with s. NR 110.15 (1).

(2) BASIS OF DESIGN. (a) Number of cells. A minimum of 2 treatment cells shall be provided for aerated lagoons and stabilization ponds. Where a controlled discharge is required, additional effluent storage cells shall be provided.

1. For aerated lagoons designed to treat domestic wastewater only, the hydraulic detention time of each cell shall be based on the following formula:

$$T = \frac{E}{K(100 - E)}$$

Where:

T = detention time, days

E = BOD removal efficiency, percent

K = Reaction coefficient (log base e), days⁻¹

a. For domestic wastewater K = 0.5 at 20°C.

b. The reaction coefficient (K) must be adjusted for temperature according to the formula:

$$K_T = K_{20}^{\Theta(T-20)}$$

Where:

K_T = Corrected reaction coefficient

K₂₀ = 0.5

Θ = 1.07

T = Low design temperature, °C

- **PERMITS**

- **TMDL** and SEASONAL EFFLUENT QUALITY CHANGES
 - i.e. FIXED LOAD and VARIABLE FLOW → affects EFFLUENT
- AMMONIA
- PHOSPHOROUS
- SOLIDS

CHALLENGES

- **OPERATIONS**

- LESS CONTROLLED ENVIRONMENT
- LAG / DELAY with LAB DATA
- LOW BIOLOGY CONCENTRATIONS
- SEASONAL
 - 'TURN-OVERS'
 - BLOOMS, ALGAE and MACRO-PHYTES
- DO / O₂
- RELATIONSHIP → DO, SOLIDS and PHOSPHOROUS RELEASE

STRATEGIC TOOLS

- EFFLUENT PARAMETERS and TREATMENT
- OPERATIONS
- WPDES

STRATEGIC TOOLS

- EFFLUENT PARAMETERS and TREATMENT
 - NH_3 AMMONIA and NITRIFICATION
 - P_T TOTAL PHOSPHOROUS
 - P_{ortho} planning and operations tool
 - TSS TOTAL SUSPENDED SOLIDS

STRATEGIC TOOLS - OPERATIONS

- CASCADE

- **CUSTOMERS**

- RESIDENTIAL (700 V + 250 SD) 950
 - ✓ • INDUSTRIAL (DAIRY and MEAT) ~ + 50% LOAD ✓
 - ✓ • INDUSTRIAL MONITORING 2 x YEAR

- **INFLUENT (2016)**

- Q_{avg} 0.080 mgd
 - BOD₅ avg 340 ppm / 230 ppd
 - TSS avg 260 / 170
 - P_T - avg 12 / 7

STRATEGIC TOOLS

- CASCADE

- **WPDES**

- 2006
 - ✓ • 2010
 - 2011
 - 2016

NH₃ and P_T INTERIM ✓
UPGRADE COMPLETE
NH₃, P_T INTERIM 3.8 ppm
P_T 1.1 ppm 1.2 ppd
TMDL (READ the FINE PRINT . . .) ✓

- **CHALLENGES**

- DAIRY ↑ PRODUCTION x 3
 - TMDL
 - Q_{FLOW}
 - FIXED EFFLUENT LOADS
 - EFFLUENT CONCENTRATIONS ↓ as Q ↑

STRATEGIC TOOLS

- **CASCADE - PROCESS SUMMARY**

- **PRETREATMENT**

- DAIRY INTERCEPTOR (10^k) and SILO (30^k)
- MEAT MARKET INTERCEPTOR / SLAUGHTER WASTE

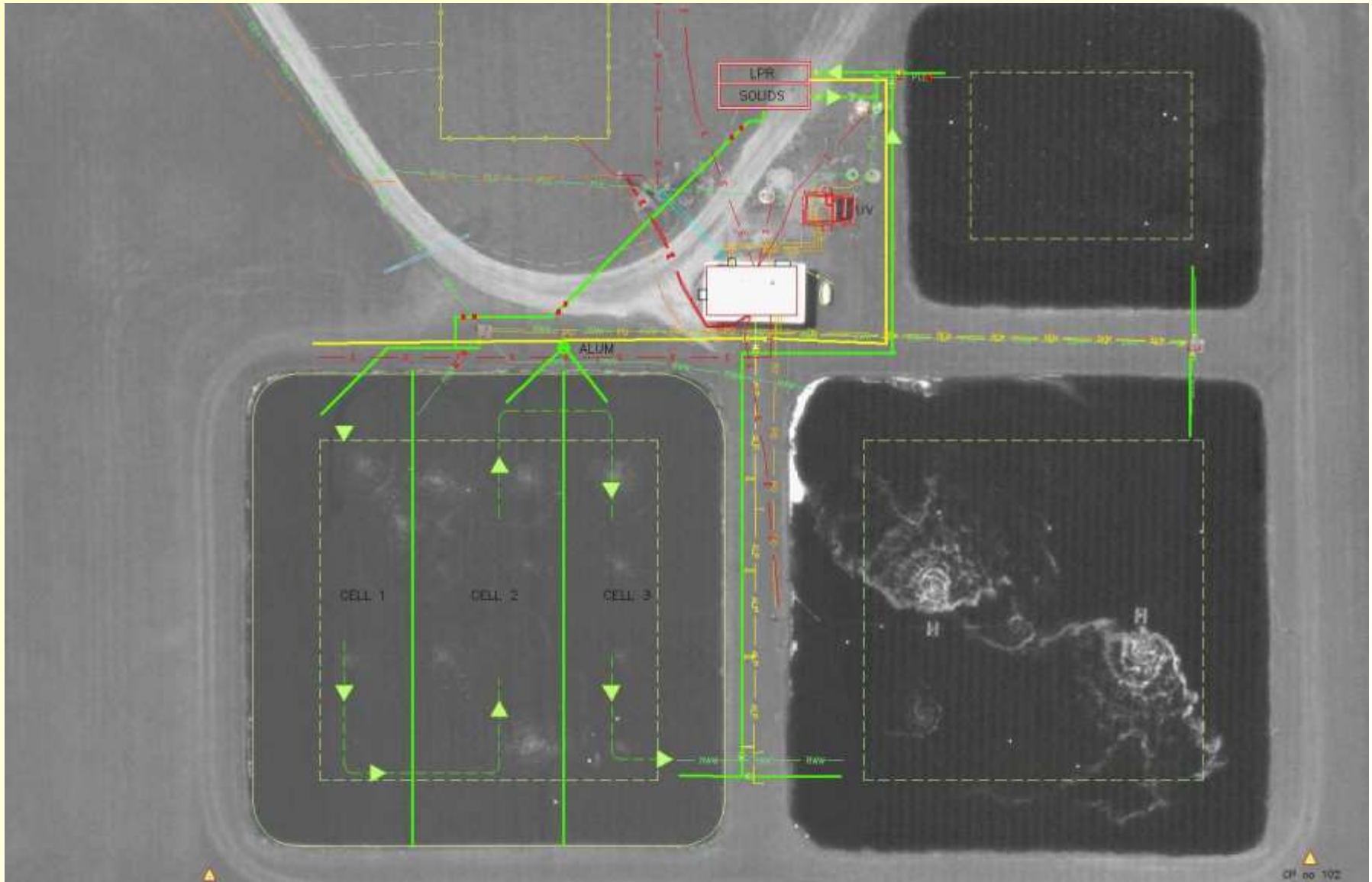
- **PUMP STATION**

- COMMINUTOR

- **HIGH PERFORMANCE LAGOON** 30-45 d HRT

- COMPLETE MIX TREATMENT
- PARTIAL MIX 'REST'
- SETTLING
- FIXED FILM REACTOR and SOLIDS CAPTURE
- UV DISINFECTION

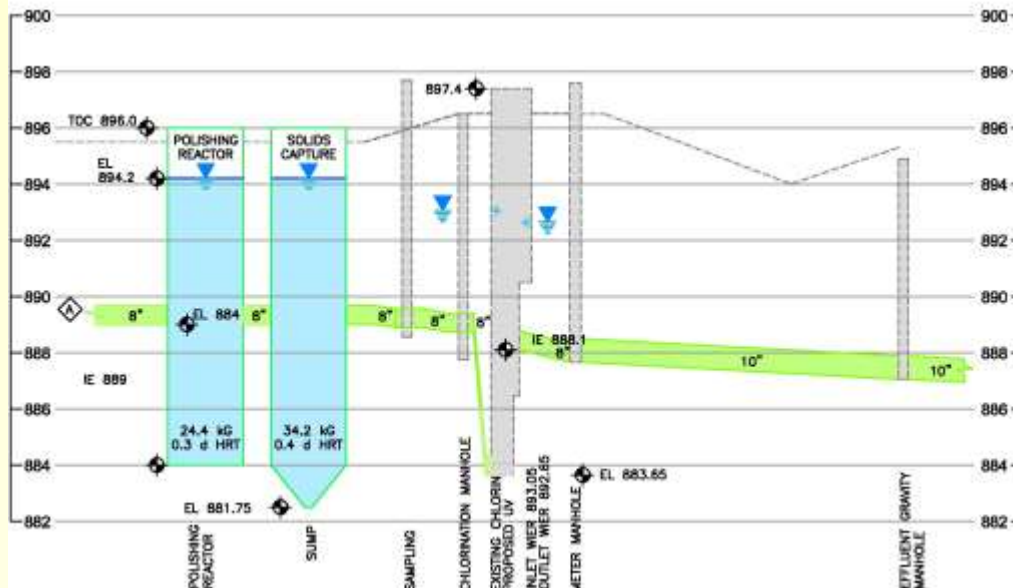
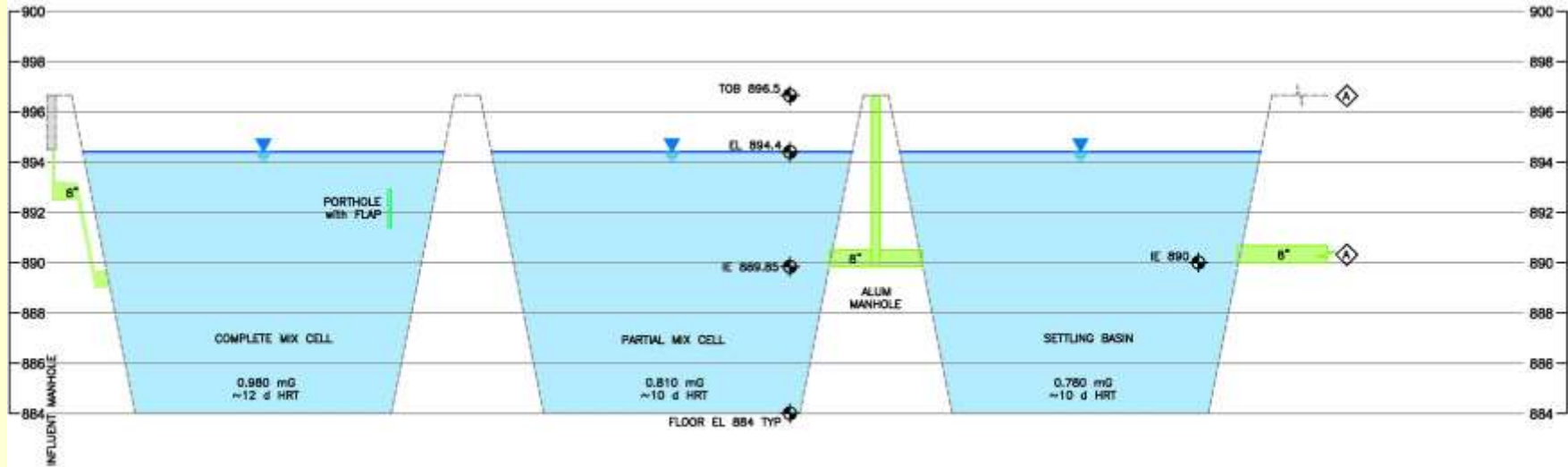
STRATEGIC TOOLS



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STRATEGIC TOOLS



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STRATEGIC TOOLS

SUMMARY of WPDES PERMIT and TMDL (f) PARAMETERS (as APPLIED to FLOW CONDITIONS)
Wastewater Treatment Operations Review
Village of Cascade

Description	Load Allocation												Notes
	January 31	Feb 28	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31	Nov 30	Dec 31	
Total Phosphorous (P_T) (2)													
daily TMDL Table A.16	say –	1.2	1.3	1.3	1.3	1.5	1.0	0.8	0.6	0.7	0.7	1.3	1.2 ppd
$L_{load(ppd)} = ppm(mg/L) \times Q(mgd) \times 8.327$													
ppm (mg / L) WPDES design flow (mgd)	0.130	1.1	1.2	1.2	1.2	1.4	0.9	0.7	0.55	0.7	0.6	1.2	1.1 ppm
ppm (mg / L) existing average flow (mgd) – present day (annual average)	0.080	1.8	1.9	2.0	2.0	2.3	1.5	1.2	0.9	1.1	1.0	1.9	1.8 ppm
WPDES / WQBEL comparison prior interim limit	1.2 ppd / 1.1 ppm 3.8 ppm												
Total Suspended Solids (TSS) (3)													
daily TMDL Table A.18	say –	50.6	43.2	47.4	38.0	67.7	53.4	48.2	30.6	44.0	44.7	85.8	55.1 ppd
ppm (mg / L) WPDES design flow (mgd)	0.130	46.8	39.9	43.8	35.1	62.5	49.4	44.5	28.3	40.7	41.3	79.2	50.9 ppm
ppm (mg / L) existing average flow (mgd) – present day (annual average)	0.080	76.0	64.9	71.2	57.1	101.6	80.2	72.3	46.0	66.1	67.1	128.7	82.7 ppm
WPDES / WQBEL comparison	60 wk / 60 m												
B / CBOD₅													
BOD ₅ weekly (November - April)	45												
monthly	30												
CBOD ₅ weekly (May - October)	40												
monthly	25												
Ammonia NH₃													
weekly (November - March)	37												
weekly (April)	23												
monthly (November - March)	22												
monthly (April)	14												
monthly (October)	18												
Fecal Coliform (FC) (4)													
daily TMDL Table A.20	say ~	4.7											
monthly TMDL Table A.21	say –	59.8											

Footnotes:

- (f) TMDL DRAFT (07/29/16)
- (2) permit effective 04/01/16 (expires 03/31/21)

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STRATEGIC TOOLS

- P_T
 - COMPLETE and PARTIAL MIX ~ 45-50% REMOVAL ↓ w/ TSS ✓
 - CHEMICAL PRECIPITATION ~ REMOVE BALANCE
 - DOSING LOCATIONS - PILOT TESTING
 - RIGOROUS MIXING
 - DOSING RATES for LOW LIMITS \neq 1:1 STOICHIOMETRY < 0.8



STRATEGIC TOOLS

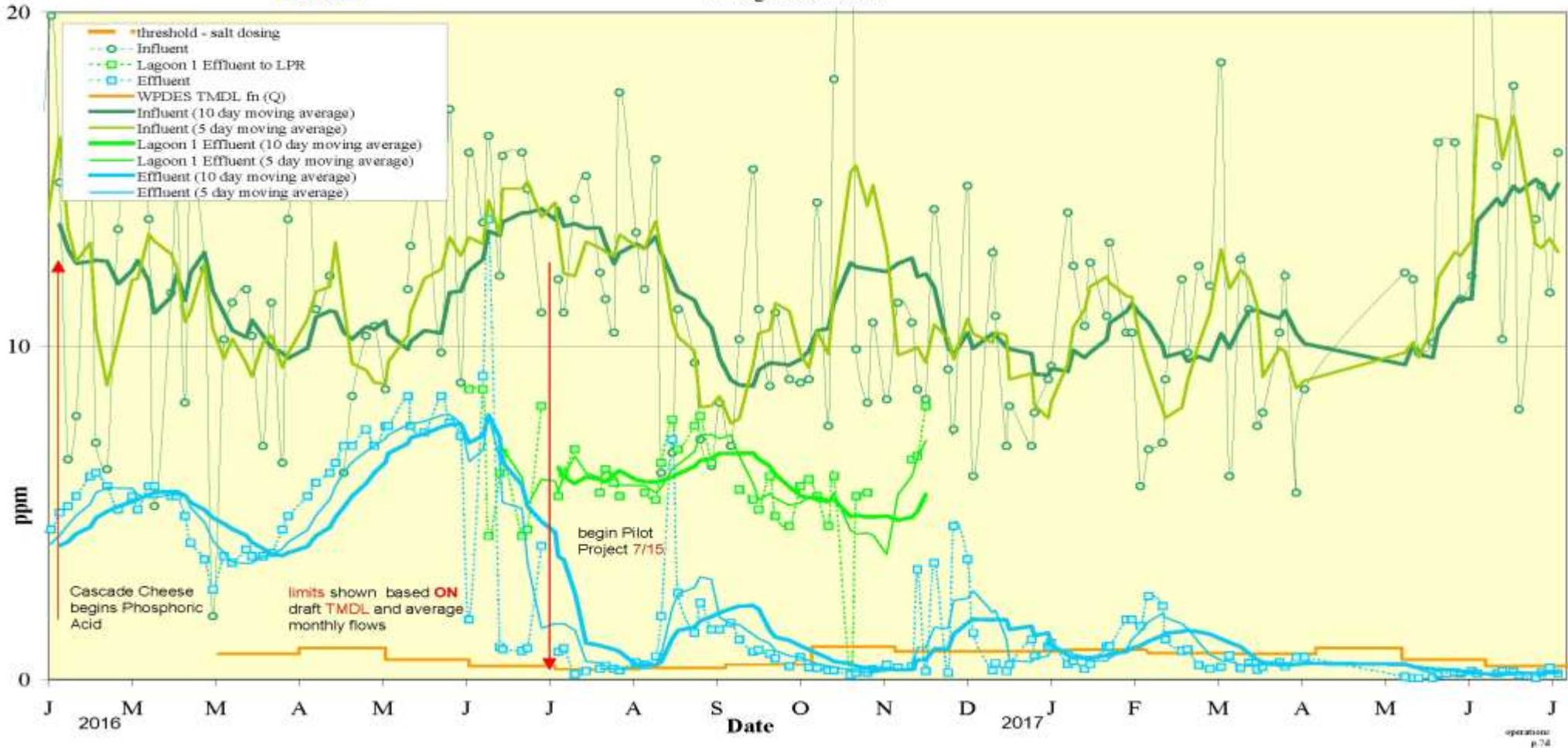
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INFLUENT and EFFLUENT PHOSPHOROUS

Wastewater Treatment Operations Review

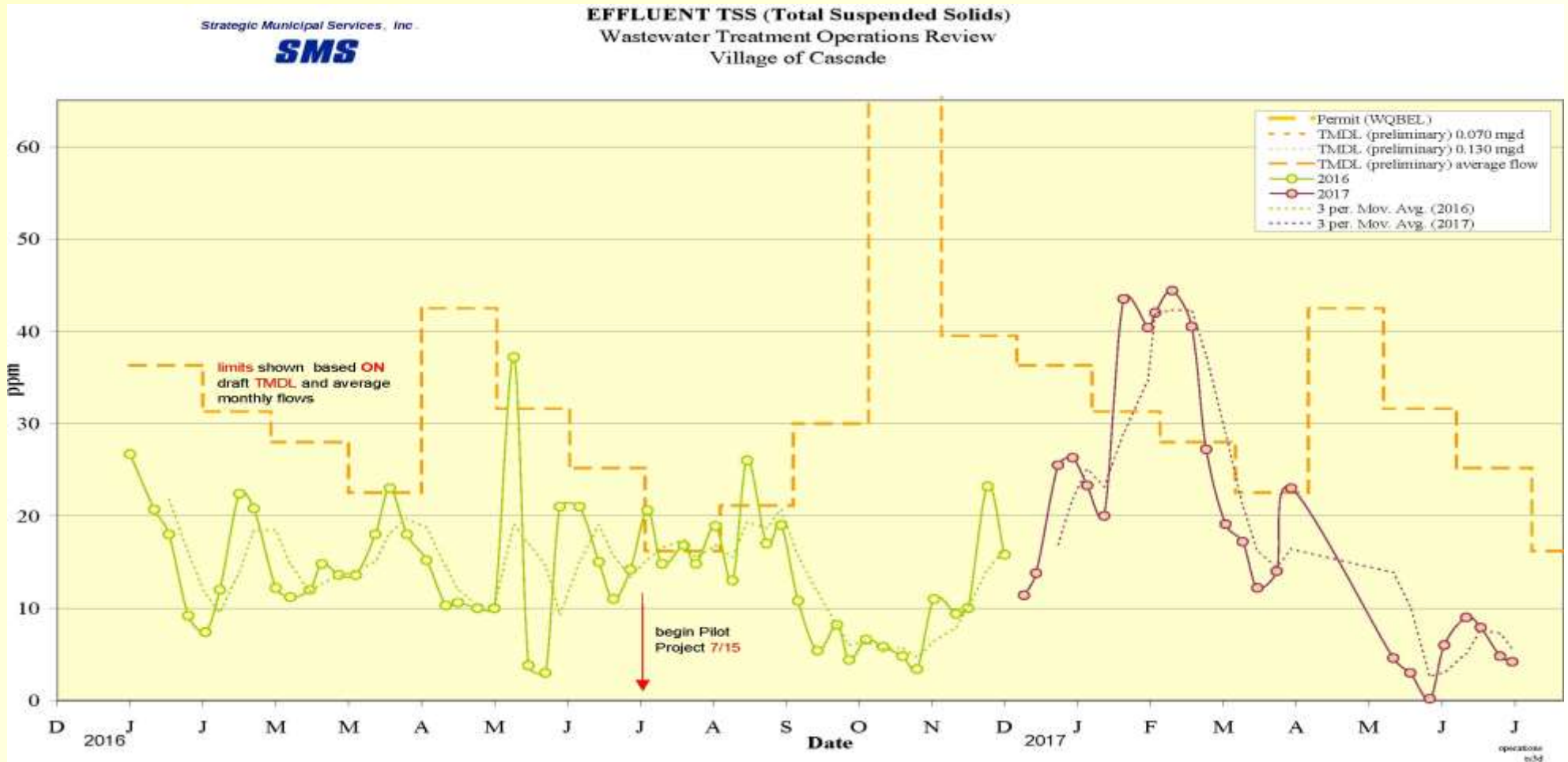
Village of Cascade



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STRATEGIC TOOLS

✓ • LESSONS

- OBSERVE TRENDS WEEKLY (O₂, LABS, VISUAL)
- WATCH MORE CLOSELY
- TEST MORE at KEY TIMES
- MAINTENANCE – SOLIDS
- CAN IMPROVE PROCESS with SIMPLE ADJUSTMENTS

STRATEGIC TOOLS

- ✓ • OPERATIONS and RISKS
 - O₂
 - COMPLETE MIX
 - PARTIAL MIX 'REST'
 - SETTLING MIN 4-5 ppm MAINTAIN P 'BIND'
 - 'POLISHING'
 - MAINTENANCE and SOLIDS
- FILL and DRAW
 - ADJUST DISCHARGE PERIOD f^n (SEASONAL TMDL / WPDES)

STRATEGIC TOOLS

- **ALTERNATIVES - WPDES**
 - PHOSPHOROUS
 - VARIANCES NR 217.19
 - WQT WATER QUALITY TRADING
 - AM ADAPTIVE MANAGEMENT

DISCUSSION and QUESTIONS



RESOURCES

- WASTEWATER ENGINEERING METCALF & EDDY
- PONDS, LAGOONS and NATURAL SYSTEMS wisDNR STUDY
- HIGH PERFORMANCE AERATED LAGOON SYSTEMS RICH
- PRINCIPLES of ... POND SYSTEMS EPA
- WASTEWATER LAGOONS - GUIDELINES EPA

THANK YOU ...

see

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for UPDATED HANDOUTS

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