

# Decentralized Wetland-Based Treatment of Oil-Rich Farm Wastewater for Reuse in an Arid Environment



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# Objective:

**Develop and test a constructed wetland-based system for on-site treatment and reuse of concentrated, oil-rich dairy farm wastewater**

**Constructed wetlands were selected  
due to simplicity of design and  
operation  
Challenges:**

- **Large variation in wastewater quality and quantity**
- **High organic load – not typical wastewater for constructed wetlands**
- **High oil and grease – problematic even for conventional treatment**
- **Desert climatic fluctuation**

# Only limited use of constructed wetlands in arid environments has been reported



## ·Arid environment:

- Rainfall  $<150$  mm y-1
- Evaporation  $>2000$  mm y-1
- Water reuse important

# Previous treatment consisted of septic tank; effluent disposed to the wadi

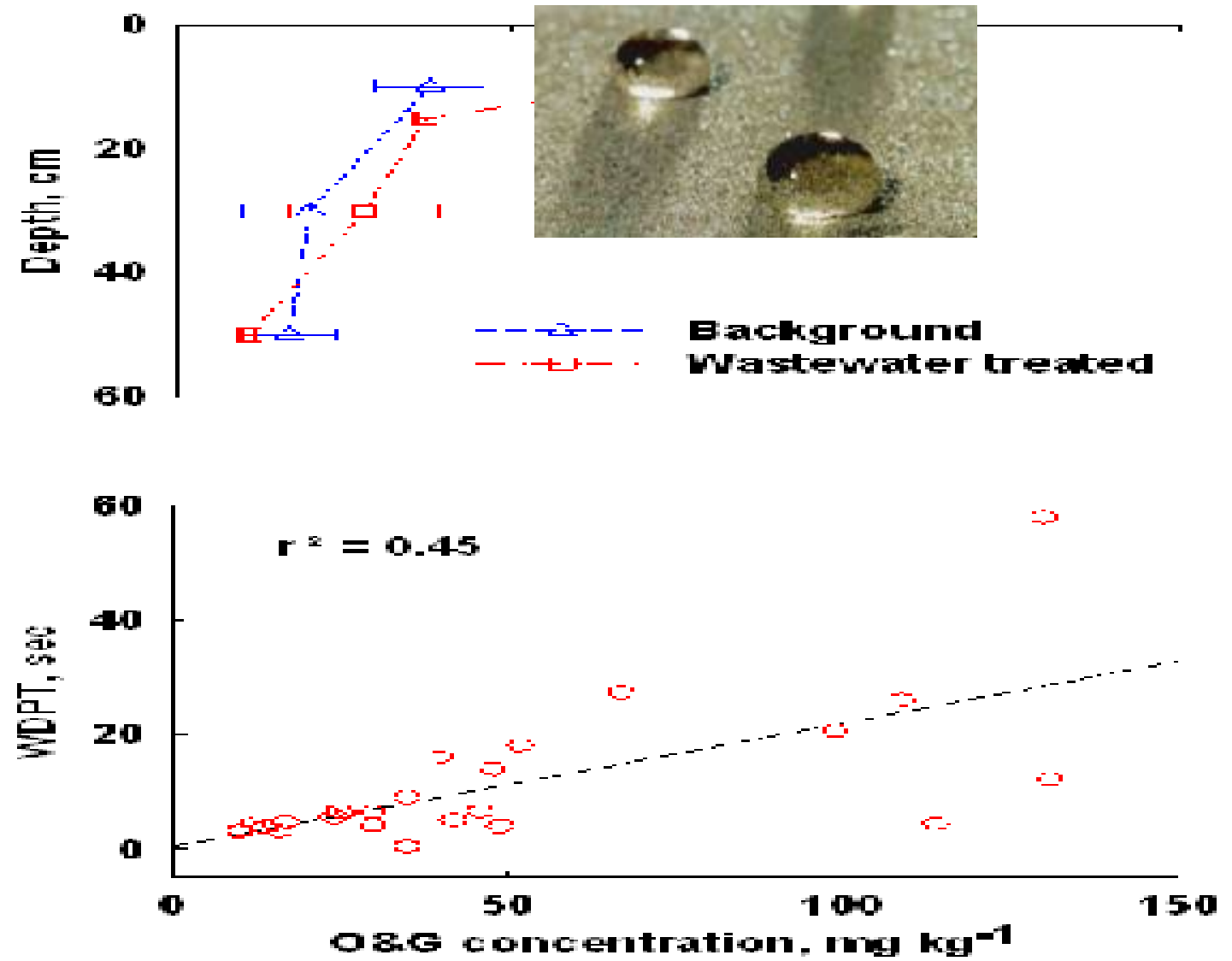
- Soil samples were collected to determine impact of septic tank treated wastewater



# Initial sampling showed effects of septic-tank-treated dairy wastewater on soil (upper 30-cm)

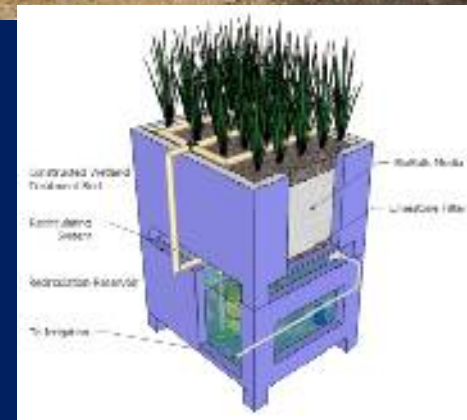
Parameter	Background	Treated	
EC mS cm <sup>-1</sup>	0.60±0.18	1.2±0.6	↑
O&G mg kg <sup>-1</sup>	24±14	67±39	↑
WDPT sec	4.6±1.6	15±14	↑
P	14±14	90±77	↑
K	420±190	700±50	↑
Na	490±80	460±170	—
SAR	1.7±0.3	1.6±0.6	—





# The treatment system consisted of three components

- Anaerobic digestion
- Vertical-flow constructed wetland
- Recirculating vertical-flow constructed wetland



# Anaerobic tanks provided solids settling, oil skimming and initial degradation

- Anaerobic tanks installed in series
- HRT ~4 days
- Equalization
- Solids settling
- Oil/Fat skimming
- Initial degradation



# A vertical-flow constructed wetland received anaerobically pretreated wastewater

- Modified French design (Molle et al., 2005)
- COD = 1,500 mg L<sup>-1</sup>
- Q = 4 m<sup>3</sup> d<sup>-1</sup>
- Total bed: 60 m<sup>2</sup>



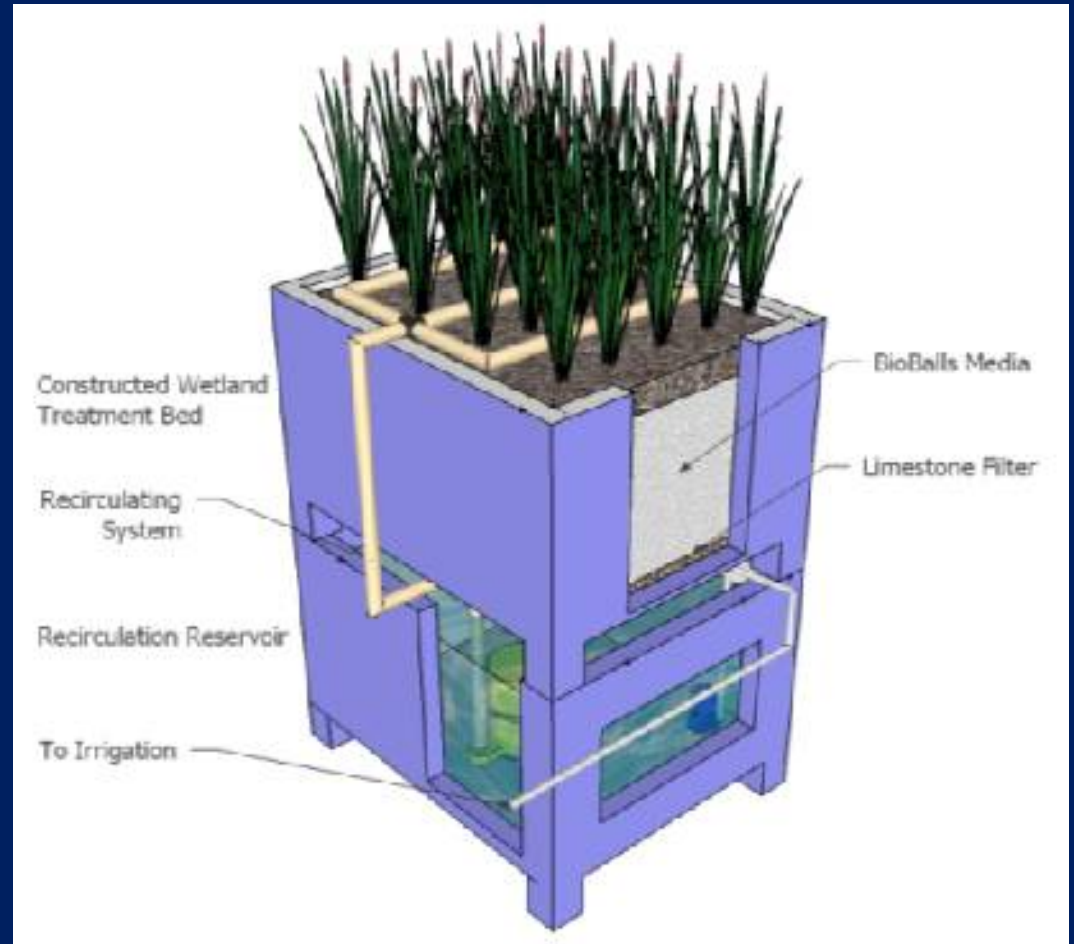
# A vertical-flow constructed wetland received anaerobically pretreated wastewater

- 3 layer sand/gravel
- 0.6 m depth
- 2 alternating beds
- Anaerobic treated WW distributed on the surface, free-drainage
- Planted – ornamental

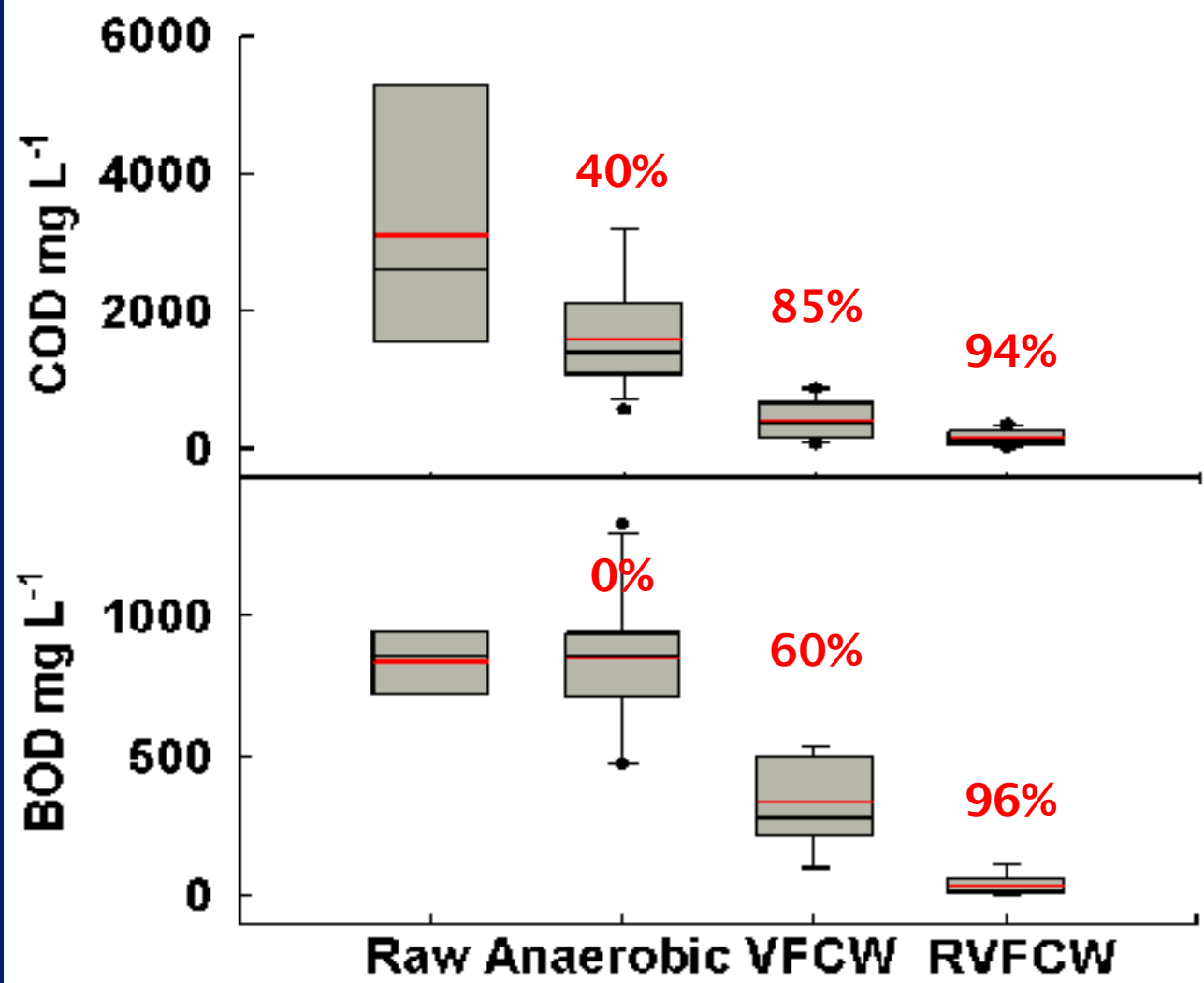


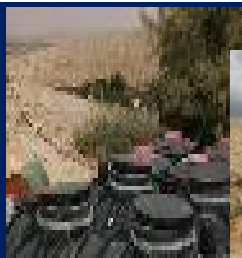
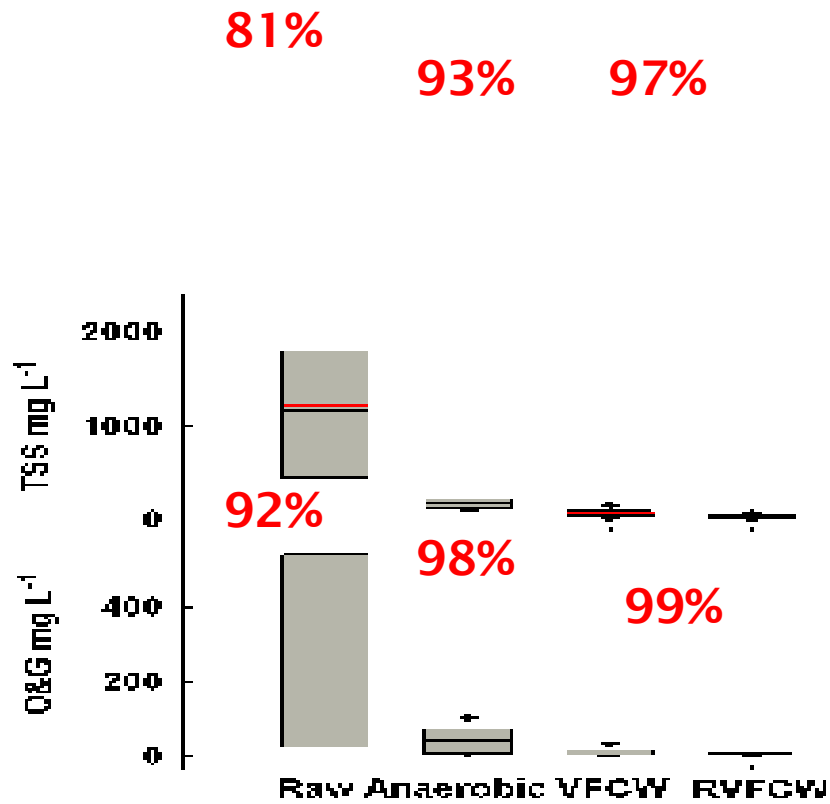
# A recirculating vertical-flow constructed wetland provided final treatment

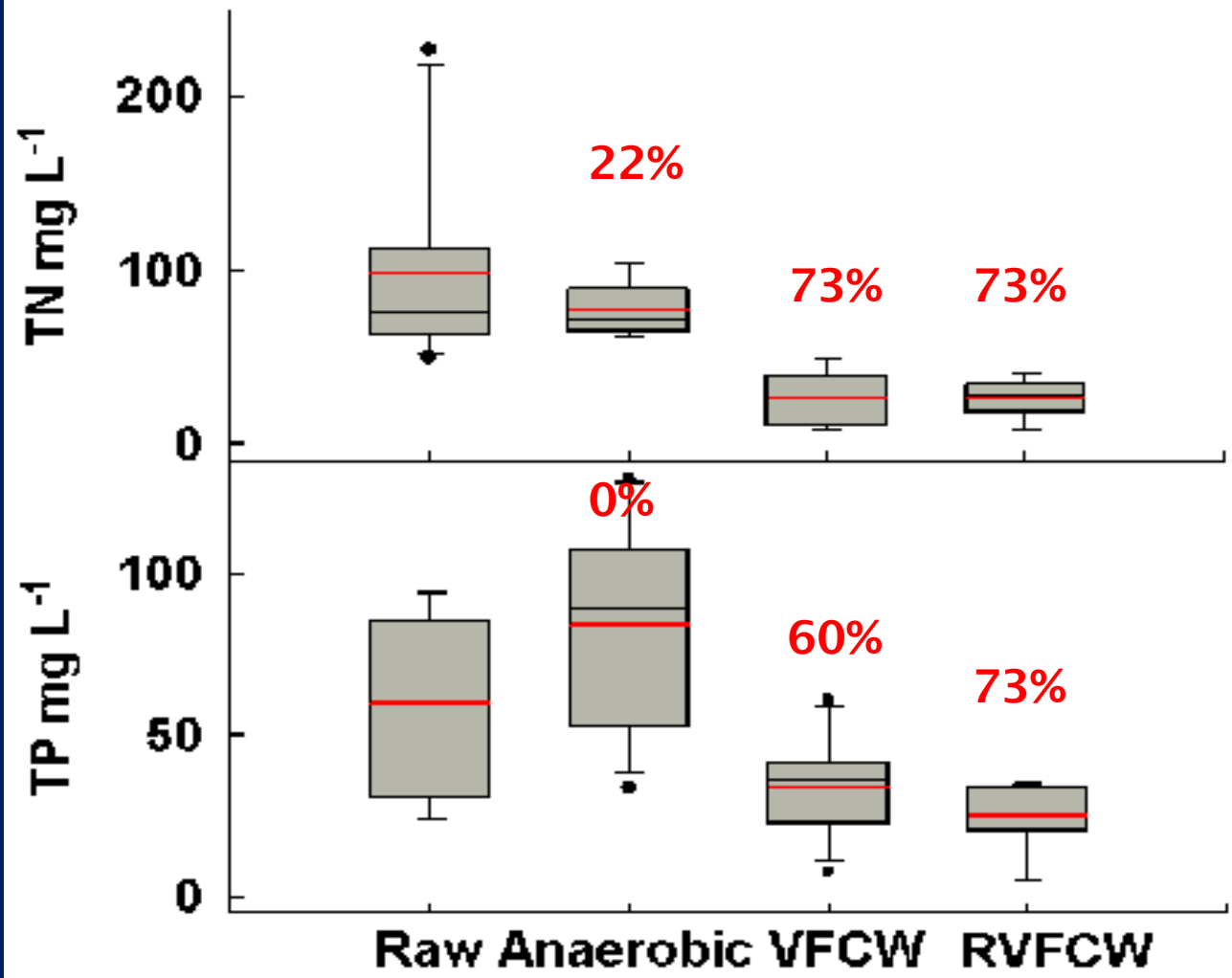
- Modular units
- 4 m<sup>2</sup> total surface area
- Average HRT ~12 hr
- Recirculation
- Treated water to irrigation



# RESULTS

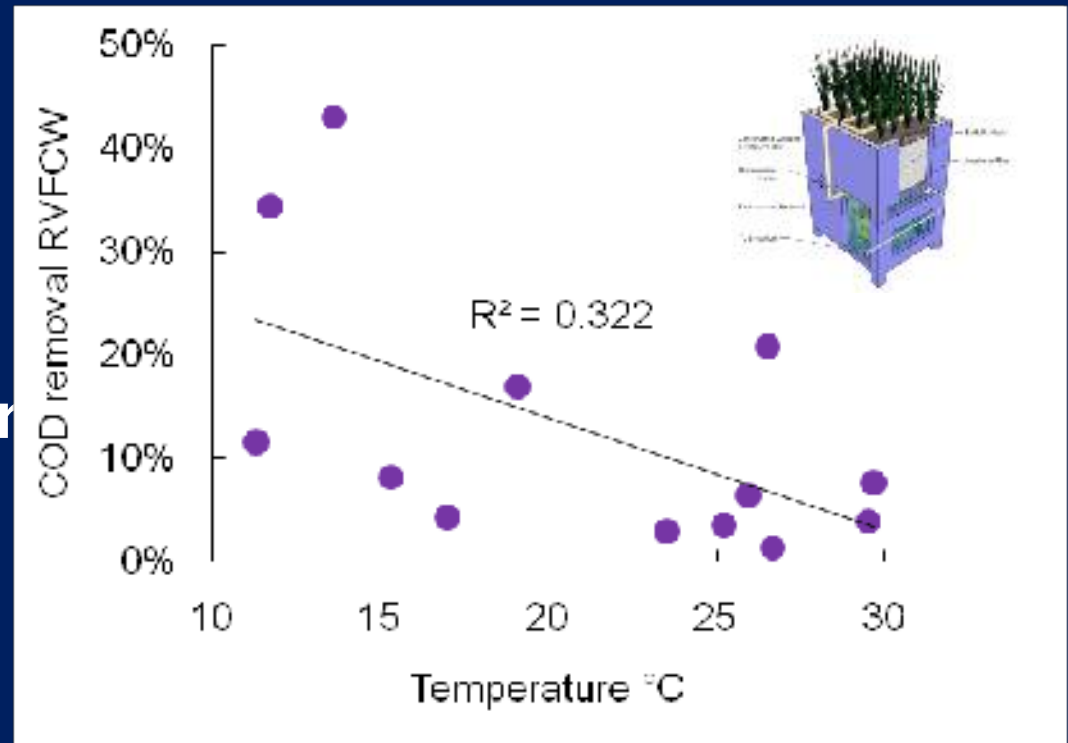






# Treatment was seasonally affected

- COD removal in the VFCW decreased with lower temperature
- RVFCW showed Opposite trend ??
  - Recirculation
  - Robust treatment



# SUMMARY & CONCLUSIONS

# The combined system achieved effective overall treatment

- **Anaerobic system:**

- solids and O&G removal/pretreatment
- equalization of wastewater discharged to wetland



- **VFCW:**

- 40% to 80% COD removal, majority N, P
- seasonally variation



- **RVFCW:**

- relatively stable effluent quality throughout year
- recirculation key to winter treatment



# Combined system achieved high removal rates for most parameters

- 94-99% reduction in COD, BOD5, TSS and O&G
- TN and TP removal >70%
- Long-term assessment of P removal is needed
- Long-term assessment of oil accumulation or degradation in CW bed also needed

# Salinization potential was not statistically increased

- EC, Na and SAR of wastewater not statistically altered during treatment
- evapotranspiration in the wetlands did not significantly increase the wastewater salinity



# Thank You!

