New Zealand Land Treatment Collective

Dedicated to improving and communicating technology for the land treatment of waste products

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Performance of Enhanced Wetland and Pond System (EWPS) for BTF effluent treatment in Gisborne

Jason Park*, Rupert Craggs, and Chris Tanner

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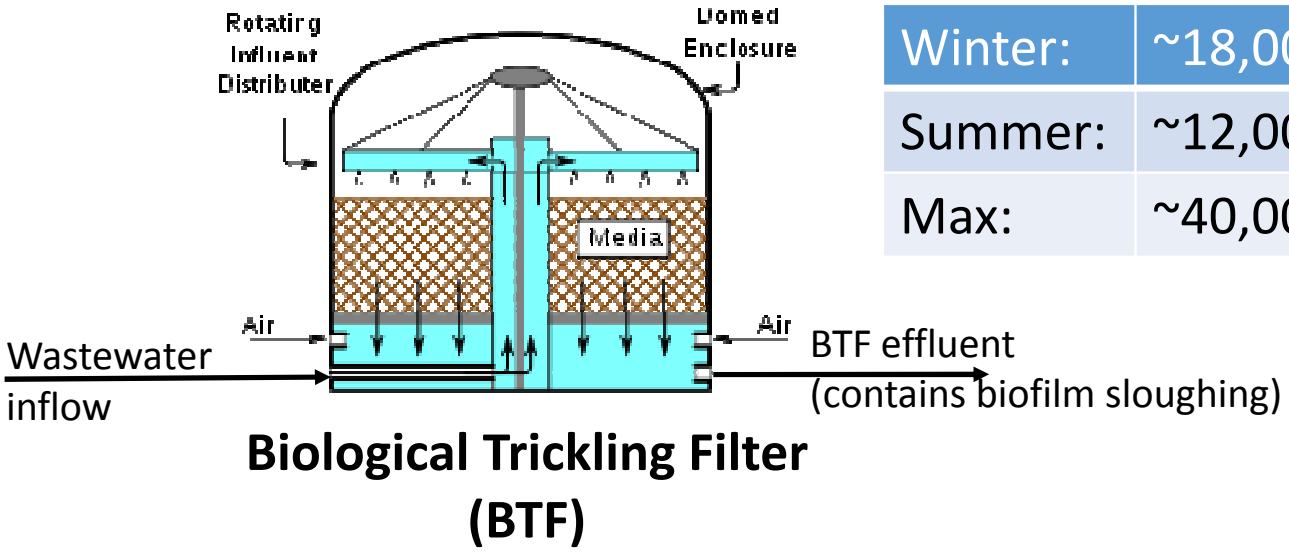
- WTAG members
- ESR: Jacqui Horswell, Staci Boyte

who have maintained and operated the pilot-scale EWPS system. Their collaborative and supportive contributions were essential for achieving the goals outlined the project.

Outline

- Research background
  - Current wastewater discharge and issues
  - NIWA proposed Gisborne wetland system
- Pilot-scale Enhanced Wetland and Pond System (EWPS) set-up
- Wastewater treatment performance
- Summary
- Options for reducing land area and costs
  - Projected treatment performance

BTF system operation and effluent discharge



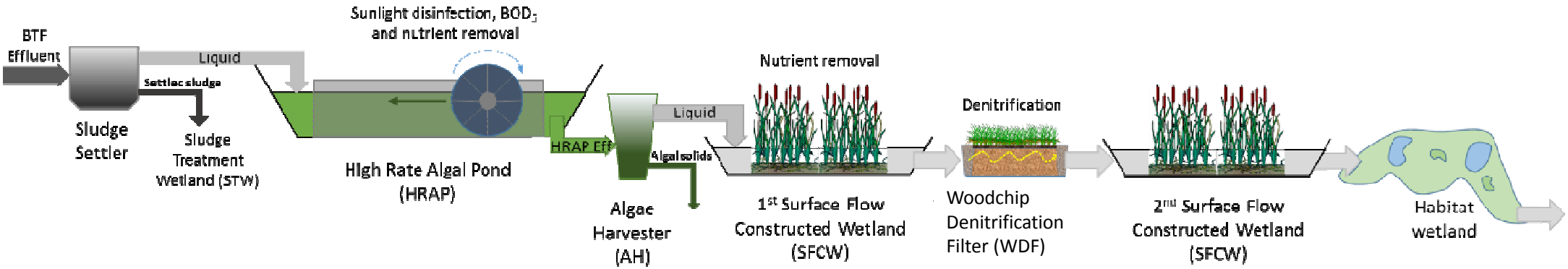
Biological Trickling Filter (BTF)

Winter:	~18,000 m^3/d
Summer:	~12,000 m^3/d
Max:	~40,000 m^3/d

Current wastewater discharge and issues

- BTF effluent is discharged from the outfall pipeline to the coastal marine area
- GDC aims to eliminate any discharge of human originated waste/wastewater to the sea by 2020

NIWA proposed Gisborne wetland system



Wetland treatment objectives

- Robust, reliable and cost-effective solution for Gisborne
  - Simple to operate and manage
  - Incorporate a diversity of treatment processes
    - Promote biotransformation of contaminants
- Improve water quality
  - Efficiently remove organic matter (TSS/BOD_5), nutrients (N &P) and Faecal coliform (*E.coli*)
- Enhance Mauri and public perception
- Foster wider social, cultural and ecological benefits
  - Asset for the people of Gisborne
  - Self-sustaining ecological system

Gisborne Pilot-scale Enhanced Wetland and Pond System (EWPS)

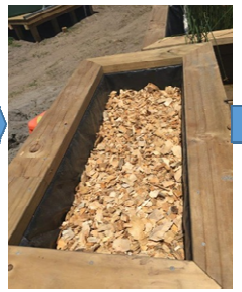
- To demonstrate the feasibility of an Enhanced Wetland and Pond System (EWPS),
  - a pilot-scale system was installed at the WWTP to treat the BTF liquid effluent

Sludge settler

High Rate Algal Ponds (HRAPs)

Algal Harvester (AH)

SFCW1

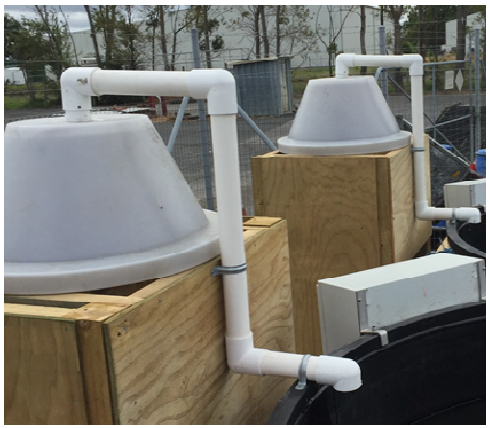
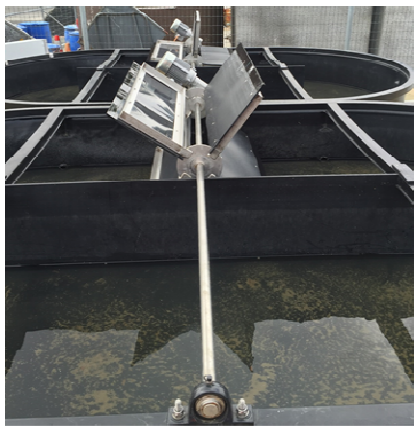


WDF

SFCW2

Commissioning the Gisborne EWPS

- A 20 litre typical HRAP algal culture (from a NIWA's experimental scale HRAP) was seeded into each HRAP.
  - The HRAPs were gradually filled with the settled BTF liquid effluent,
  - Once full the effluent flowed into and filled the AHPs, SFCWs and WDF
  - Monitored from 23rd Feb until 30th Aug 2016 over six months

EWPS operation

- To mimic the seasonal variation of the BTF outflow (summer: 12,000 m^3/d; Winter: 18,000 m^3/d), the inflow to the HRAP was varied with season

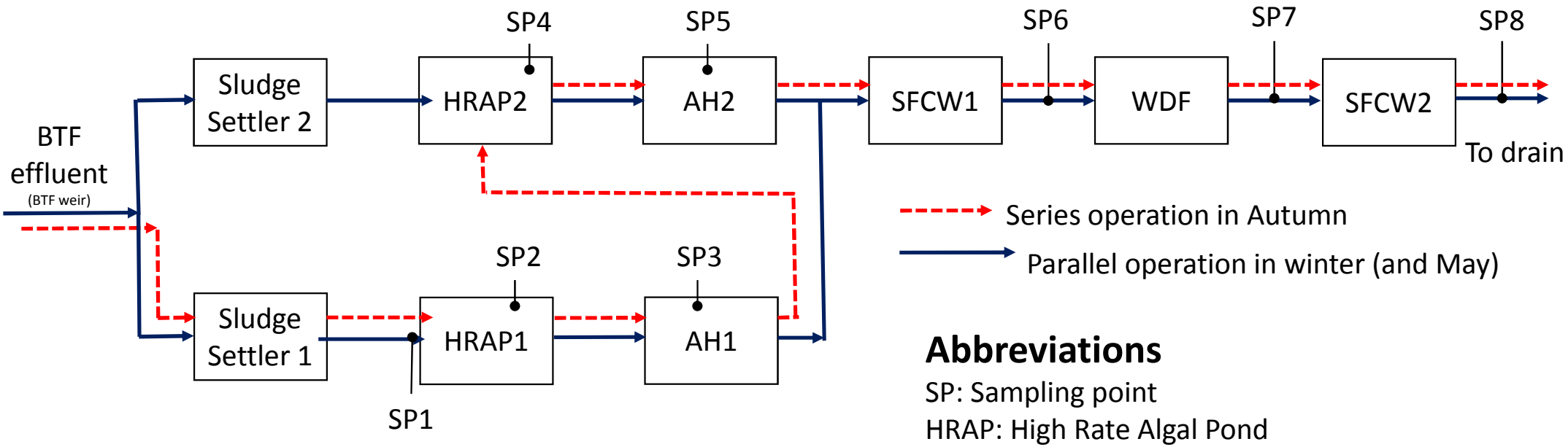
HRAP operation

Periods	Operation	Inflow (L/d)	HRT (d)
Feb-Apr (Autumn)	In series	428	3.5 (7)[(2)]
May[(1)]	In parallel	500	6
Jun-Aug (Winter)	In parallel	600	5

(1) Transition period between autumn and winter

(2) Combined HRT of HRAPs 1 and 2

EWPS sampling



Sampling locations and Sample I.D.

Series operation in Autumn

Parallel operation in winter (and May)

Abbreviations

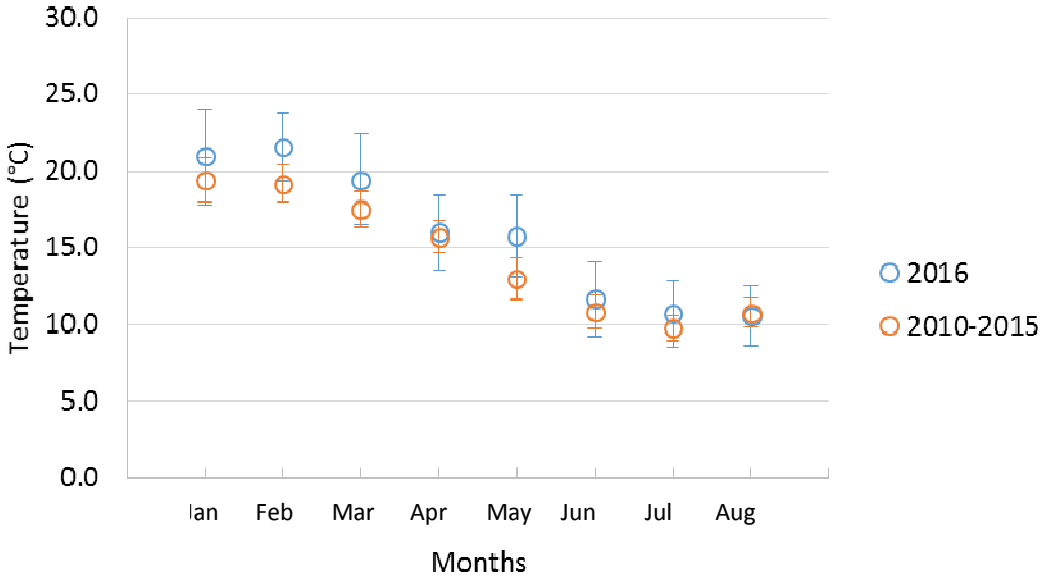
SP: Sampling point
HRAP: High Rate Algal Pond
AH: Algal Settler
SFCW: Surface Flow Constructed Wetland
WDF: Woodchip Denitrification Filter

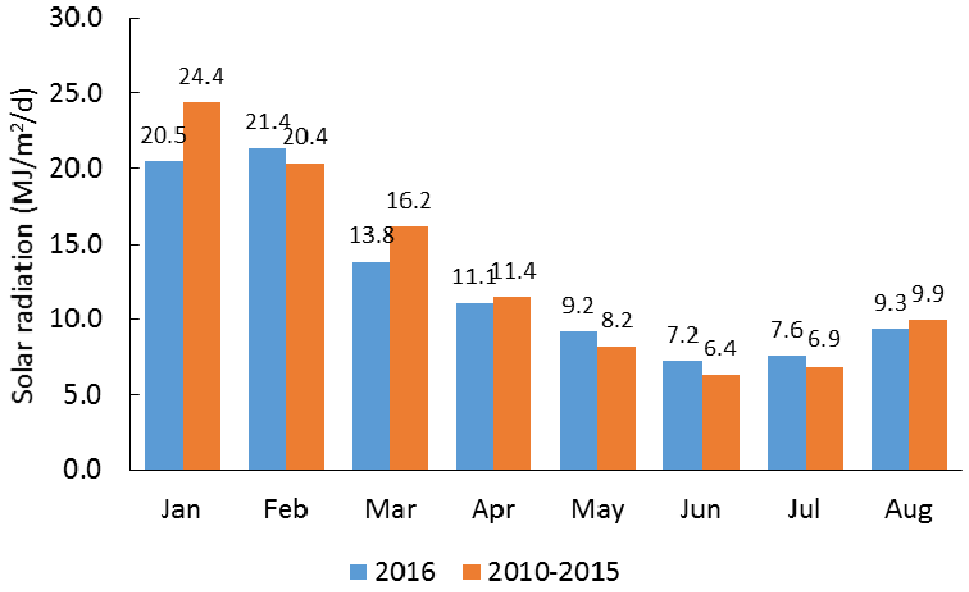
Water quality analysis

Water quality parameters	SP1 (SS eff)	SP2 (HRAP1 eff)	SP3 (AH1 eff)	SP4 (HRAP2 eff)	SP5 (AH2 eff)	SP6 (SFCW1 eff)	SP7 (WCF eff)	SP8 (SFCW2 eff)
Dissolved nutrients (NH_4-N, NO_3-N, DRP)	√		√		√	√	√	√
Total Kjeldahl Nitrogen (TKN)	√							√
Total Phosphorus	√							√
Total Suspended Solids (TSS)	√	√	√	√	√	√		√
Volatile Suspended Solids (TSS)	√	√	√	√	√	√		√
Dissolved BOD_5	√		√		√		√	√
Total BOD_5	√				√			√
Escherichia coli (*E.coli*)	√		√		√	√	√	√

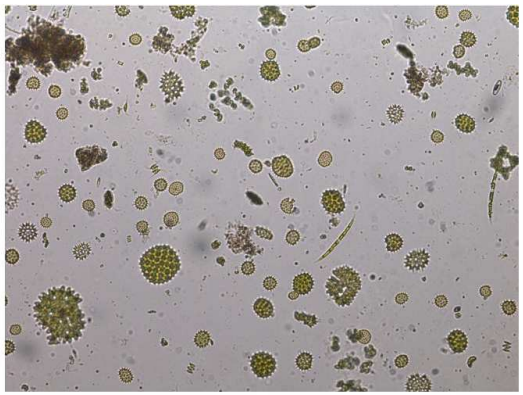
Gisborne climatic conditions

- Rainwater addition (autumn: 0.01 m^3; winter: 0.45 m^3) to the pilot-scale system was minimal (only 0.1 and 2.4% of total inflow to the system)

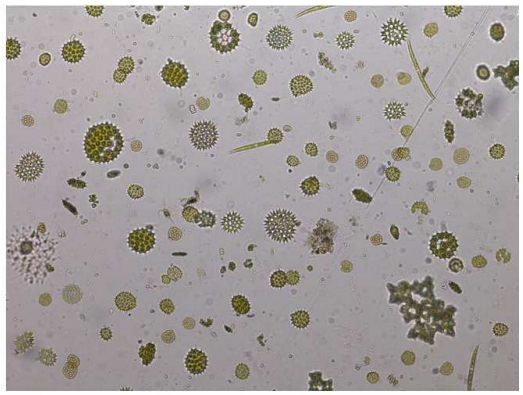




Dominant algae

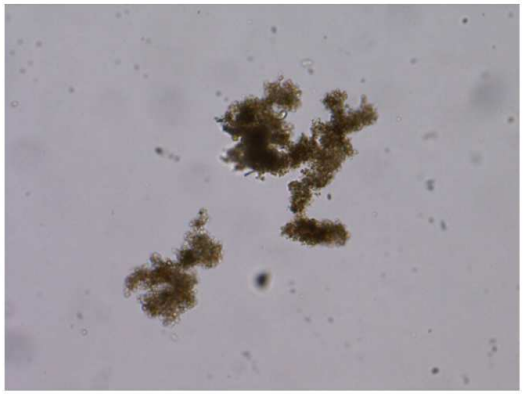


HRAP1

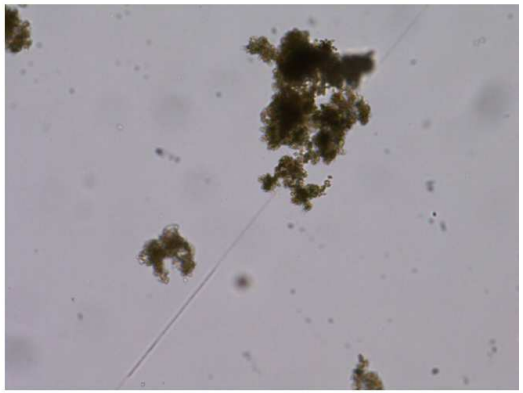


HRAP2

- *Pediastrum* sp. (that were originally seeded) grew well until 12th April
- Photos taken on 15th March



HRAP1



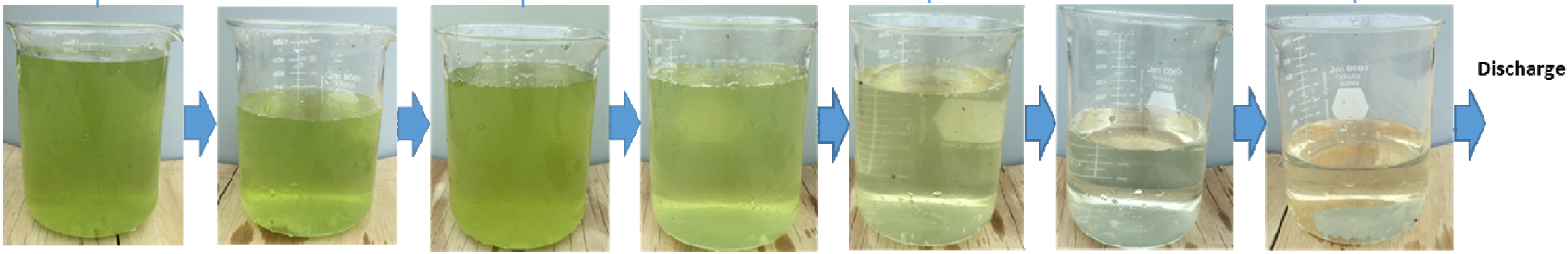
HRAP2

- Unicellular algae *(Chlorella* sp.) grew in winter but formed large algal aggregates (>1 mm) improving algal settling
- Photos taken 12th April

TSS removal (~5 mg/L)

Algal growth in HRAP increased TSS concentration (TSS: ~100 mg/L)

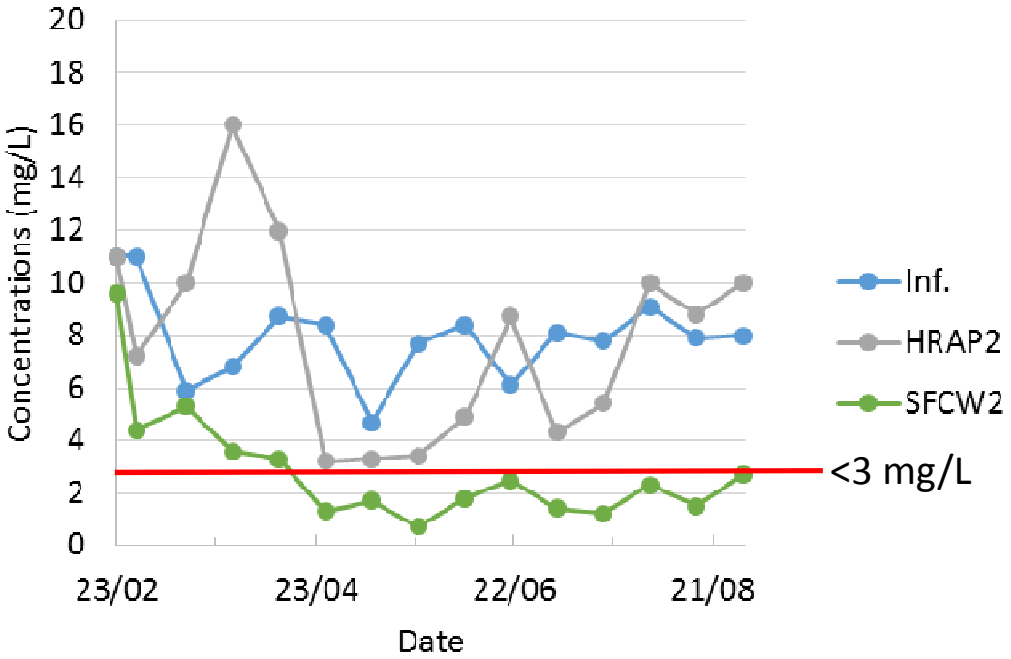
SFCWs and WDF removed most of the algal solids (TSS: <5 mg/L)



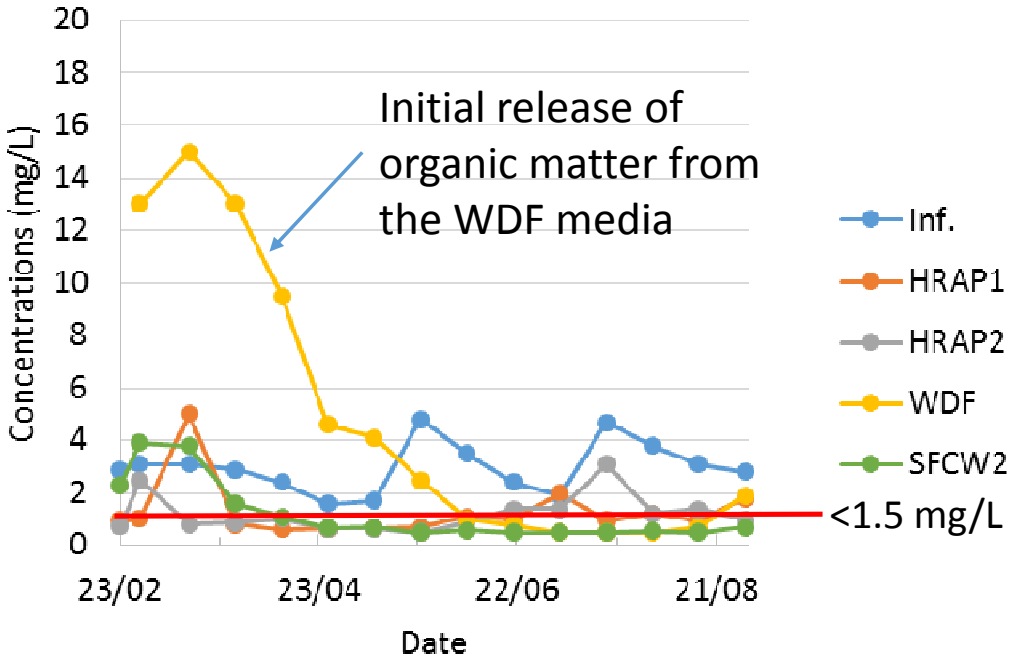
Achieved 70% TSS removal by gravity (TSS: ~30 mg/L)

$TBOD_5$ (<3 mg/L) and $SBOD_5$ (<1.5 mg/L) removal

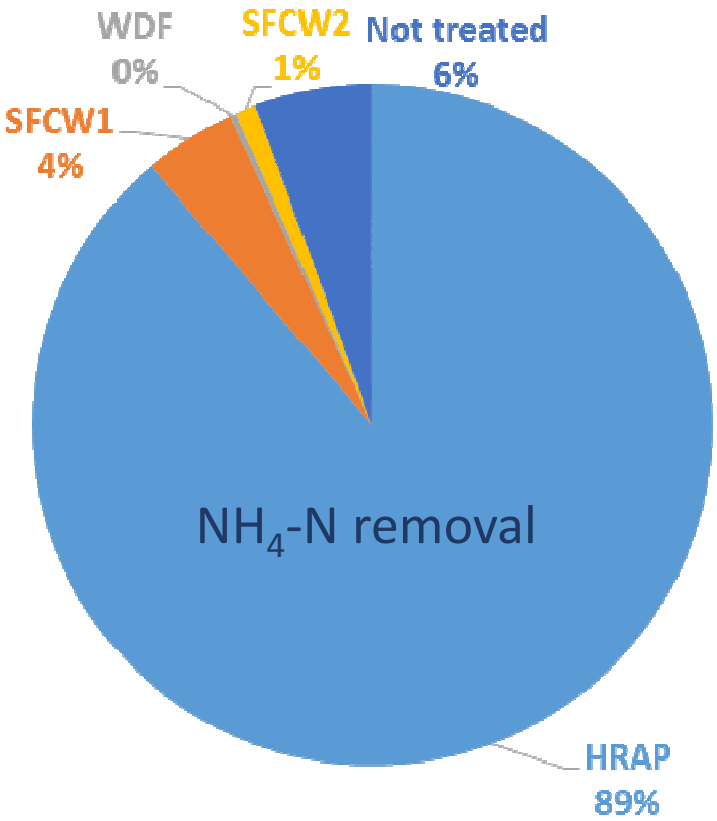
Total BOD_5

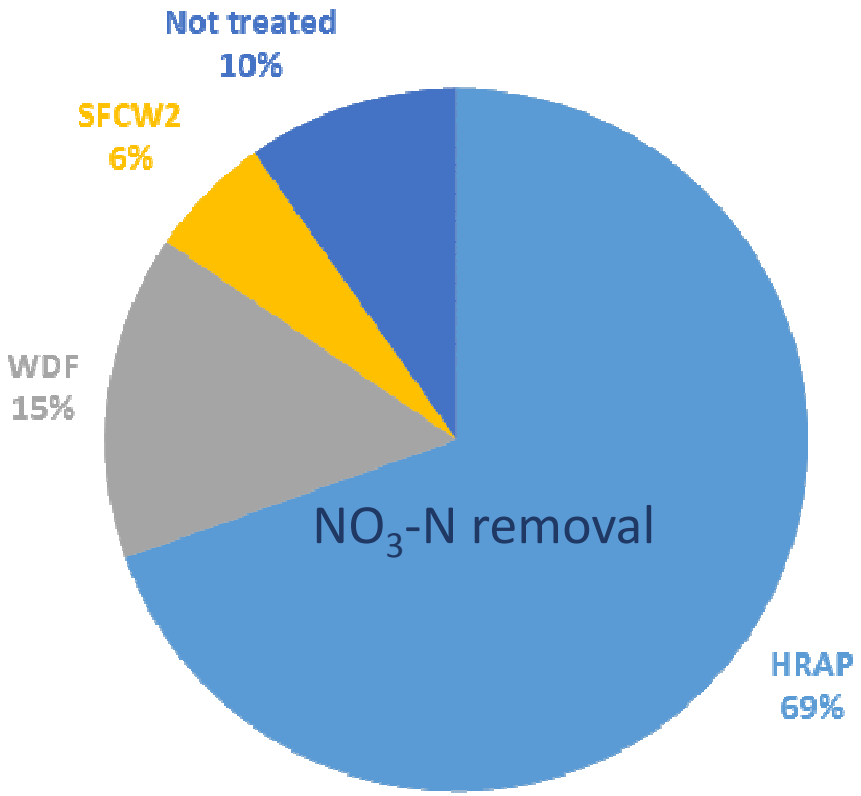


Soluble BOD_5

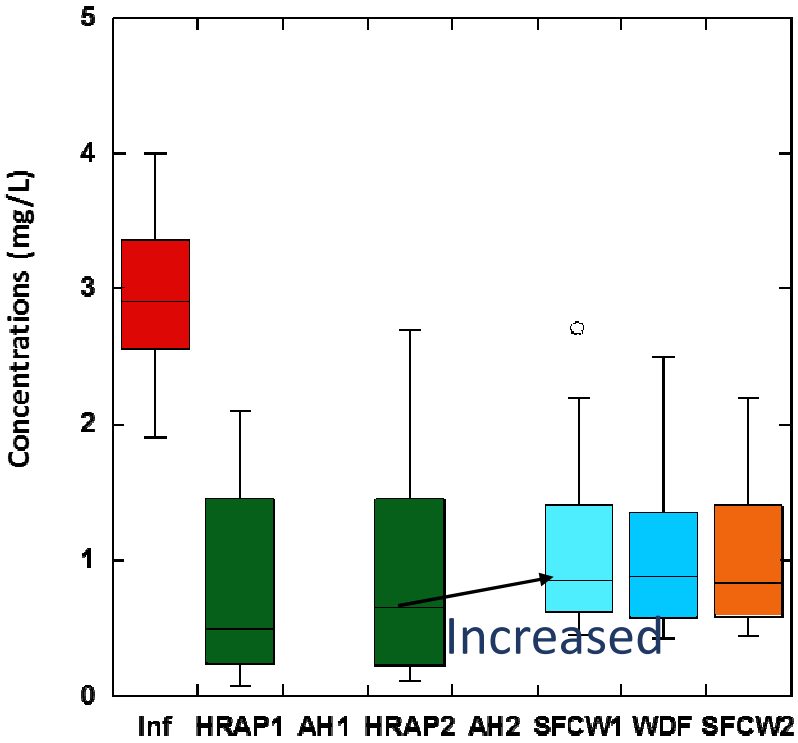


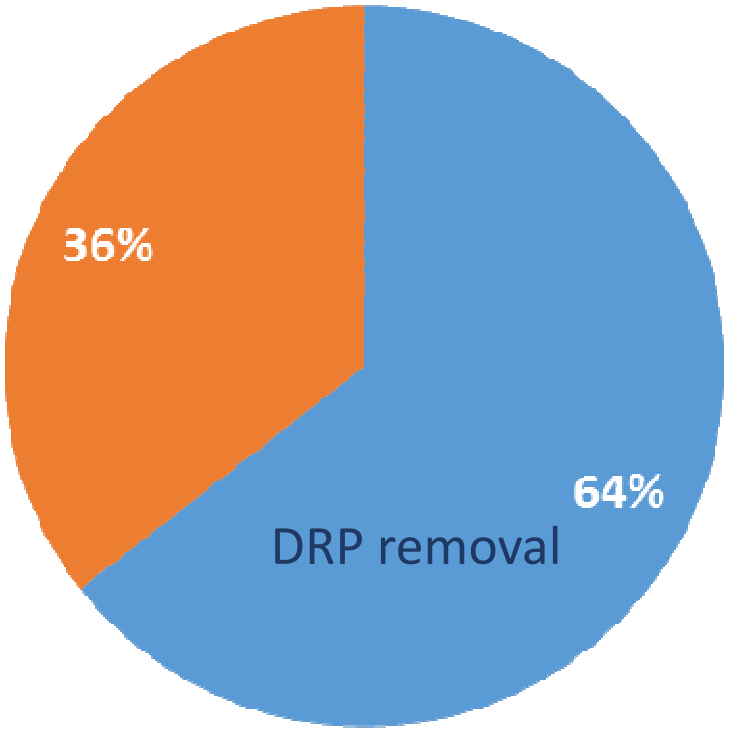
NH_4-N (~0.3 mg/L) and NO_3-N (~0.7 mg/L) removal



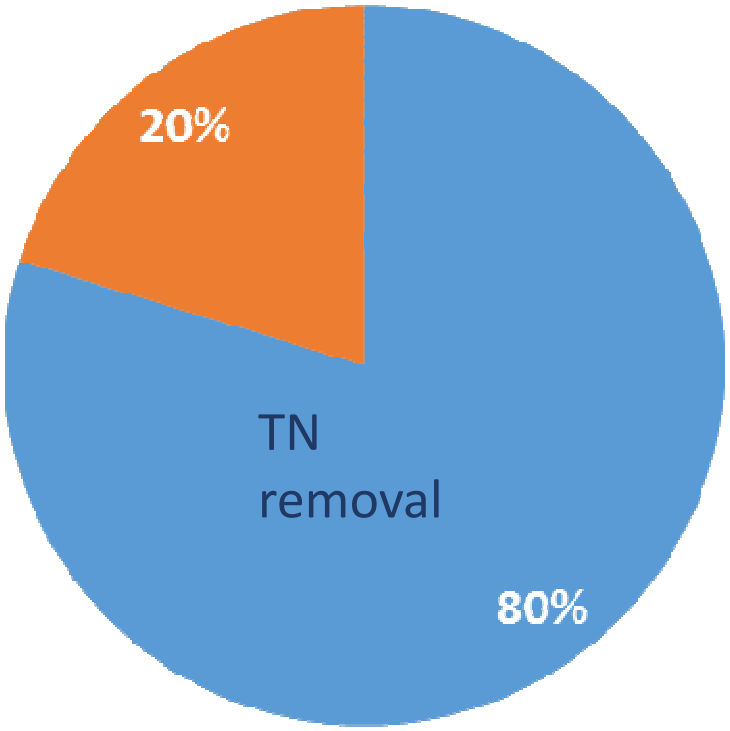


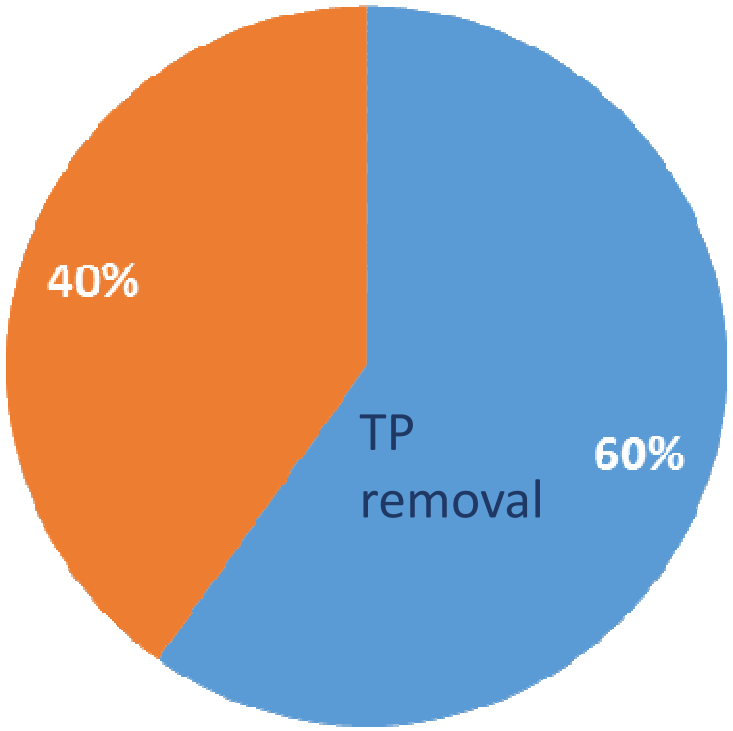
DRP (~1.0 mg/L) removal





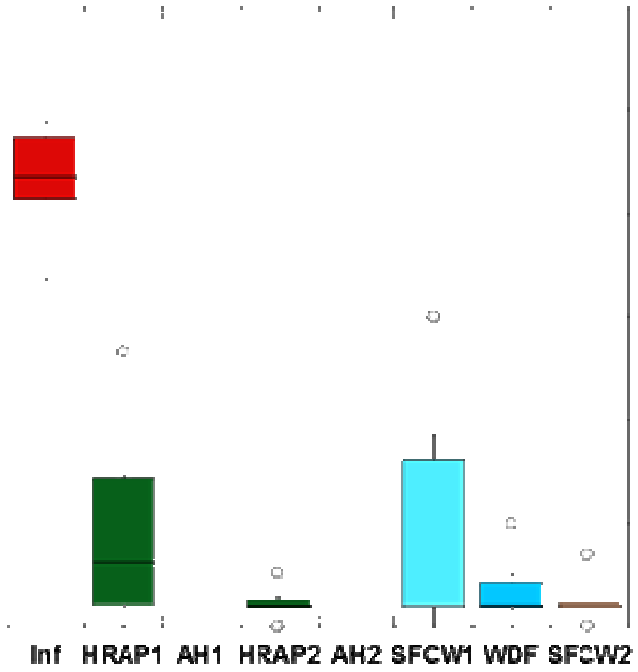
TN (~2 mg/L) and TP (~1.4 mg/L) removal



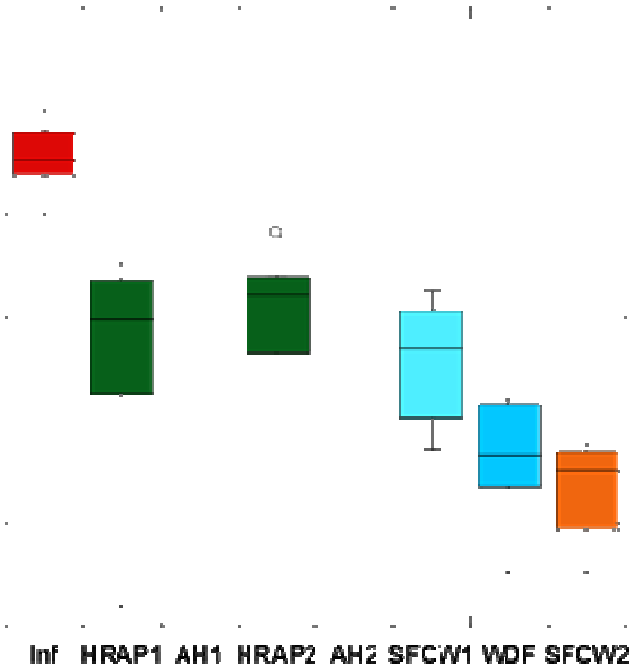


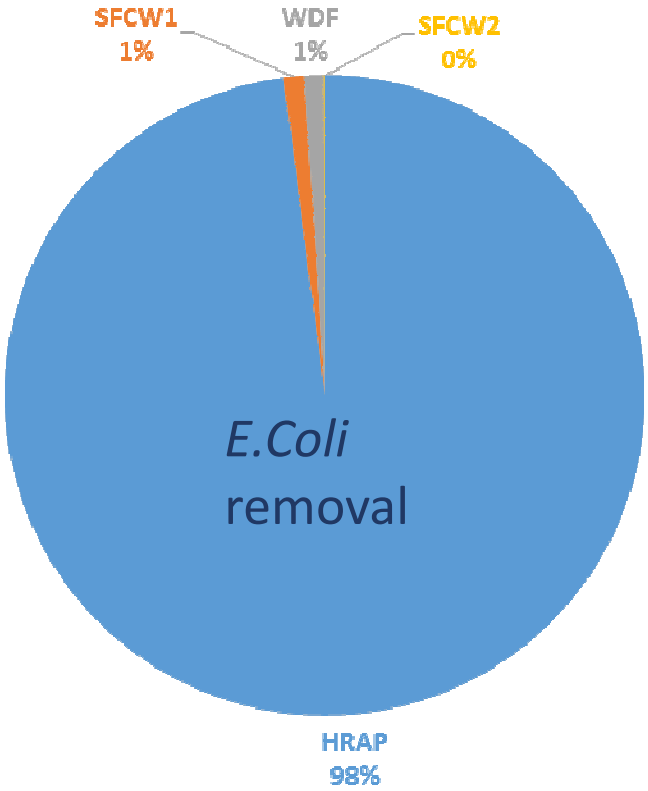
E. coli removal (3-log reduction: ~15 cfu/100 ml)

Autumn (4-log)

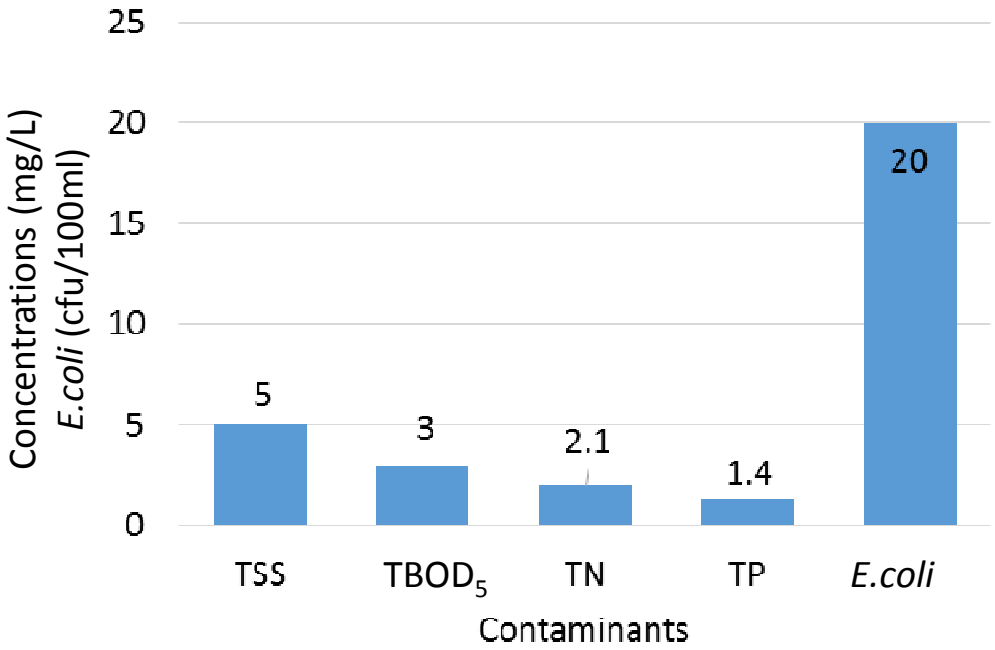


Winter (3-log)





Conclusions



- The pilot-scale EWPS system achieved excellent wastewater treatment performance and maintained a very high level of effluent quality
- However, the wastewater treatment performance will increase with a full year (particularly summer) of operation
- an analysis of which elements of the system are providing the majority of the treatment could assist in reducing the costs for a Gisborne full-scale system