

# Evaluation of the Newlands Mashu Anaerobic Baffled Reactor and Constructed Wetlands

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## INTRODUCTION

Anaerobic Baffled Reactors (ABR) have been implemented by the German NGO BORDA as a standard component of Decentralized Wastewater Treatment Plants (DEWATS) in developing countries to treat low and medium strength domestic wastewater. This technology is being investigated in-depth by the eThekweni Water and Sanitation in a DEWATS plant located in the Newlands East area of Durban, South Africa. Analyses were conducted by the International Research Experience for Students (IRES) 2015 cohort to assess the overall water quality within the DEWATS plant including the testing of flow rate, chemical oxygen demand (COD), solids movement, nutrient removal through constructed wetlands, and biodegradability of organic matter in the ABR.

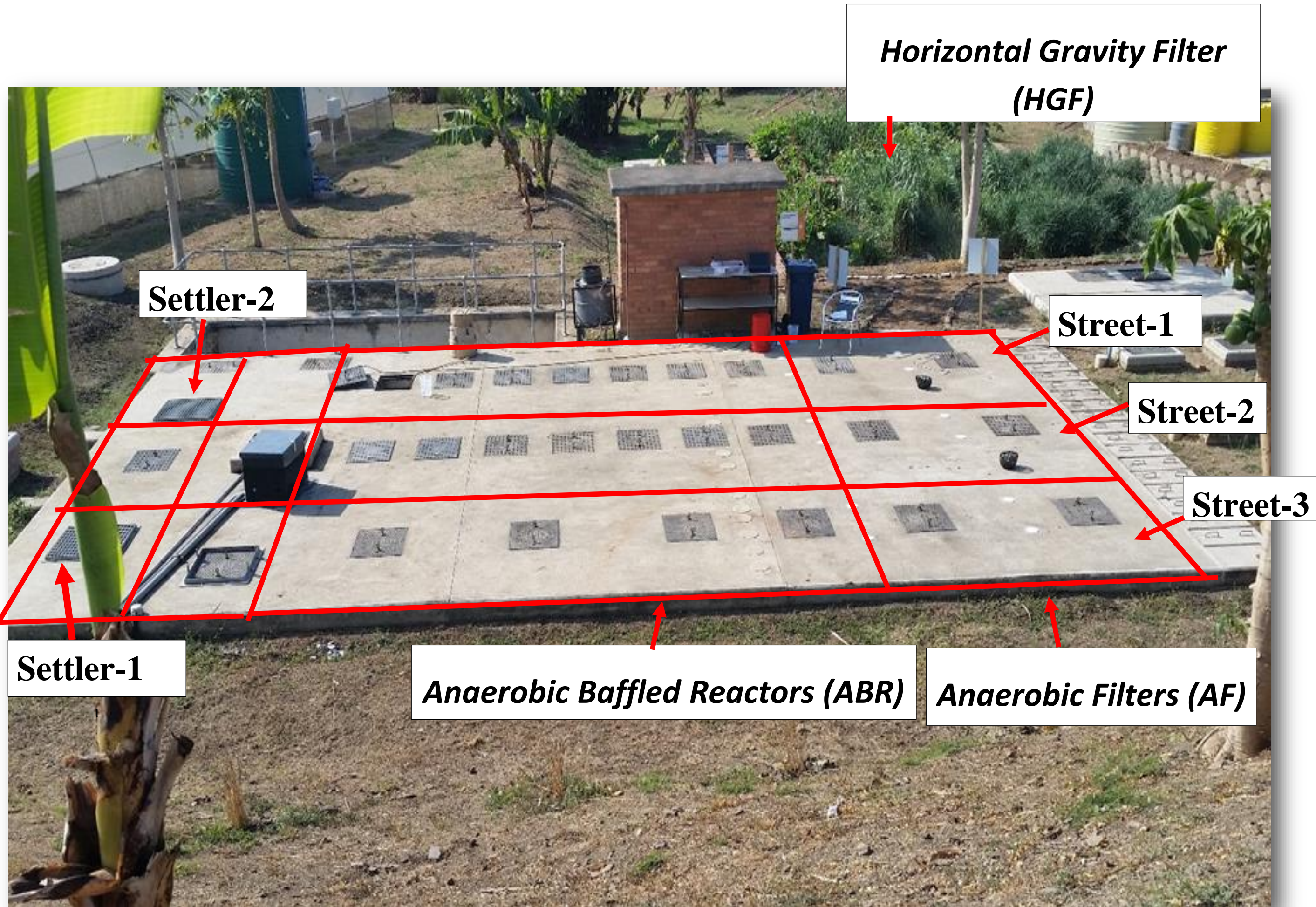


Figure 1. Newlands Mashu DEWATS plant in Durban, South Africa

## METHODS



Figure 2. Grab sampling

- Sampling.** liquid samples were collected by submerging the sampling device (1-L plastic bottle attached to 2m rod) into chambers. Solids were sampled with a TS column sampler. Sampling took place over the course of 3 weeks.
- Flow rate** distribution measured in each chamber using Fluorescein and Lithium Bromide tracers. *Equipment: GGUN-FL fluorimeter and MP-AES Spectrophotometer.*



Figure 3. COD titration rainbow

- Chemical oxygen demand (COD)** degradation using a titrimetric method to calculate COD after the total COD and soluble COD samples are digested. *Equipment: Ethos One High Performance Microwave Digestions System.*
- Total solids (TS), volatile solids (VS), total suspended solids (TSS) and volatile suspended solids (VSS)** measured using gravimetric methods, drying oven and muffle furnace.

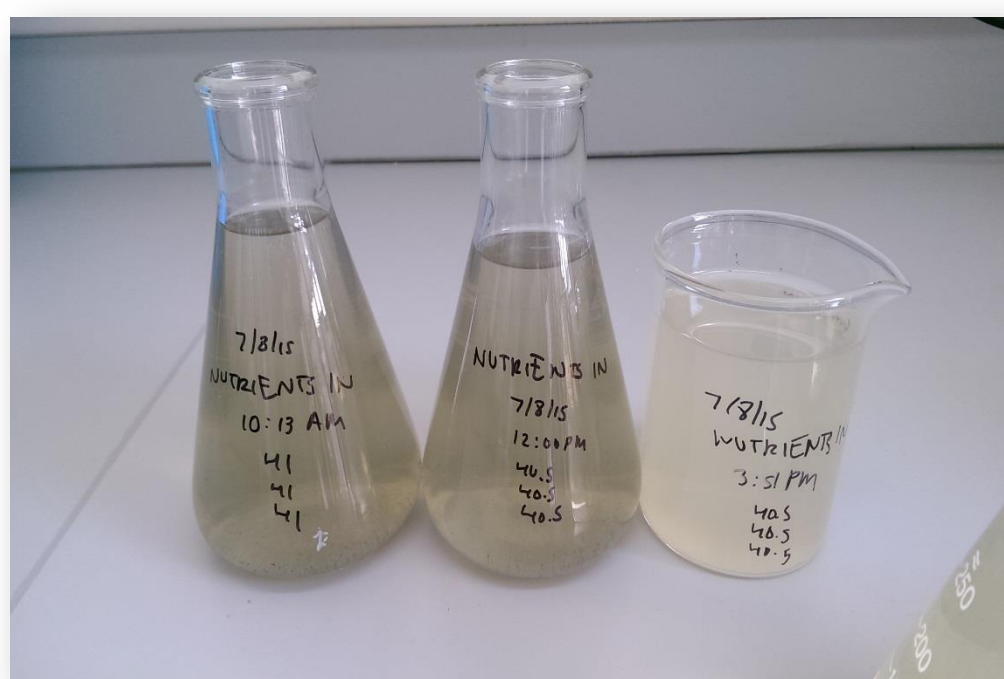


Figure 4. Nutrient Samples

- Nutrient concentrations in wetlands** obtained by sampling the inlet syphon and outlet of horizontal planted gravel filters. Colorimetry and spectrophotometry were used to obtain concentration values.
- Fluorescence intensity** of tryptophan-like compounds (TRP; surrogate for biodegradable organic matter) and chromophoric dissolved organic matter (CDOM) measured using in-situ 2-D fluorescence spectrophotometer (Turner C-3).

## RESULTS

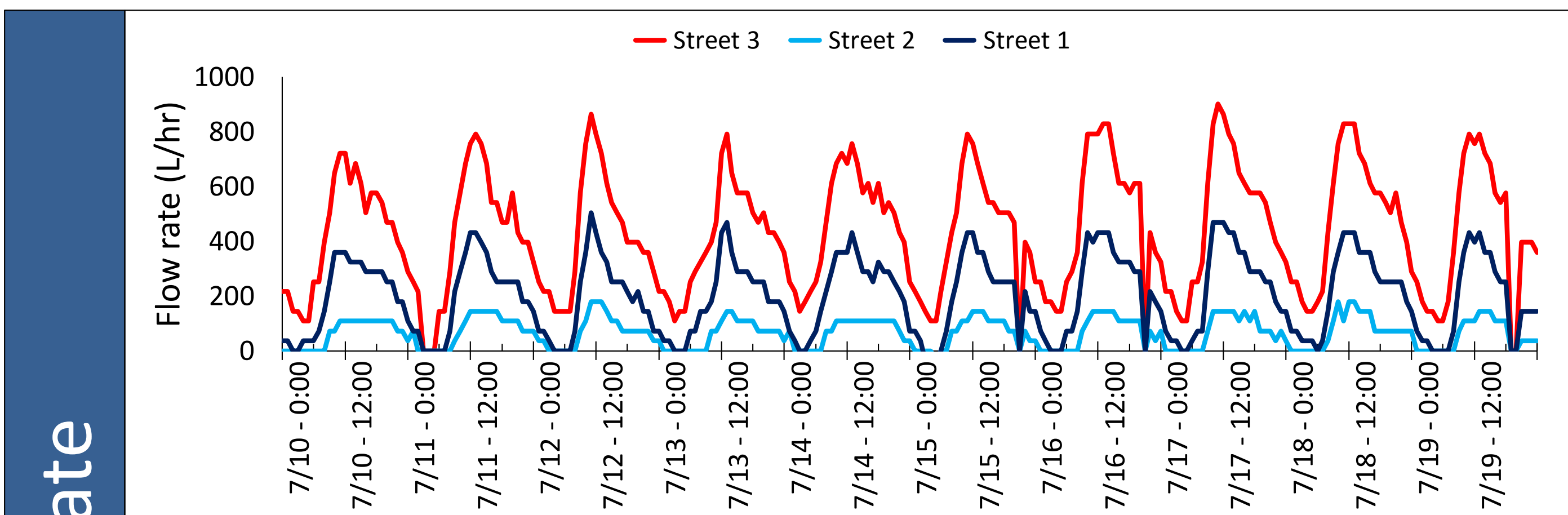


Figure 5. Flow rates for 10 July (Friday) – 19 July 2015 (Sunday). Flow peaked at around 13:00 reaching >790 l/hr in street 3 with a noticeable flow pattern peaking in the morning and declining in the afternoon.

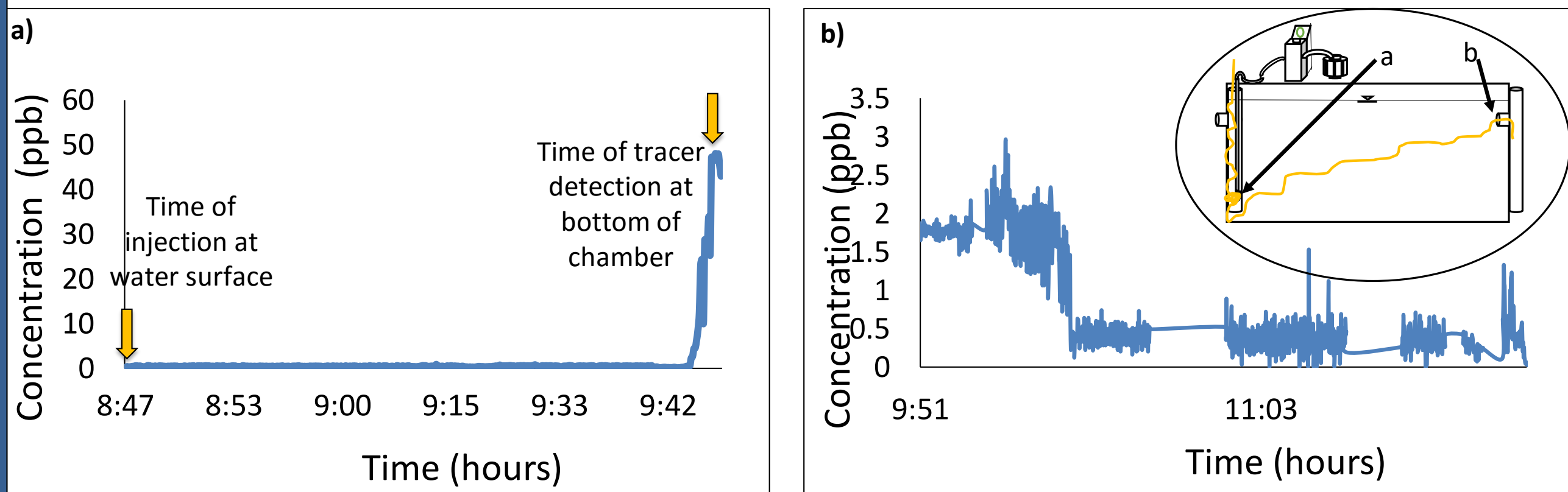


Figure 6. Concentration of fluorescein tracer measured at a) inlet bottom (165 cm depth) and b) the outlet of Chamber 7 of the ABR. Fluorescein concentration at the outlet was much lower than at the inlet due to dispersion. HRT in the chamber was found to be 3.55 hours.

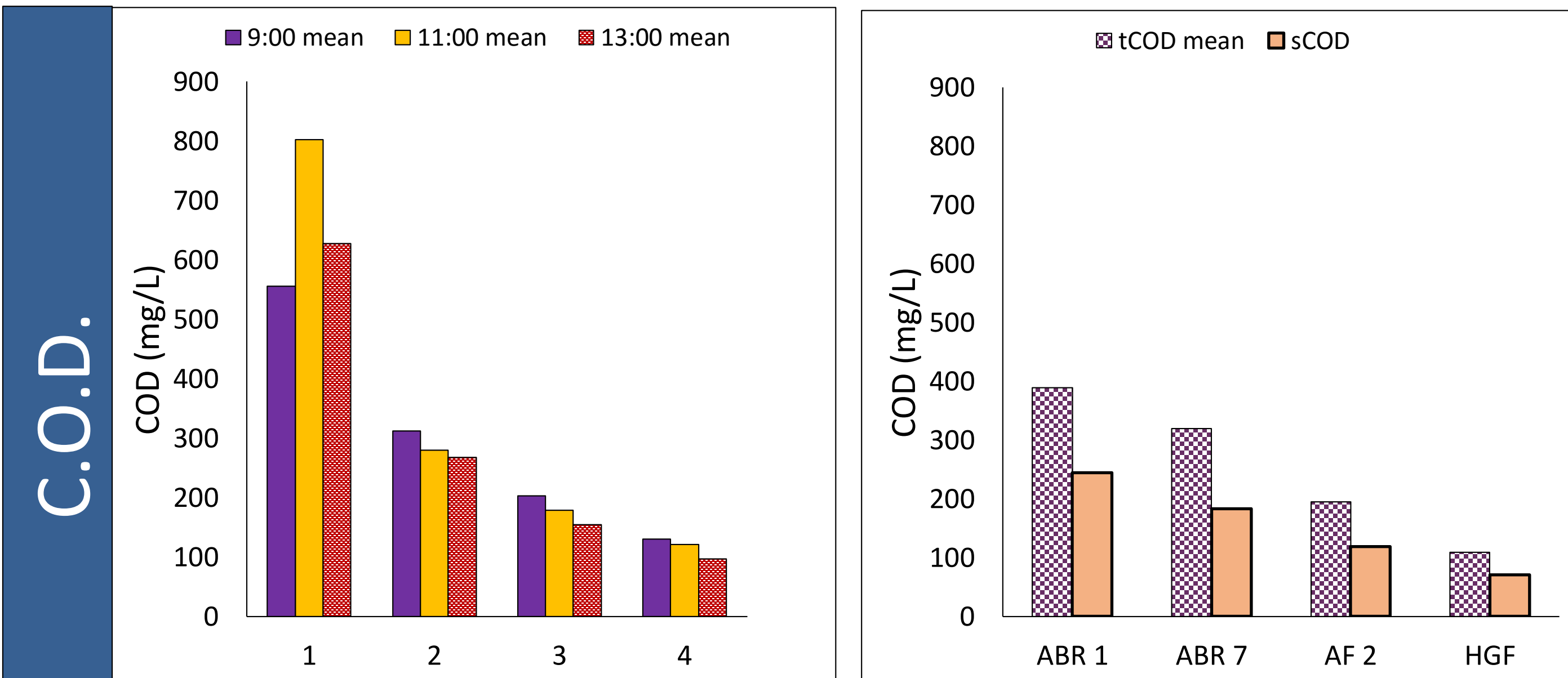


Figure 7. tCOD concentrations in Street 1 at 9:00, 11:00, and 13:00 on 6 July, 2015. Highest COD concentrations occur at 11:00 and greatest decrease in COD (50% to 75% reduction) is observed between ABR 1 and ABR 7.

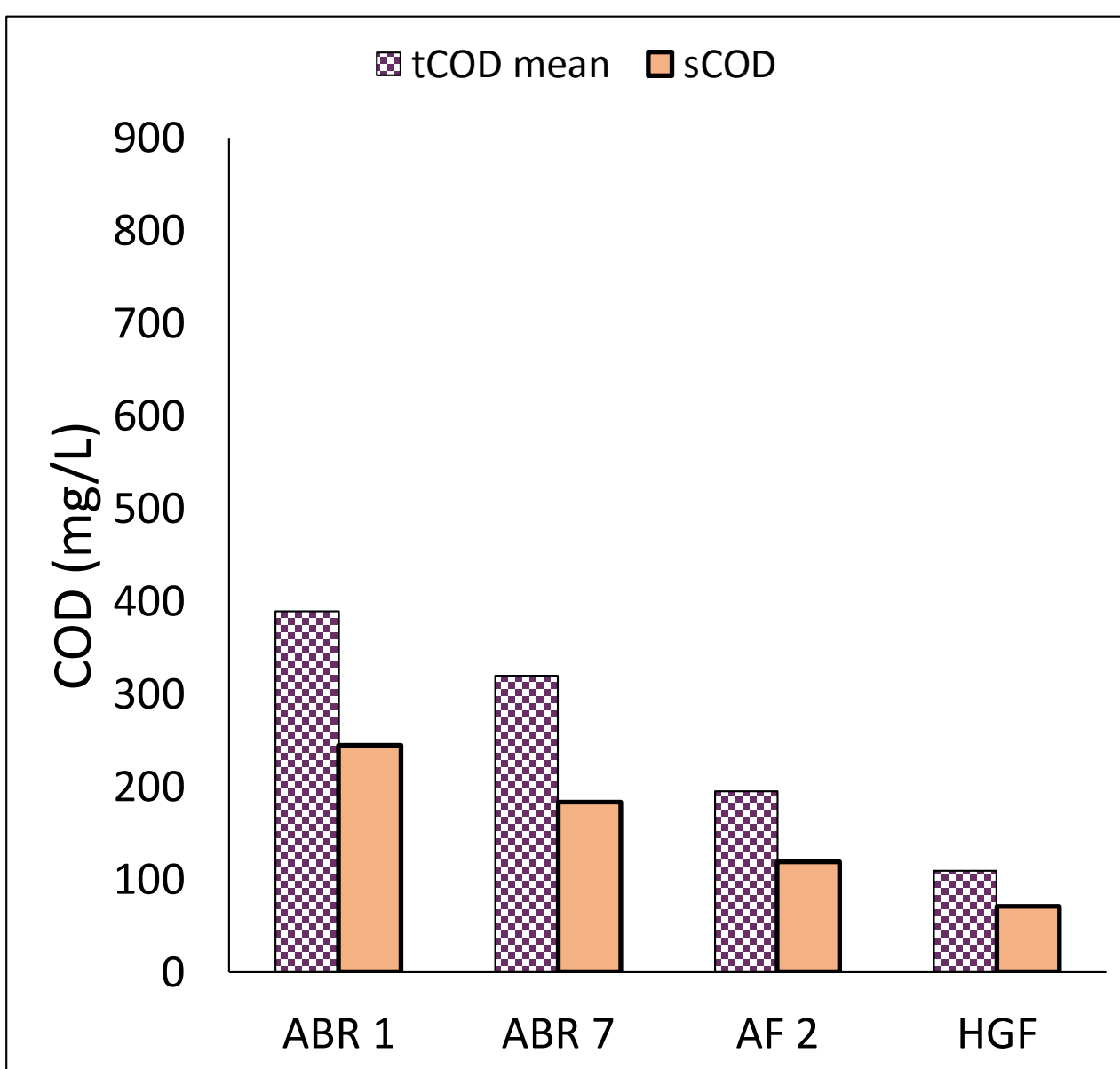


Figure 8. Total COD (tCOD) and soluble COD (sCOD) concentrations in Street 1 on 30 June 2015.

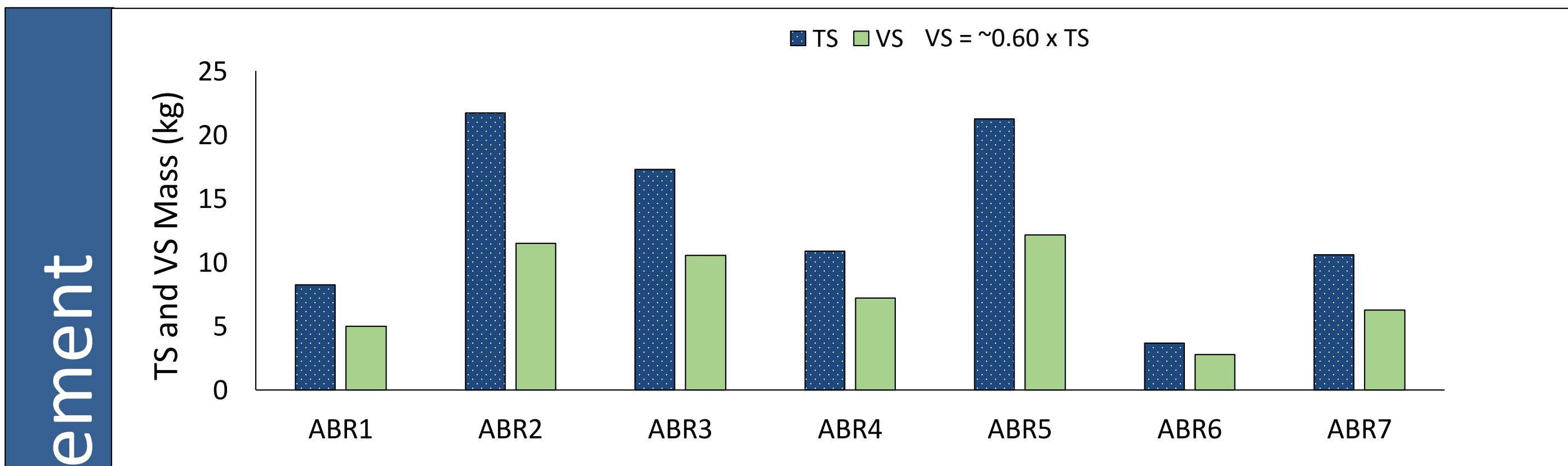


Figure 9. Mass of TS, VS, and the ratio of TS/VS of individual ABR chambers of Street 1.

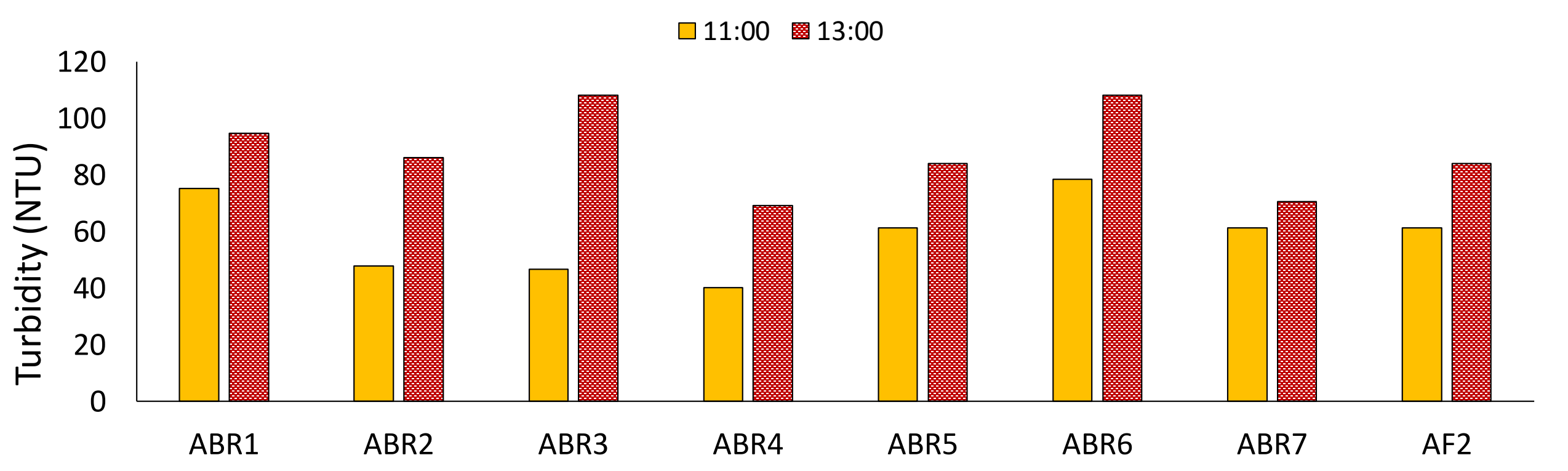


Figure 10. Turbidity for the individual chambers of the ABR from Street 1. Higher values of turbidity were recorded in each chamber at 13:00 which corresponded to a slower flow rate of 252 L/hr than 11:00 at 288L/hr.

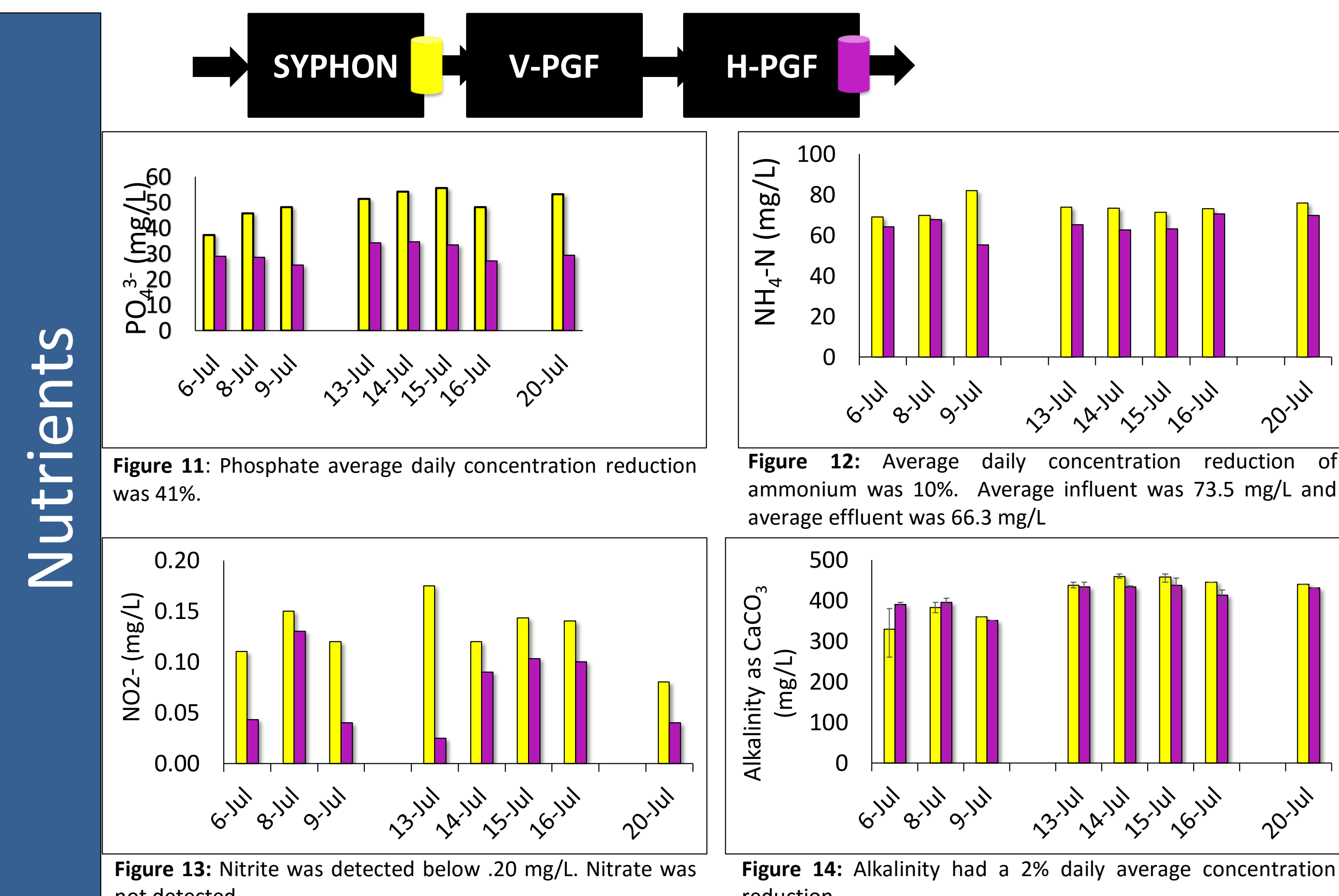


Figure 11: Phosphate average daily concentration reduction was 41%.

Figure 12: Average daily concentration reduction of ammonium was 10%. Average influent was 73.5 mg/L and average effluent was 66.3 mg/L

Figure 13: Nitrite was detected below .20 mg/L. Nitrate was not detected.

Figure 14: Alkalinity had a 2% daily average concentration reduction.

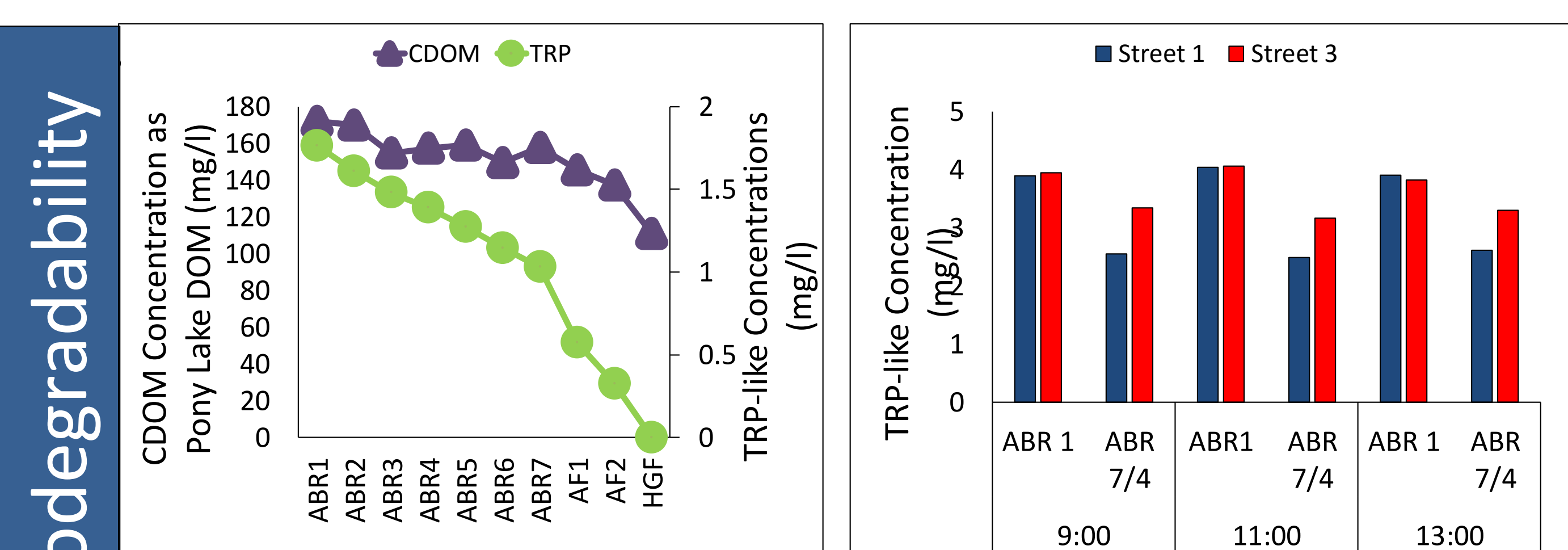


Figure 15. Street 1 Chromophoric Dissolved Organic Matter (CDOM) and tryptophan (TRP) concentrations in the ABR, AF, and HGF measured on 7 July 2015 at 11:00. TRP decreases the most in AF chambers.

Figure 16. Tryptophan (TRP) concentrations in the ABR inlet and outlet in streets 1 (blue) and 3 (Red) at 9:00, 11:00, and 13:00 on 13 July 2015. Street 3 is consistently higher at the ABR outlet at every time point.

## CONCLUSION

- Flow rate has diel variation. Peak Q occurs between 10:00 and 12:00.
- Due to ABR geometry, the highest Q occurs in Street 3.
- Fluorescein tracer test results indicate a hydraulic residence time of 3.55 hours per ABR chamber.
- Street 1 and 3 not significantly different for tCOD values but planted gravel filter greatly decreases xCOD.
- Planted gravel filter was most efficient in removing phosphate. Nitrification was not observed.
- Fluorescent biodegradable organic matter (TRP) decreased most in the anaerobic filters.
- Less removal of biodegradable organic matter in street with higher flow and fewer chambers (Street 3).
- VS represents approximately 60% of TS in all the chambers, and lowest concentrations are found in the last two ABR chambers.
- Greater turbidity corresponded with lower flow rates.

## REFERENCES & ACKNOWLEDGEMENTS

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