

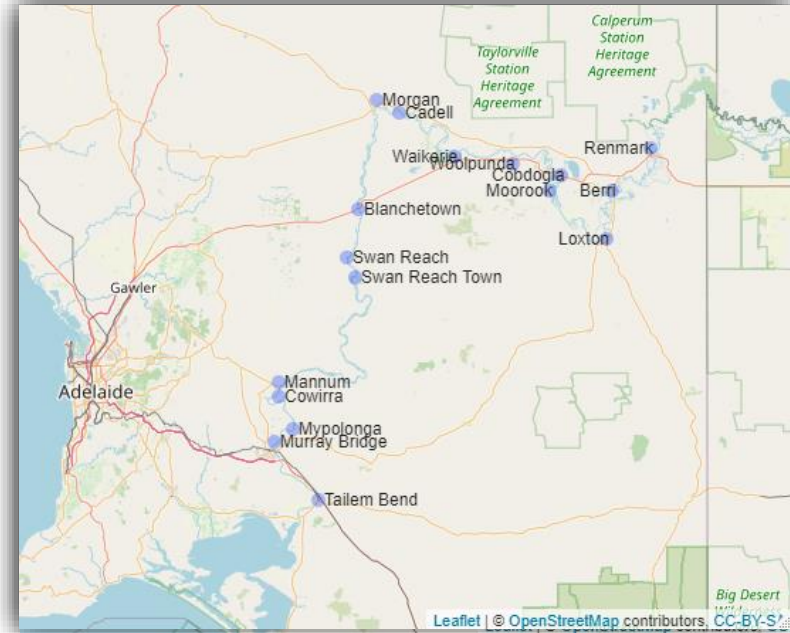
# Journey to the source of odour; dealing with extreme algal challenges

## 8<sup>th</sup> AU & NZ Cyanobacteria Workshop

Florence Choo  
26/09/23

# A challenging start to 2023

- 22 of our SA Water and Trility operated water treatment plants source water from the river
  - Mix of conventional and UF membrane GAC WTPs
- Metropolitan Adelaide receives River Murray water via the Mannum-Adelaide pipeline
- Largest flood event since 1956 in the Lower River Murray (Nov 2022 – Feb 2023).
- Floods in Lower River Murray from November 2022 to February 2023
  - Heavy rain and flood events from interstate
- 3<sup>rd</sup> largest flood event recorded in South Australia
- Peak flowrate was 186 GL per day on 22<sup>nd</sup> December
- Aftermath of the Lower River Murray (LRM):
  1. **Unprecedented T&O issues with relatively low cell numbers in 2023**
  2. **Persistent cyanobacteria issues impacting WTP performance**



# Cyanobacterial blooms along the River Murray

**1991:** Darling River, >1000 km impact: environmental disaster, livestock killed, species: *Dolichospermum circinale*

**2007 – 2010:** Millennial drought – *D. circinale* blooms

**2016:** *Chrysochloris ovalisporum* bloom – bloom never reached South Australia [now identified as *Dolichospermum brachiatum*], 999 ng/L geosmin detected at Renmark (SA)

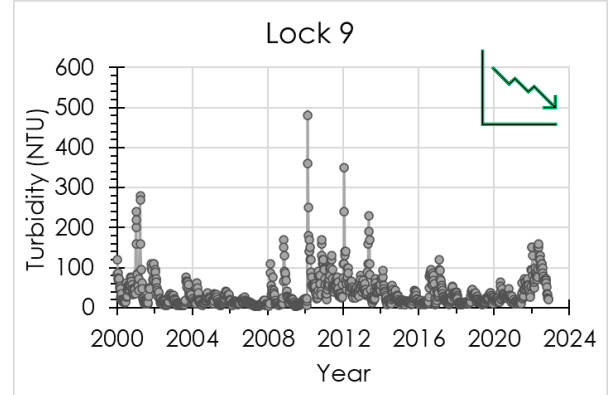
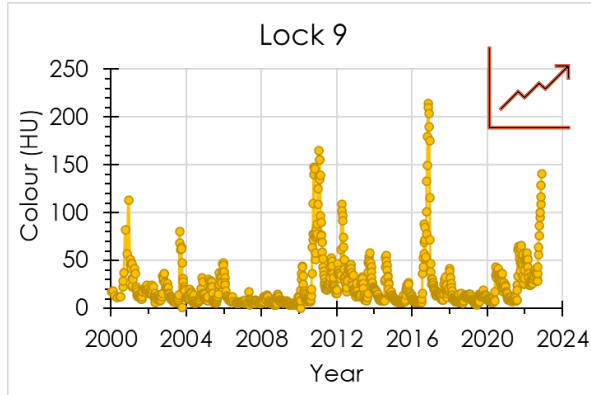
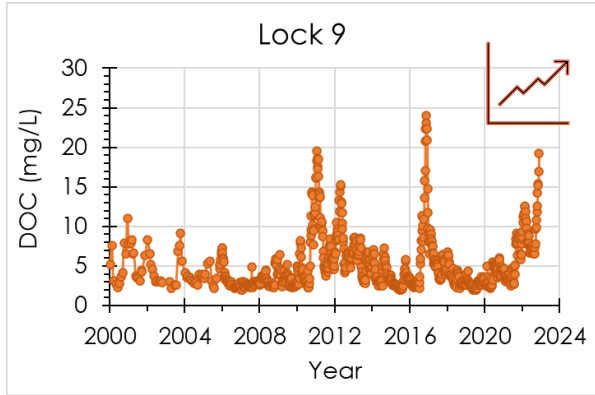
**2021:** *Dolichospermum brachiatum* bloom again, reached SA WTPs (as far out as Barmera)

**2022:** High algal counts in summer which transitioned to high MIB concentrations in winter (8 months of activity)

**2023:** Extreme MIB challenge, persistent cyanobacteria in WTPs



# Timeline of flood event and general WQ



## Post flood event

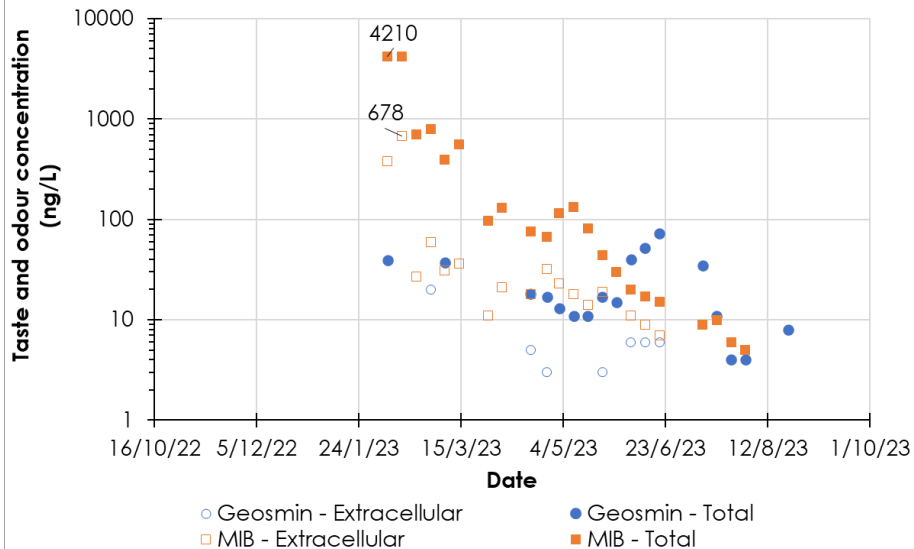
Date	pH	True Colour	UV <sub>abs254nm</sub>	Turbidity	Alkalinity	Conductivity	DOC	MIB – Total (ng/L)	MIB – Extracellular (ng/L)
14/02/23	8.00							<b>4170</b>	<b>678</b>
Total Cyanobacteria (cells/mL)		Other algae (cells/mL)		Actinomycetes (CFU/mL)		Deoxycylindrospermopsin (µg/L)		Saxitoxin gene (gene copies /mL )	
32,500		6300		20		0.12		Detected – 1400	

# 1. Ongoing T&O concentrations in the river

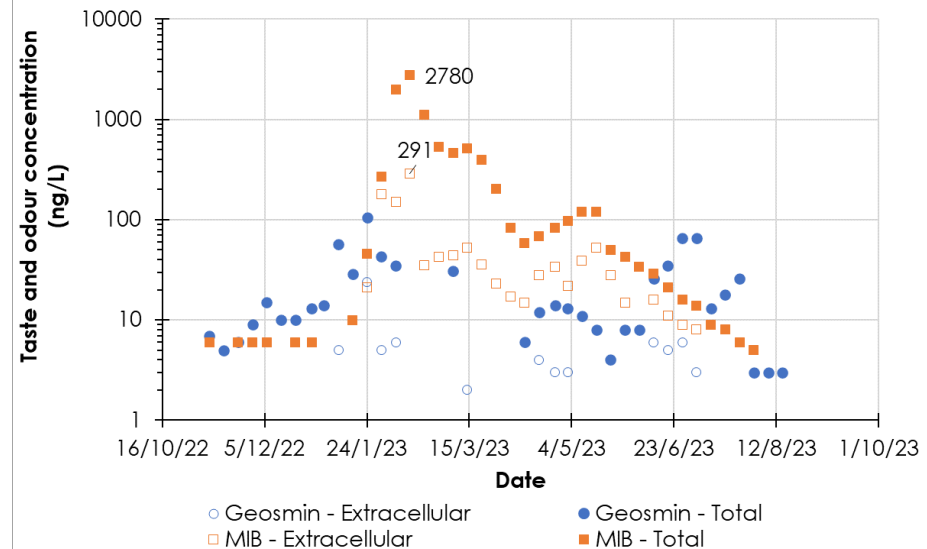
In Vic/NSW

In SA

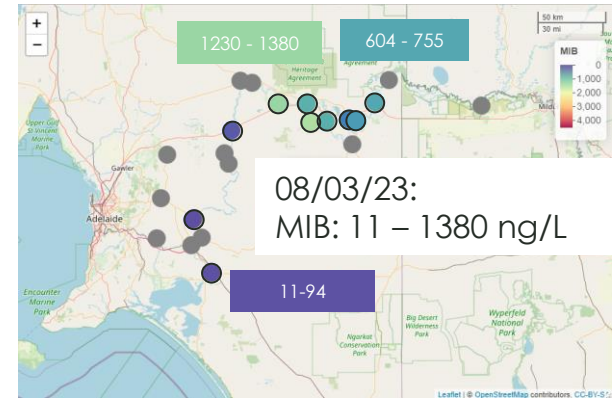
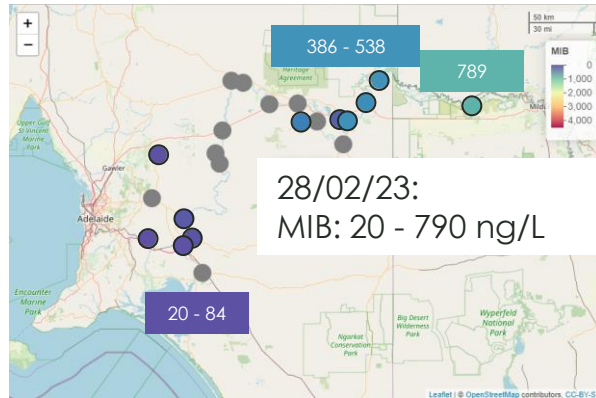
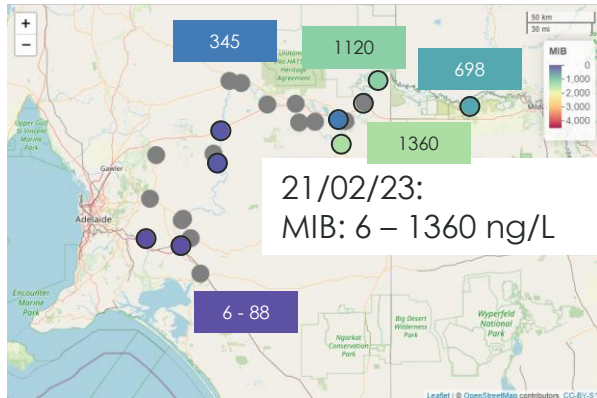
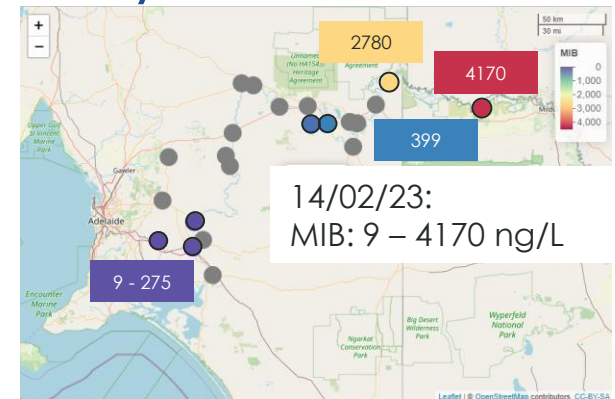
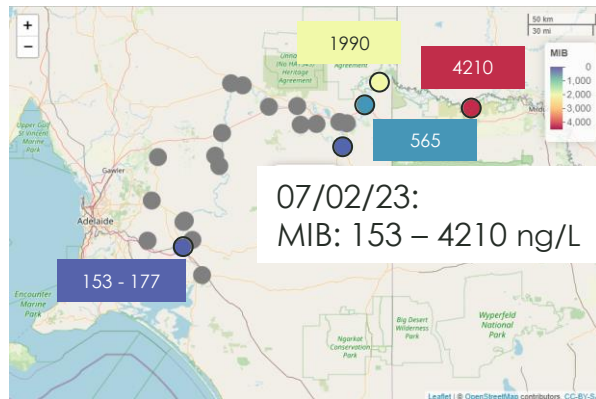
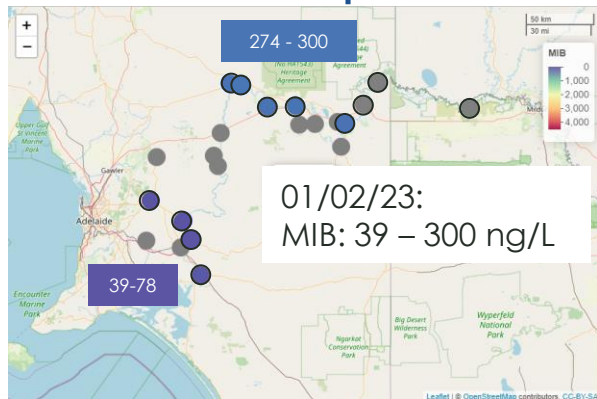
T&O concentrations @ Lock 9



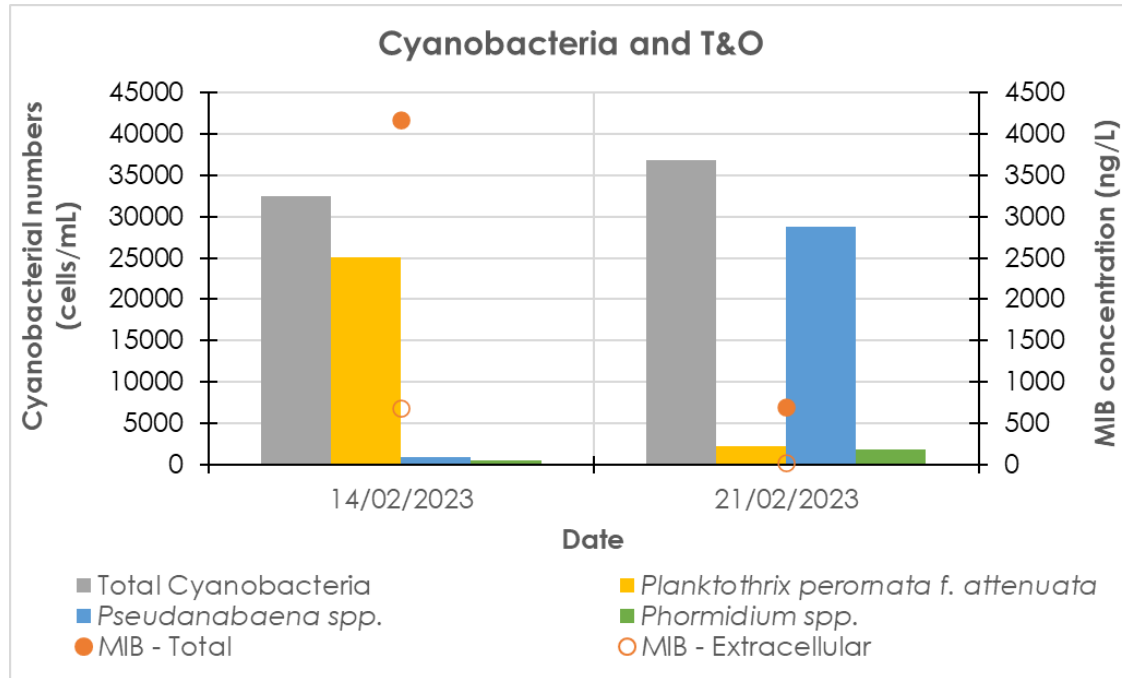
T&O concentrations 11km Downstream of lock 6



# Timelapse of MIB in the River Murray



# *Planktothrix perornata f. attenuata* was the dominant species (77%)



- 21/02/23 – *Pseudanabaena* spp. was the dominant cyanobacteria a week after

# MIB quotas

Date		14/02/23	21/02/23
MIB (ng/L)	<b>Total</b>	<b>4170</b>	<b>698</b>
Cyanobacteria (Cells/mL)	<b>Total Cyanobacteria</b>	<b>32500</b>	<b>36800</b>
	<i>Planktothrix perornata f. attenuata</i>	25100	2170
	<i>Pseudanabaena</i> spp.	860	28800
	<i>Phormidium</i> spp.	468	1830
Quota (ng/cell)	<b>Total Cyanobacteria</b>	1.28 x10 <sup>-4</sup>	1.90 x10 <sup>-5</sup>
	<b><i>Planktothrix perornata f. attenuata</i></b>	<b>1.66 x10<sup>-4</sup></b>	<b>3.22 x10<sup>-4</sup></b>
	<i>Pseudanabaena</i> spp.	4.85 x10 <sup>-3</sup>	2.42 x10 <sup>-5</sup>
	<i>Phormidium</i> spp.	8.91 x10 <sup>-3</sup>	3.81 x10 <sup>-4</sup>

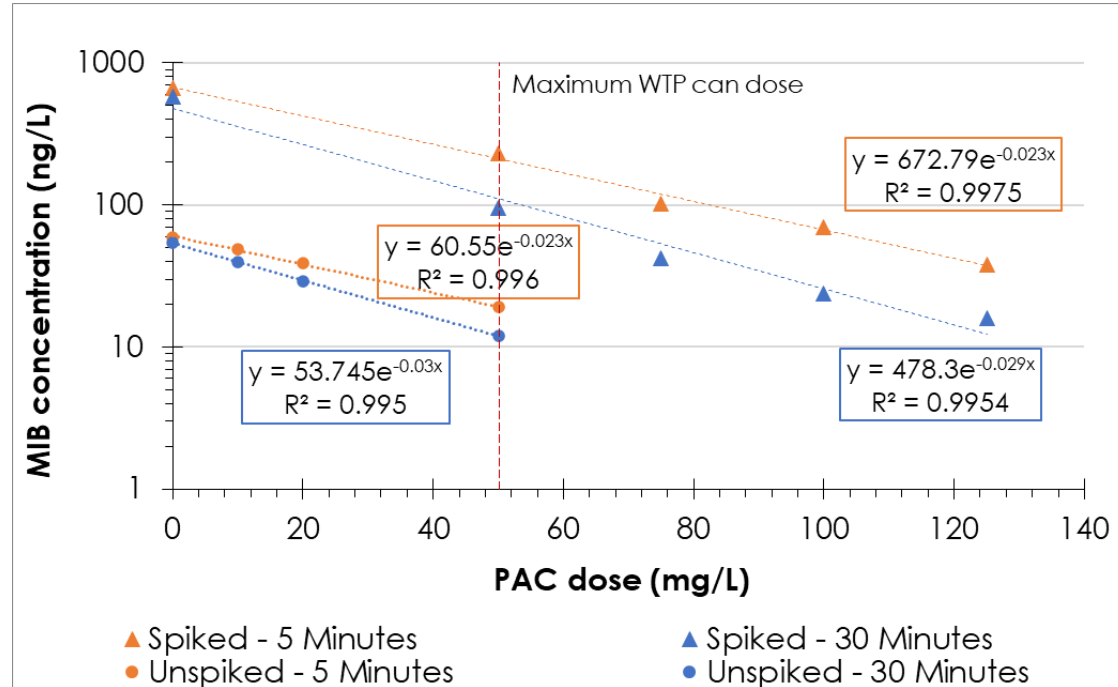
- Suspected cell quota for *Planktothrix perornata f. attenuata* is **1.66 – 3.22 x10<sup>-4</sup>** ng/cell
- *Planktothrix perornata f. attenuata* detected in **289** samples since the 2000s
- Highest previous cell number recorded at 1,470 cells/mL
- *Dolichospermum crassum* found in SA over 20 years of monitoring had a geosmin quota of **1.5 x10<sup>-04</sup>** ng/cell



# PAC kinetics tests validation

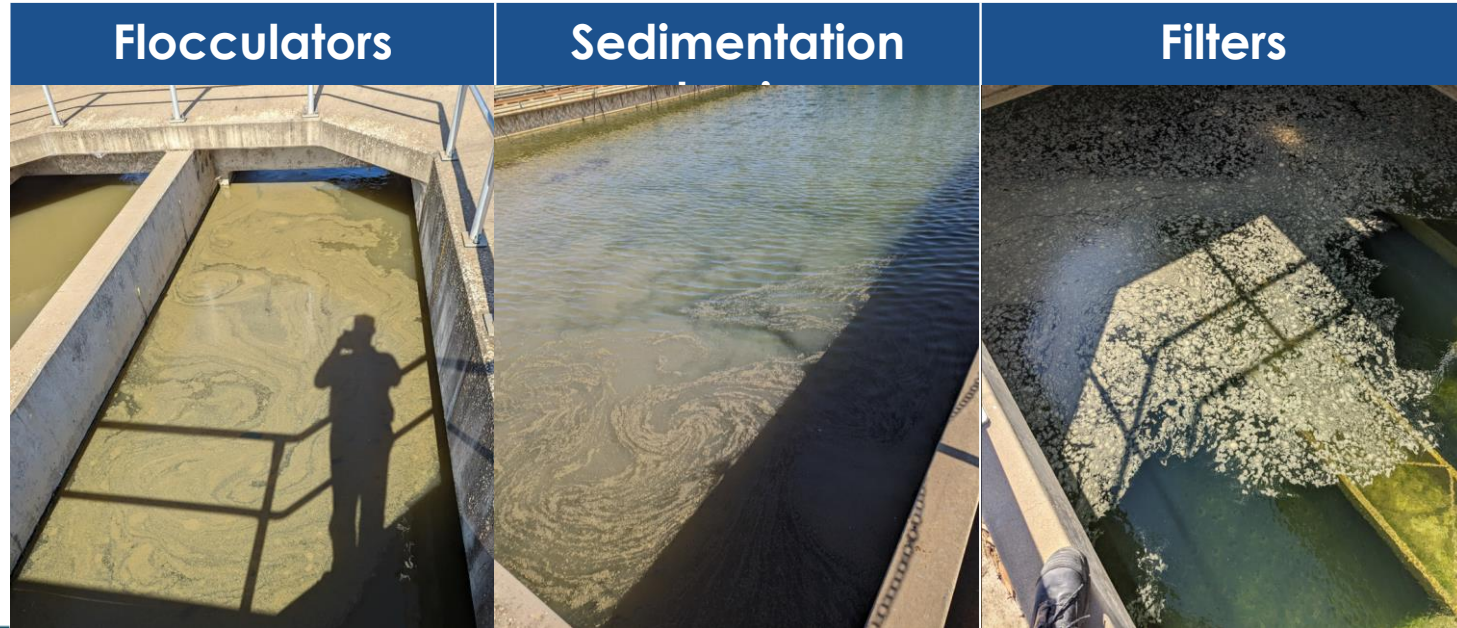
2 scenarios explored using PS1000:

1. Current scenario at a WTP – “As is”;  
Intracellular: extracellular = 90:10
  - Total = 660 ng/L
  - Extracellular = 60 ng/L
2. Simulated scenario if extracellular MIB > 500 ng/L; Intracellular: extracellular = 50:50
  - Total = 1130 ng/L
  - Extracellular = 660 ng/L

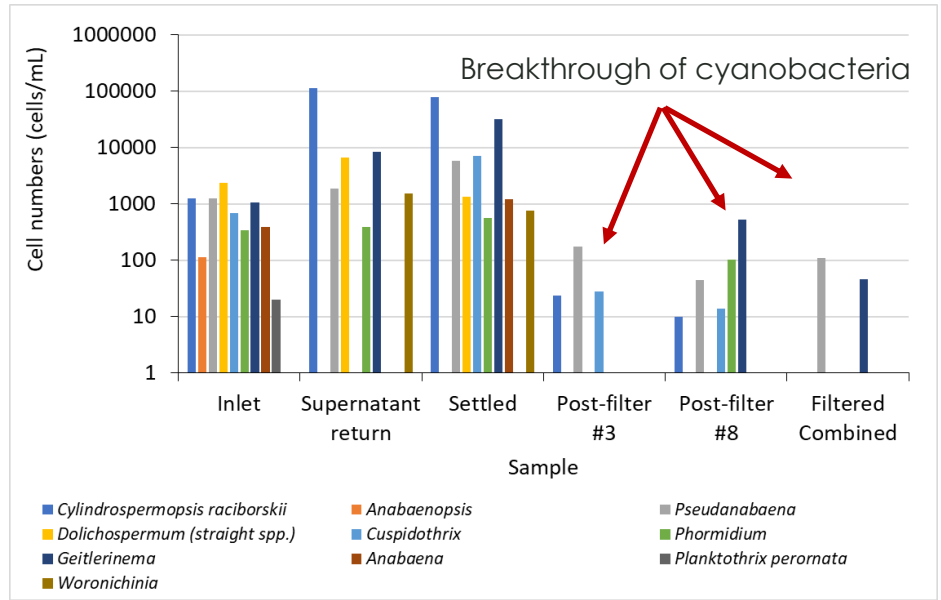
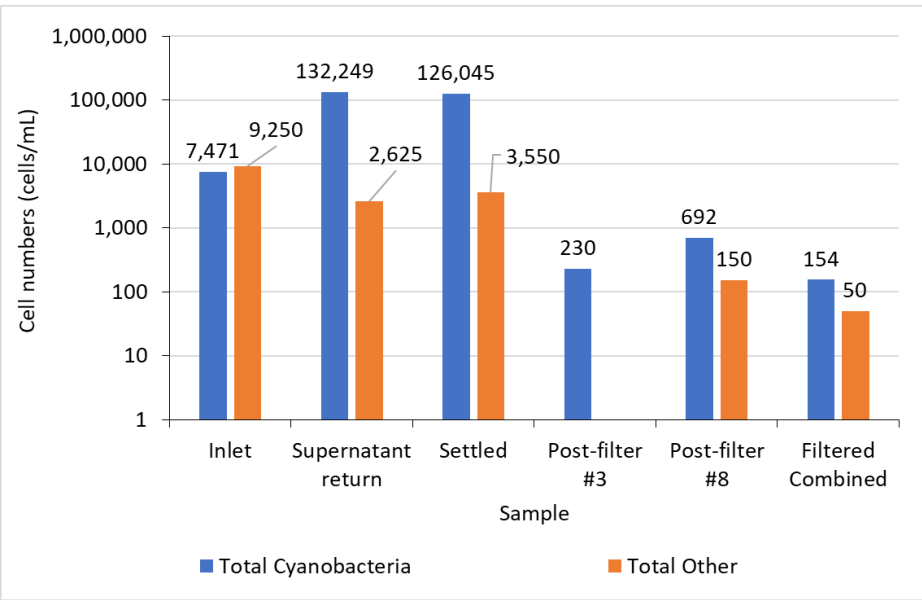


## 2. Continued Cyanobacteria issues at the WTPs

- Morgan WTP – Conventional WTP with biologically active filters
- Post the flood event (March to July) noticed filter runtime issues, required investigation

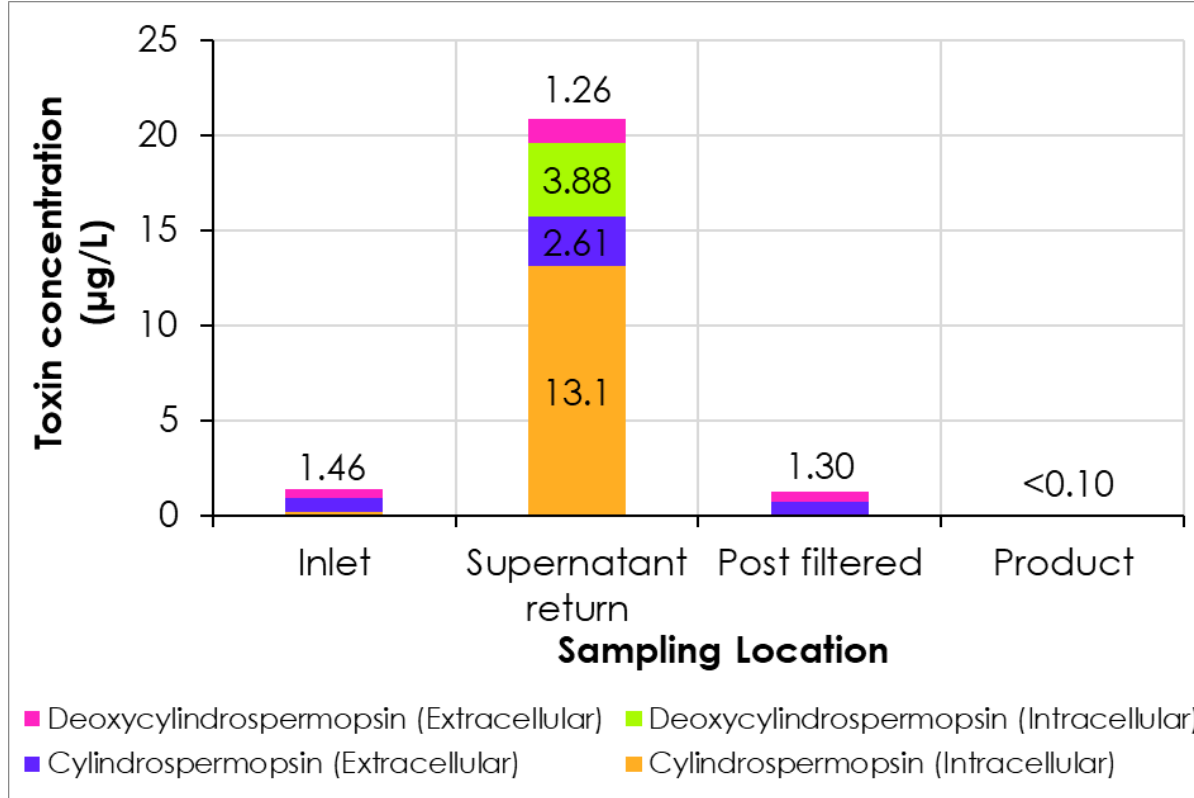


# Raphidiopsis raciborskii found at low numbers in the inlet but concentrated up in the supernatant return



Date: 21/06/23

# Toxin concentrations on the 29/06/23



# Findings from intensive sampling

Targeted sampling throughout the WTP showed the following issues:

- Relatively low numbers detected at the inlet (March to July 2023)
  - However, *Raphidiopsis raciborskii* (formerly known as *Cylindrospermopsis raciborskii*) was detected this far downstream of the River Murray (165km from Lake Alexandrina – Murray Mouth)
- Supernatant return was concentrating *Raphidiopsis raciborskii* cells.
- Breakthrough of cyanobacteria through the filter
- Presence of cylindrospermopsins throughout the treatment process
  - No toxins in final product as it is easily oxidised by the chlorine addition

**Action:** Non-routine monitoring of Morgan WTP inc. filter outlet and product water until the issues “resolved itself”

# Conclusion

The management of the 2022-2023 flood event aftermath was challenging. It followed with 2 main cyanobacterial issues

1. Large MIB concentrations detected (>4,000 ng/L)
  - Most of the MIB was intracellular (84%)
  - Determined the most probable species responsible was the seldom seen *Planktothrix f. perornata*
  - Most WTPs would be challenged to remove >500 ng/L of extracellular MIB
2. Flood events provided opportunity for other species to become a problem for WTPs. I.e. *Raphidiopsis raciborskii*
  - Potentially accumulating and producing cyanobacteria and toxins via the supernatant return
  - Observed breakthrough of cells and toxins through the filter
  - Chlorine CT exceeded requirements to ensure oxidation of toxin

# Acknowledgements:

Morgan WTP operators and personnel

Brett Kliem, Liz Quarrel and Claire Kolokas

Water Science tech team: Elloise Trotta, Con Kapralos, Miriam Nedic, Edith Kozlik

# making life flow