Wastewater GHG Emissions

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Wastewater GHG Emissions

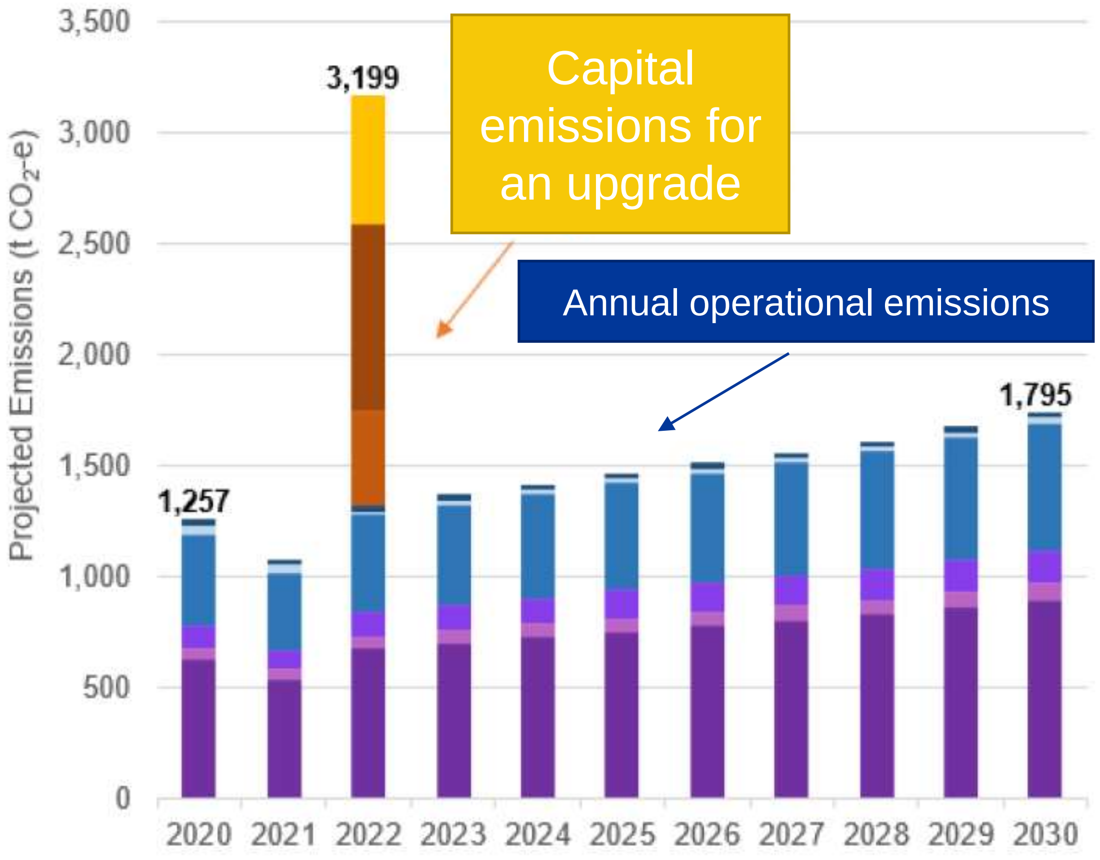
- Carbon footprint of a WWTP
- Operational carbon emissions & estimating these (different guidelines & changes to guidelines)
- N_2O and it's portion of a WWTP baseline
- The CWTP case study
- The Water NZ Climate Change SIG
- Work to consolidate + further our understanding

Council carbon neutral targets

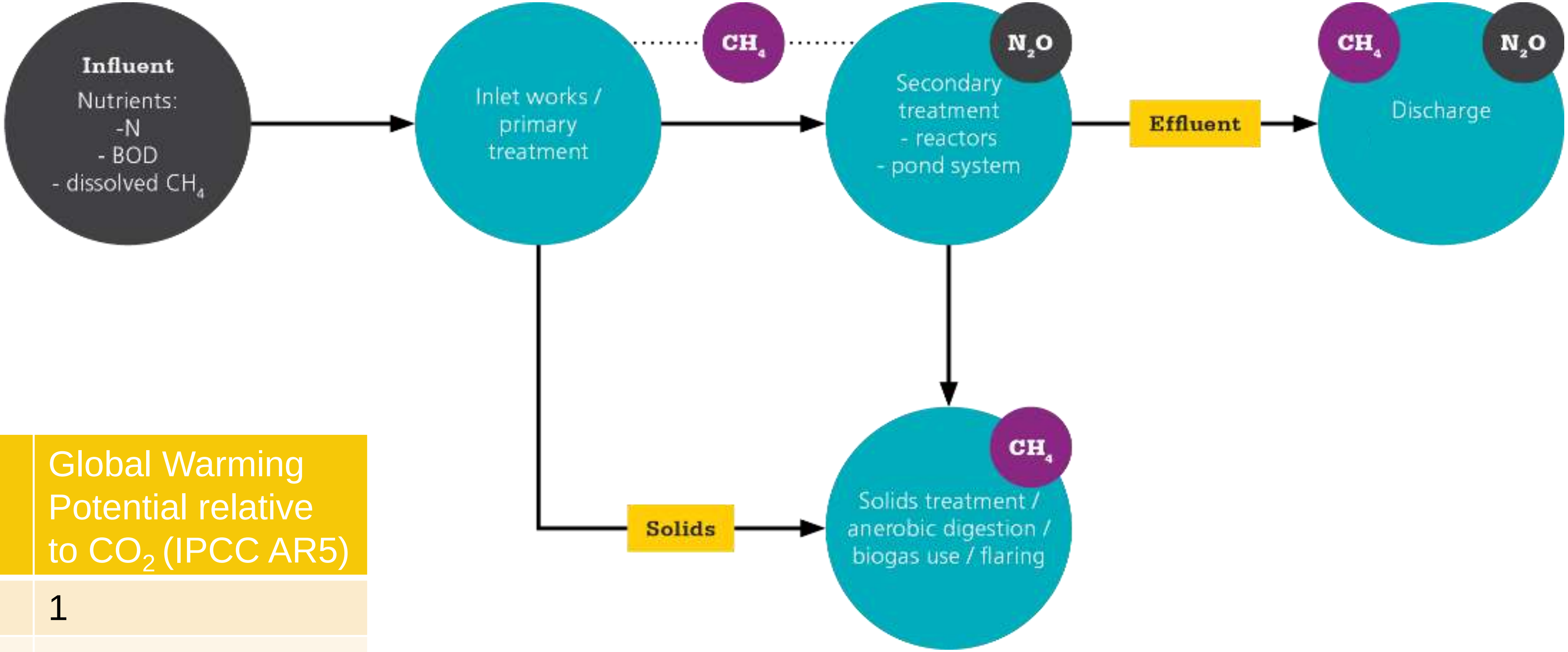
Council	2030	2050
Christchurch	Council to net zero	City to net zero (2045)
Wellington City	43%	Net zero
Auckland	50%	Net zero
Hamilton CC	50% (ex. biogenic)	

The carbon footprint of a WWTP

- **Operational carbon** - emissions associated with the operations categorised into “direct” (CH_4 and N_2O, on-site energy use), and “indirect” (e.g. electricity, biosolids management, chemical consumption)
- **Capital carbon** - emissions associated with the creation of assets projects, those embodied in materials and used in construction processes (tCO_2-e).



Operational Carbon - Process Emissions



Green-house Gas	Global Warming Potential relative to CO_2 (IPCC AR5)
CO_2	1
CH_4	28
N_2O	265

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Wastewater Greenhouse Gas Emissions

Biosolids

Process CH_4

Process N_2O

Electricity

Discharge N_2O & CH_4

Source: Christchurch City Council

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Example | WWTP Potion of Council Organisational Emissions

Waipā

stuff ≡ environment

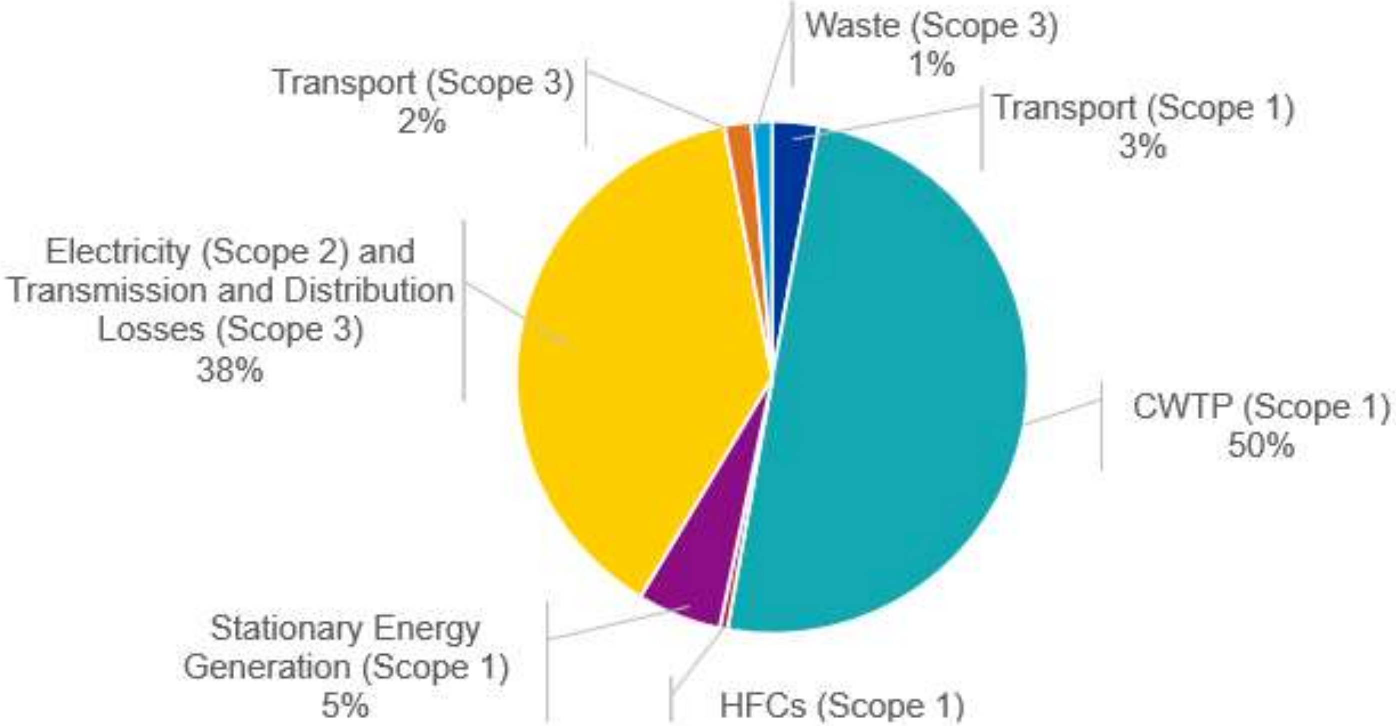
Wastewater plants highest contributor of greenhouse gas emissions in district

Lawrence Gullery · 05:00, Apr 14 2021

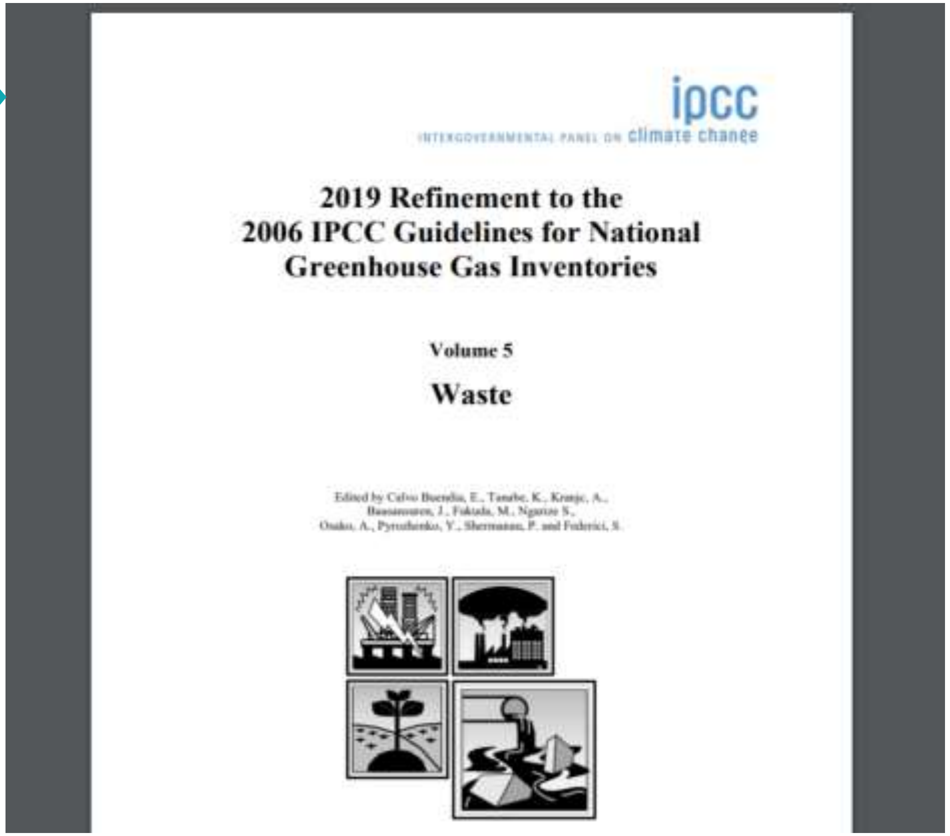
Finishing touches were recently put on the upgraded Te Awamutu Wastewater Treatment Plant while a new plant for Cambridge is in the planning stage

Reducing emissions from wastewater plants appears as the biggest challenge facing Waipā District Council if it wants to meet the expectations of the Climate Change Commission.

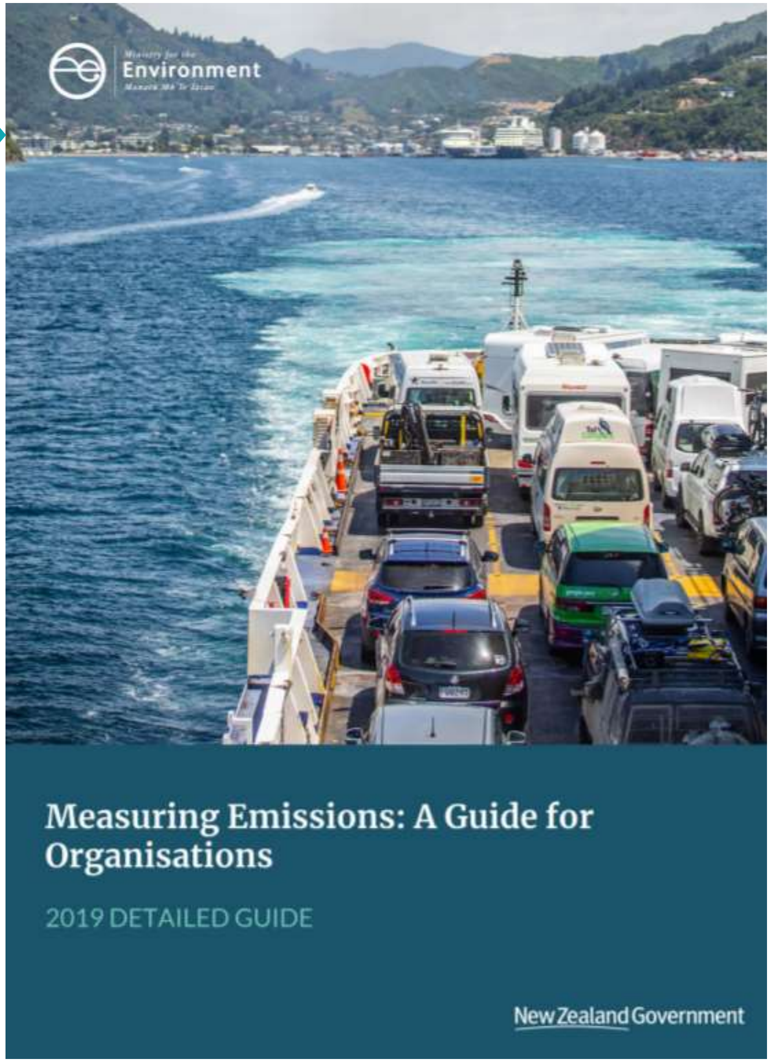
Christchurch



IPCC

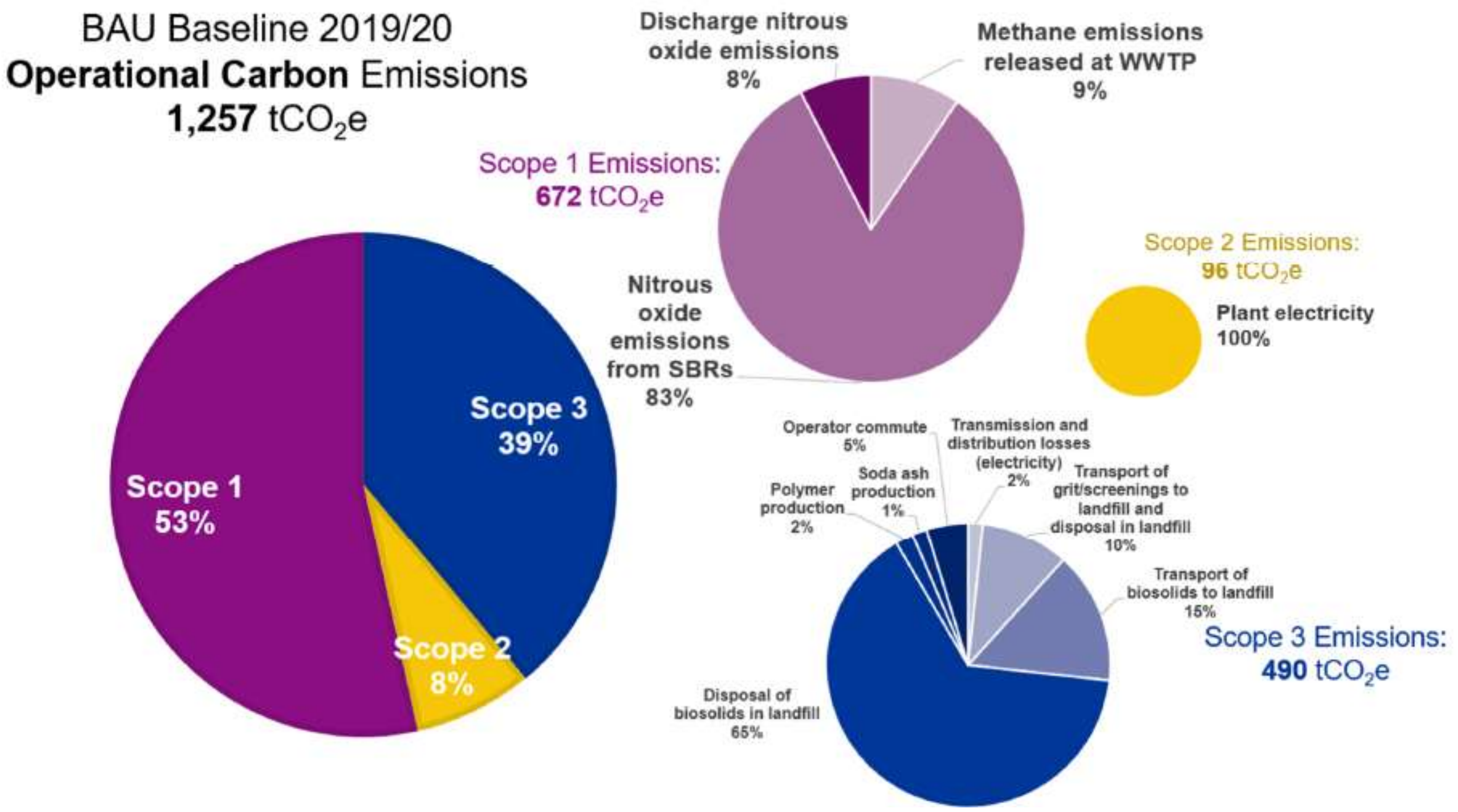


MfE



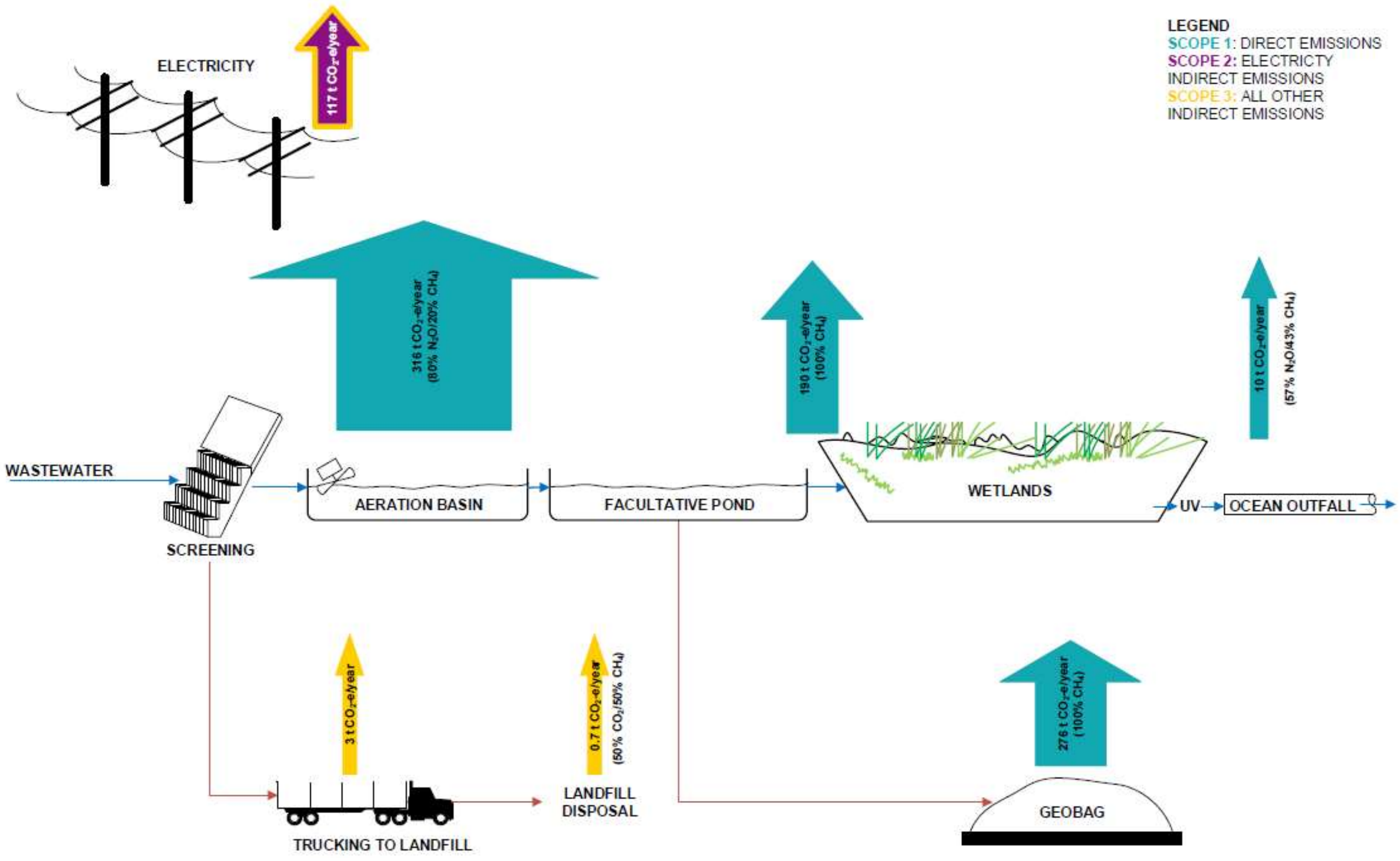
A variety of Emission Factors (EFs) are used to calculate emissions

Example Assessments (IPCC 2019)



- SBRs followed by UV and land based disposal
- Dewatered sludge trucked to landfill

Example Assessments (IPCC 2019)



- Aeration basin followed by facultative ponds and tertiary wetlands
- Ocean outfall disposal
- Geobagged sludge

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Summary – IPCC and N_2O plant EF

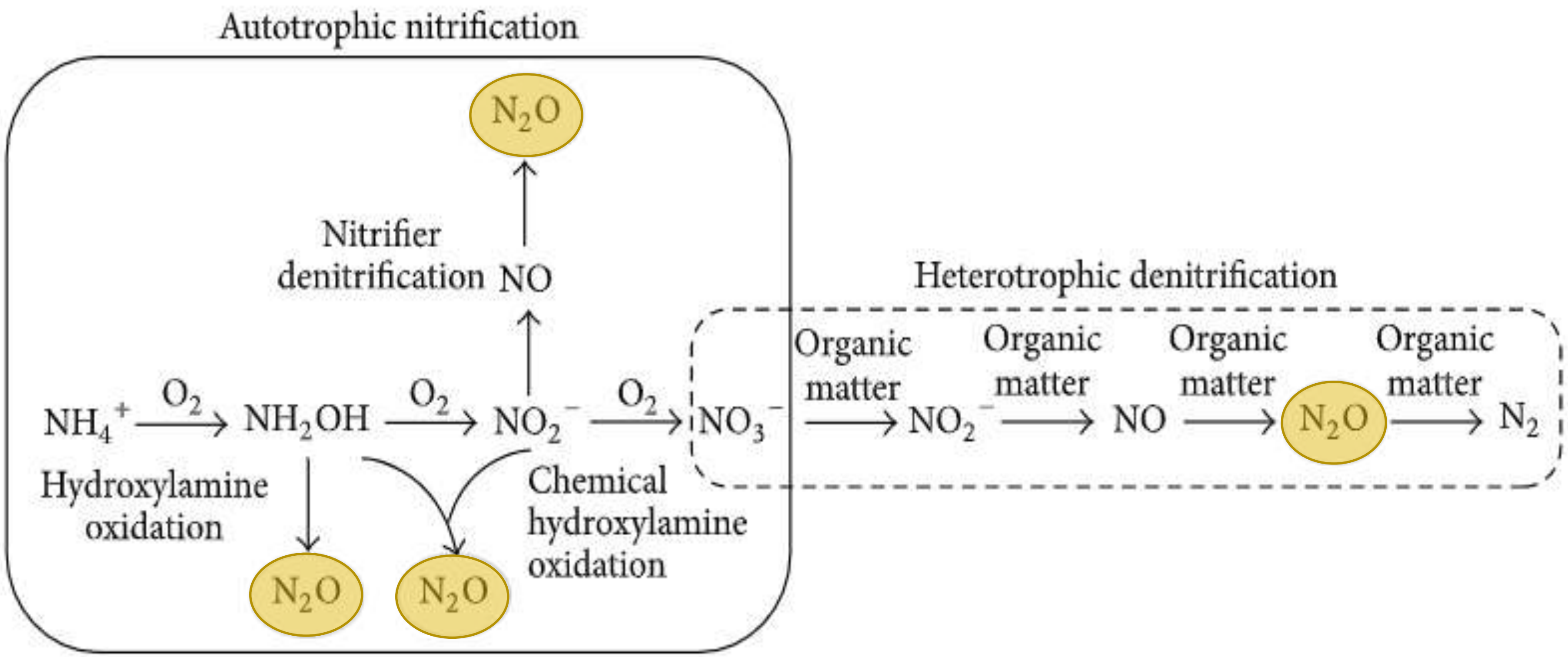
National level guidelines used for plant level estimates

Recent research focused on BNR plants as known to be a significant GHG contributor

Based on influent nitrogen (not nitrogen removed)

Large uncertainty on emission factors (EFs) – reflects large variation of these emissions within a process

N_2O Pathways of Production



Source: Campos, et al., 2016

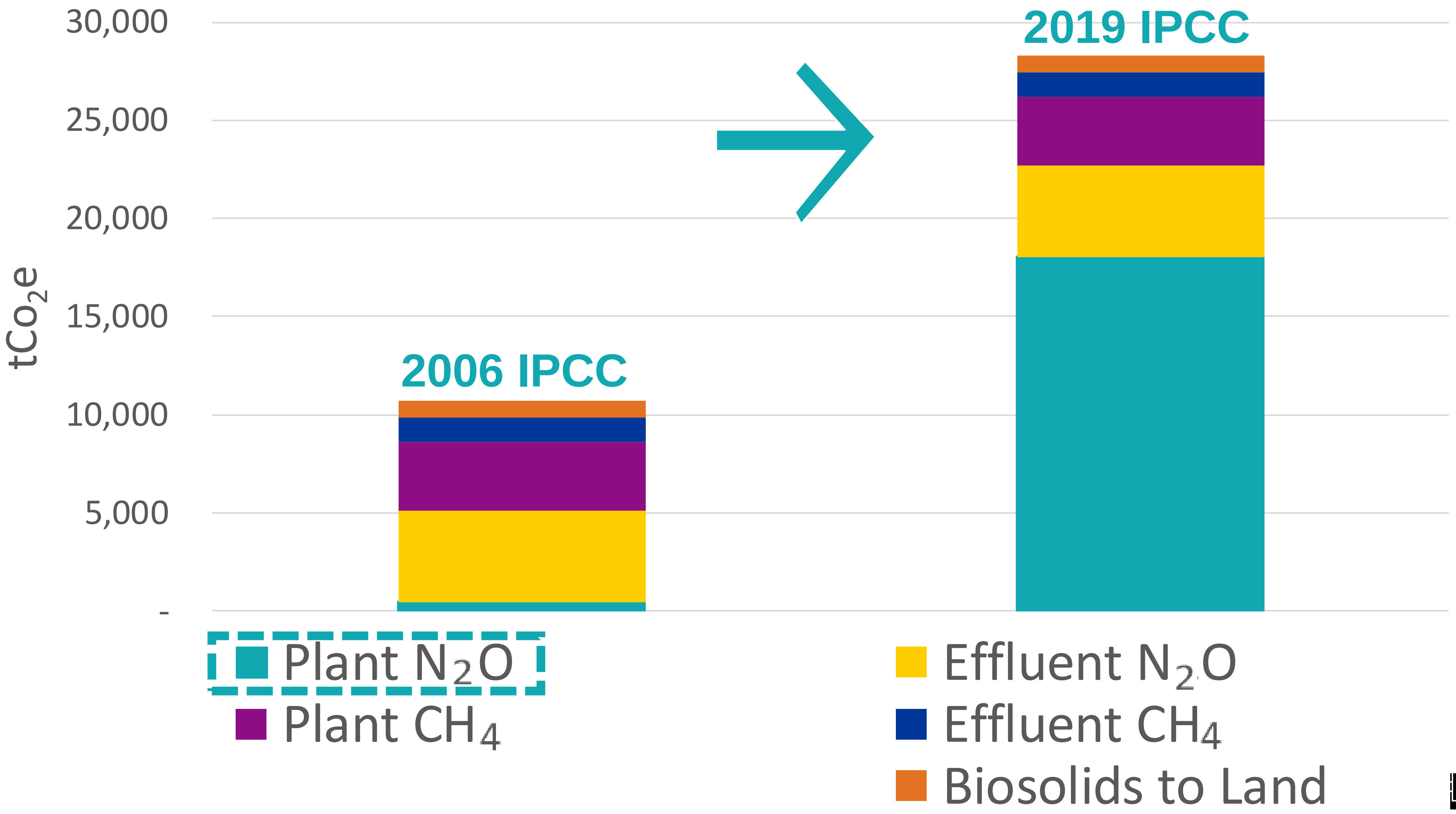
265 x the GWP of CO_2

N/dN processes

Stripped to air by aeration

Can remain dissolved → reduced to N_2

The Christchurch Example: Fortyfold increase in estimated N_2O emissions



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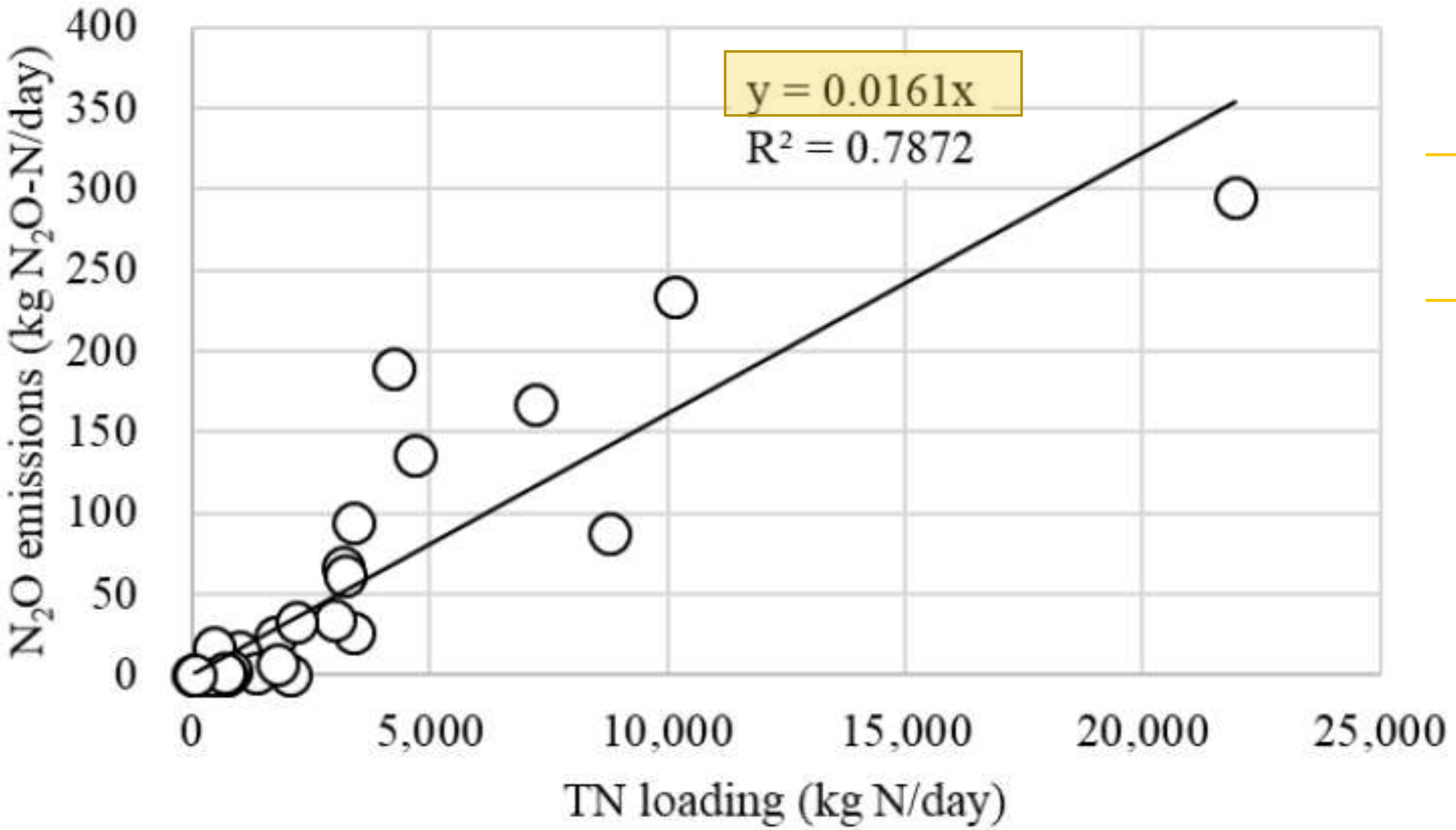
IPCC 2019 | Default Factors

Correlation between influent total nitrogen (TN) loading and N_2O emissions



- → Literature review of 30 data sets, full scale on-site testing
- → States more on-site exhaustive monitoring is required to develop different N_2O EFs for different treatment processes

Source: IPCC, 2019

IPCC 2019 | Default Factors

Table 6.8a (New) Default EF values for domestic and industrial wastewater			
Type of treatment and discharge pathway or system	**Comments**	**EF[1] (kg N_2O-N/kg N)**	**Range**
Discharge from treated or untreated system, $EF_{EFFLUENT}$			
Freshwater, estuarine, and marine discharge (Tier 1)	Based on limited field data and on specific assumptions regarding the occurrence of nitrification and denitrification in rivers and in estuaries	0.005[2]	0.0005 – 0.075
Nutrient-impacted and/or hypoxic freshwater, estuarine, and marine environments (Tier 3, if needed)	Higher emissions are associated with nutrient-impacted/hypoxic water such as eutrophic lakes, estuaries and rivers, or locations where stagnant conditions occur. See section 6.3.1.2 for more information.	0.019[2]	0.0041 – 0.091
Discharge to soil	Emissions reported in Volume 4		
Wastewater treatment system, EF_{plants}			
Centralised, aerobic treatment plant	N_2O is variable and can be significant	0.016[1]	0.00016 – 0.045
Anaerobic reactor	N_2O is not significant	0	0 – 0.001
Anaerobic lagoons	N_2O is not significant	0	0 – 0.001

Source: IPCC, 2019

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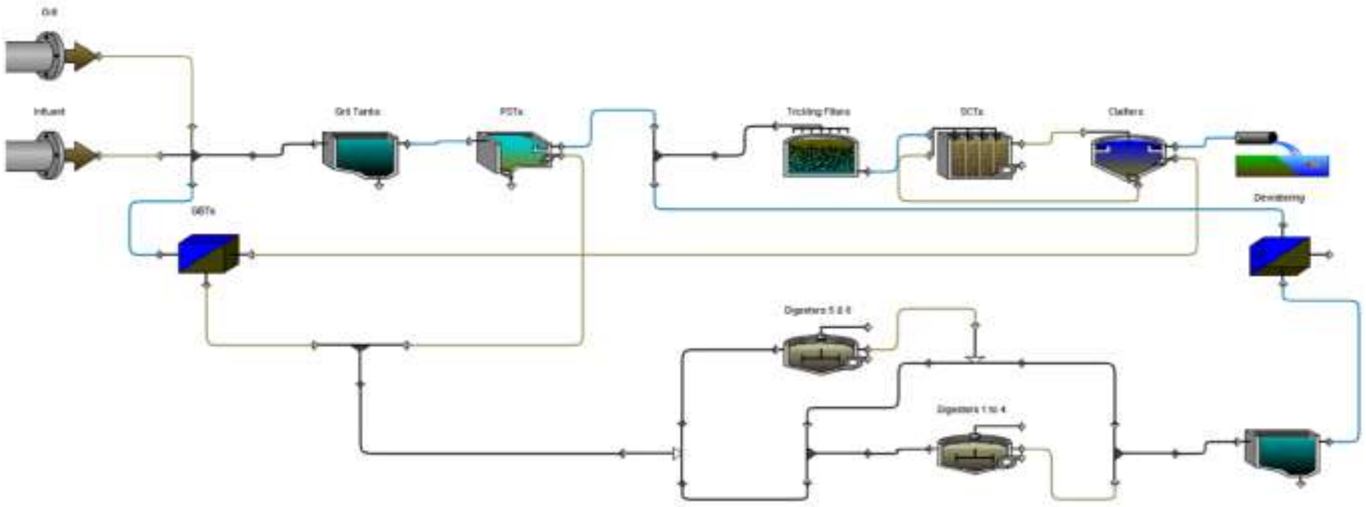
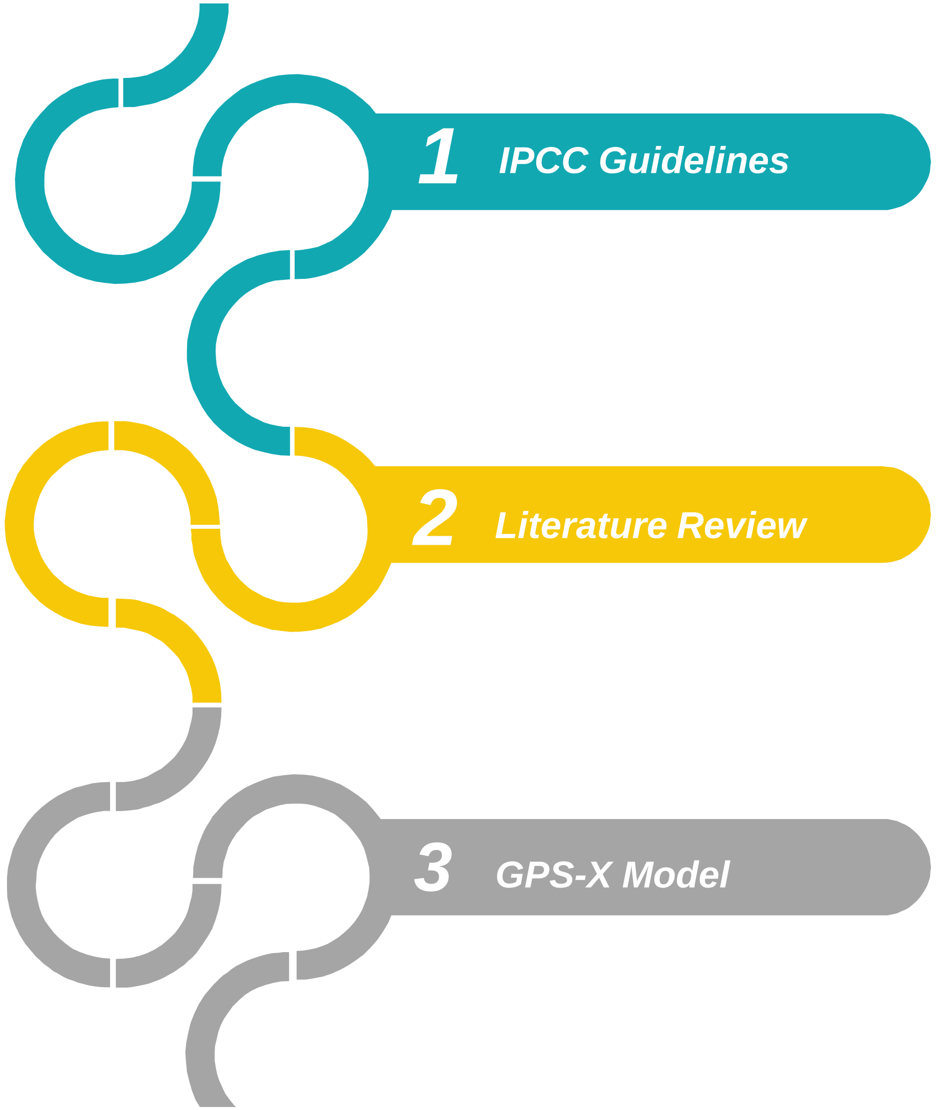
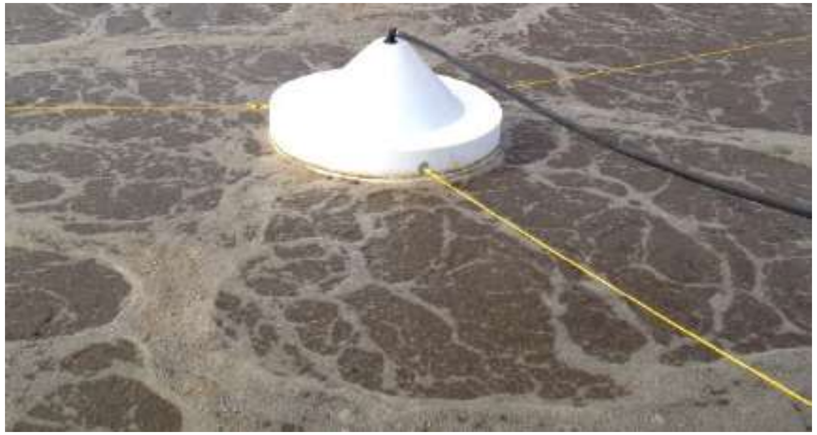
- Biological mechanistic model of plant on GPS-X
- Calibrated to plant data (influent and effluent flows and loads, sludge production, aeration requirements)
- Models Scope 1 emissions as a gas-liquid transfer process



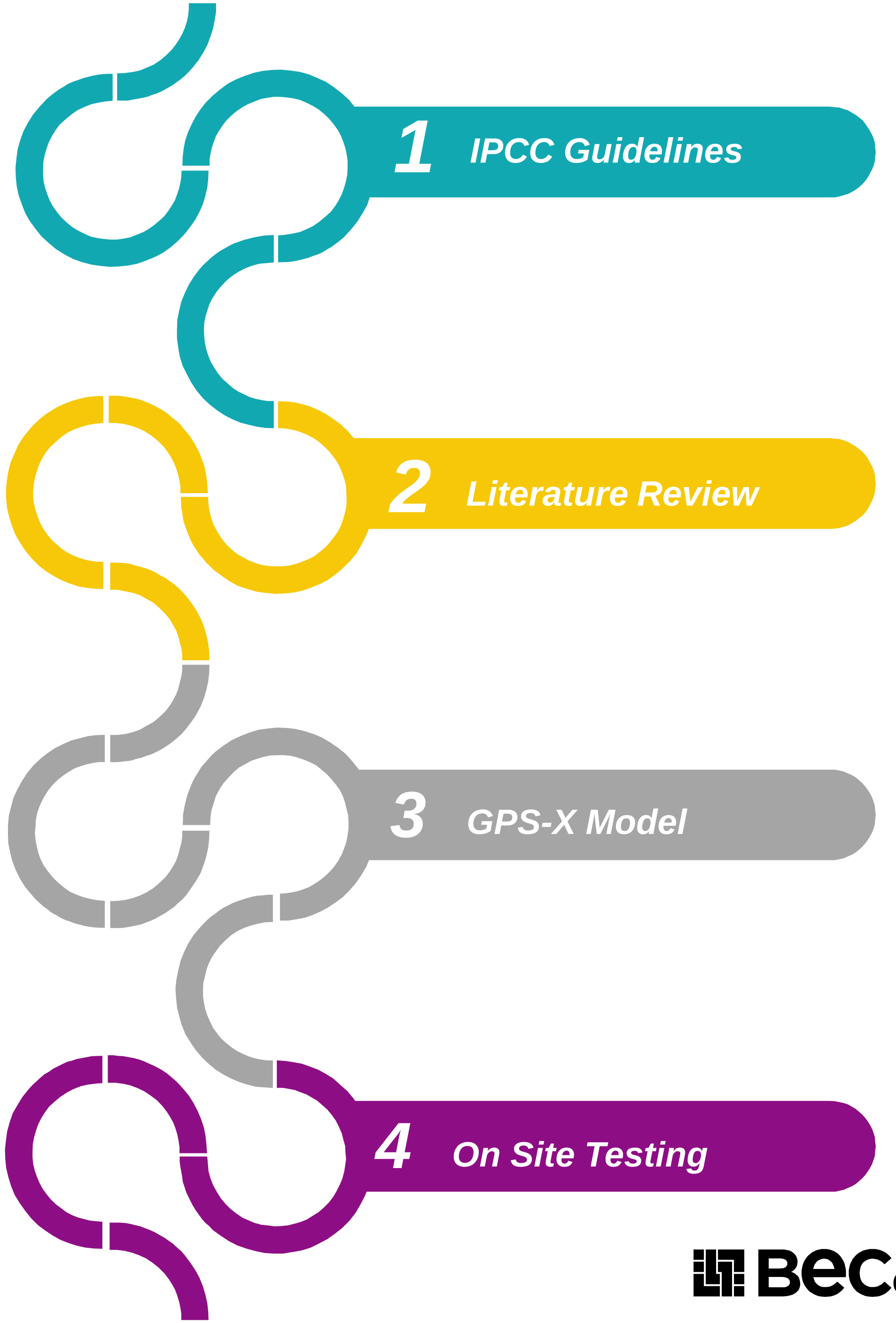


- Further accuracy of estimates requires on-site testing of emissions
- Good international examples for NZ to draw on (e.g. South Australia Water)



Source: SA Water & Water Engineering Technologies

Next steps



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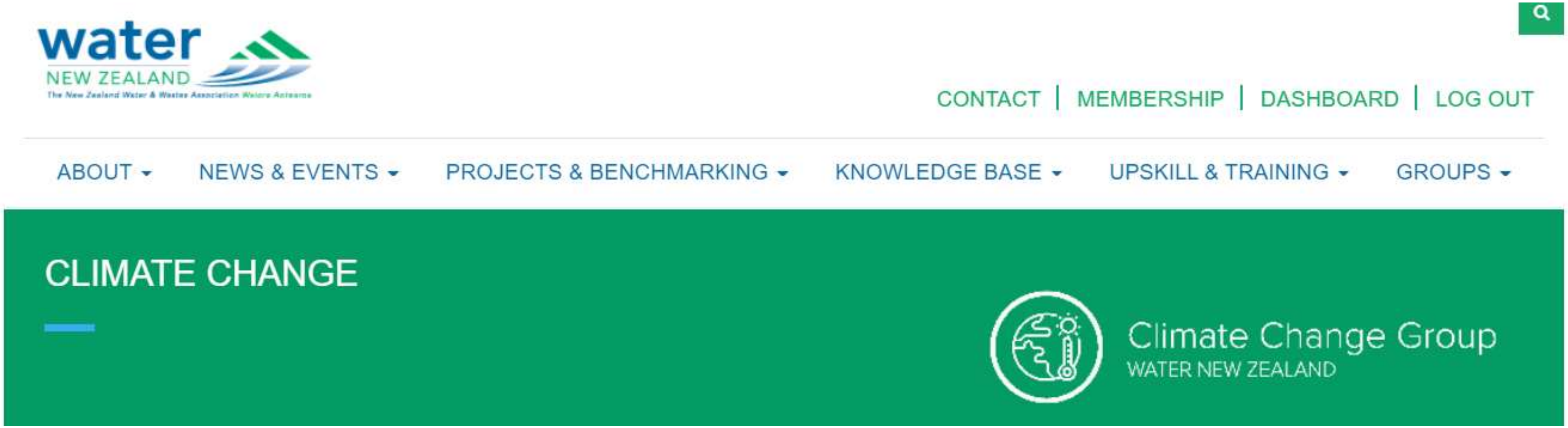
What next?



- Water NZ - Climate Special Interest Group (SIG)
  - Consultant, Council, Industry and Academic members

What next?

The Water Industry's Low Carbon Journey

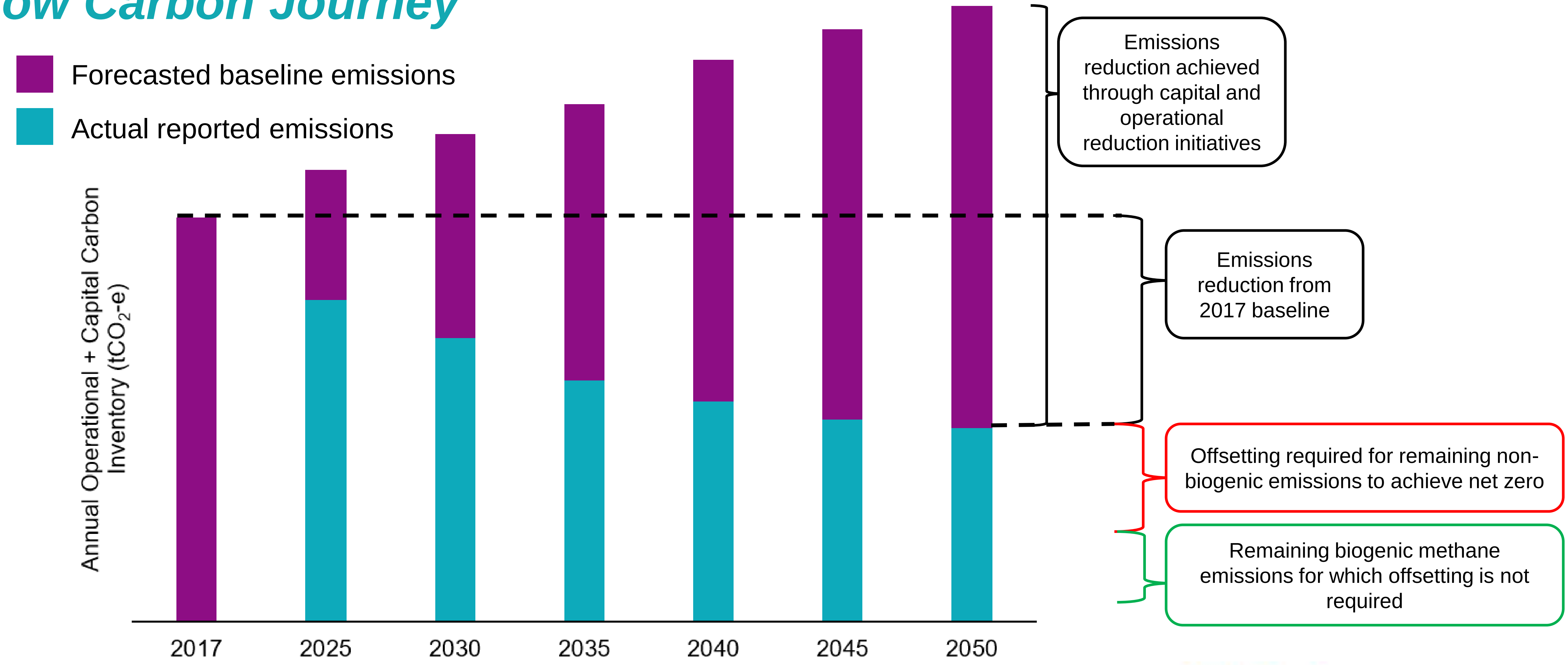
- Navigating to net zero: Aotearoa's Water Sector Low Carbon Journey
- June 23rd – Water NZ event to launch the first draft (see on Water NZ website)

Target	Quantify	Plan	Review
Now	Next	Out to 2050	Annually
Set carbon reduction targets for all forms of carbon emissions	Quantify baseline operational and capital carbon emissions	Plan operational and capital reduction initiatives	Review emissions annually to track progress

What next?

The Water Industry's Low Carbon Journey

Example Output – Operational and Capital



What next?

- ***Standard NZ Methodology for Estimating Emissions***

- Water NZ Wastewater Emissions Working Group (sit under the Climate SIG)

- Developing a standard methodology for estimating emissions
  - Based on 2019 IPCC but with changes to reflect other international guidelines and NZ's mix of WWTPs and local conditions
  - Will identify further recommendations to further understanding in this area

What next?

- ***On-Site Testing***

- Investigating on-site testing of emissions and funding opportunities to purchase testing equipment
  - Collaboration with Universities (PhD/Masters projects)
  - Shared equipment for use around NZ
  - Workshop in July for scoping (*contact lesley.smith@waternz.org.nz)*

water NEW ZEALAND

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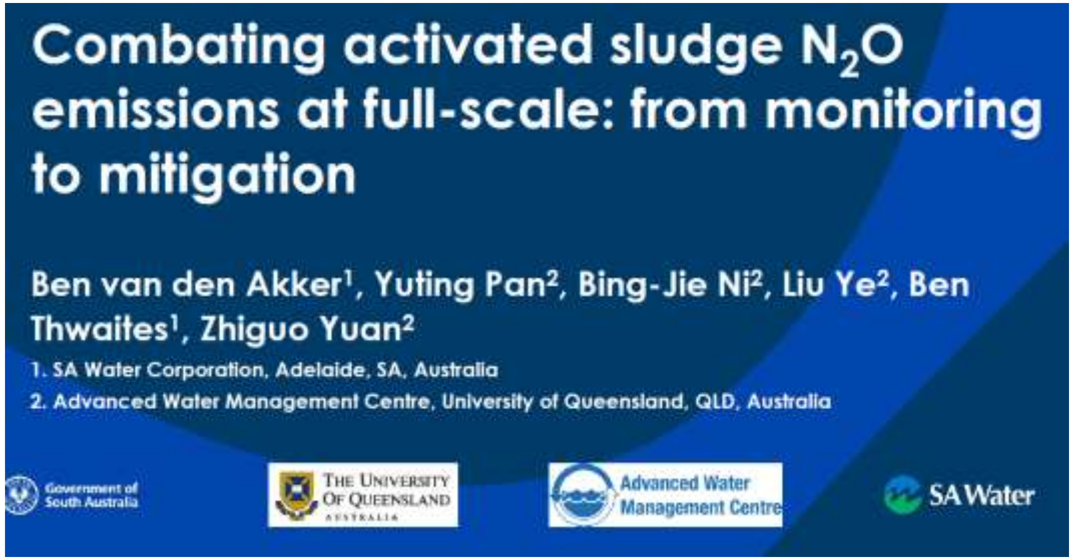
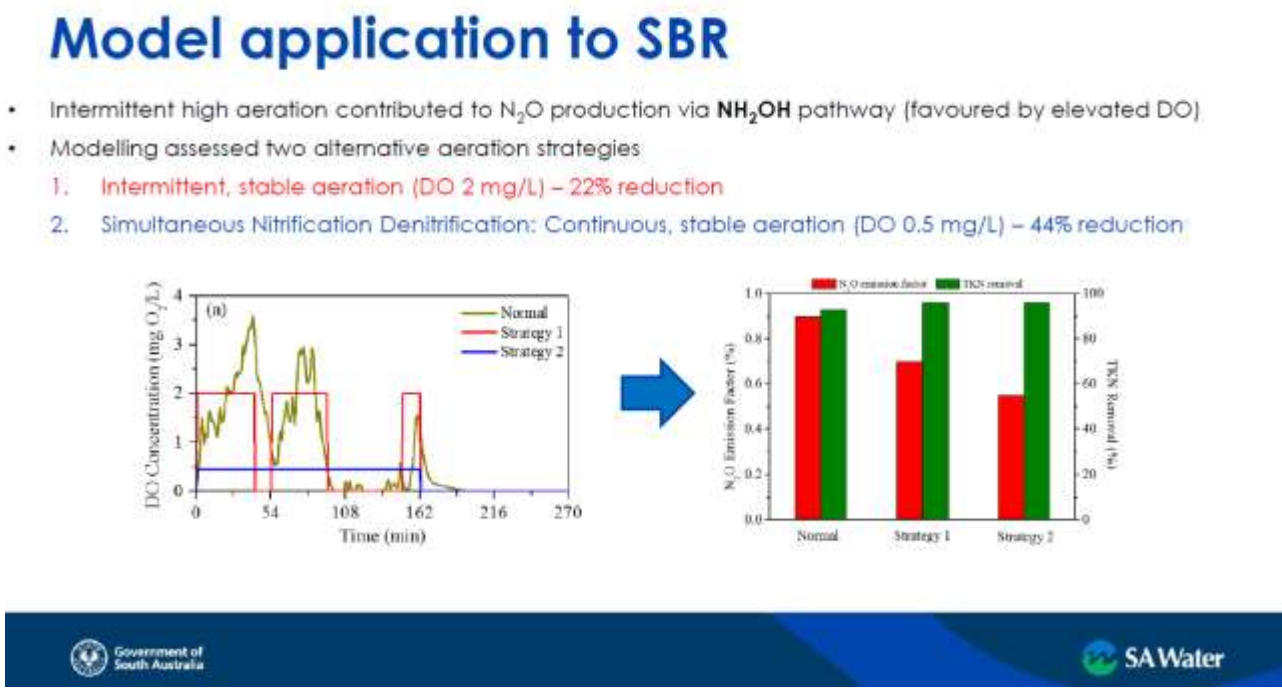
What next?

- ***International learnings***
- ***Expensive – collaboration required***





What next?

- ***Reduction opportunities***

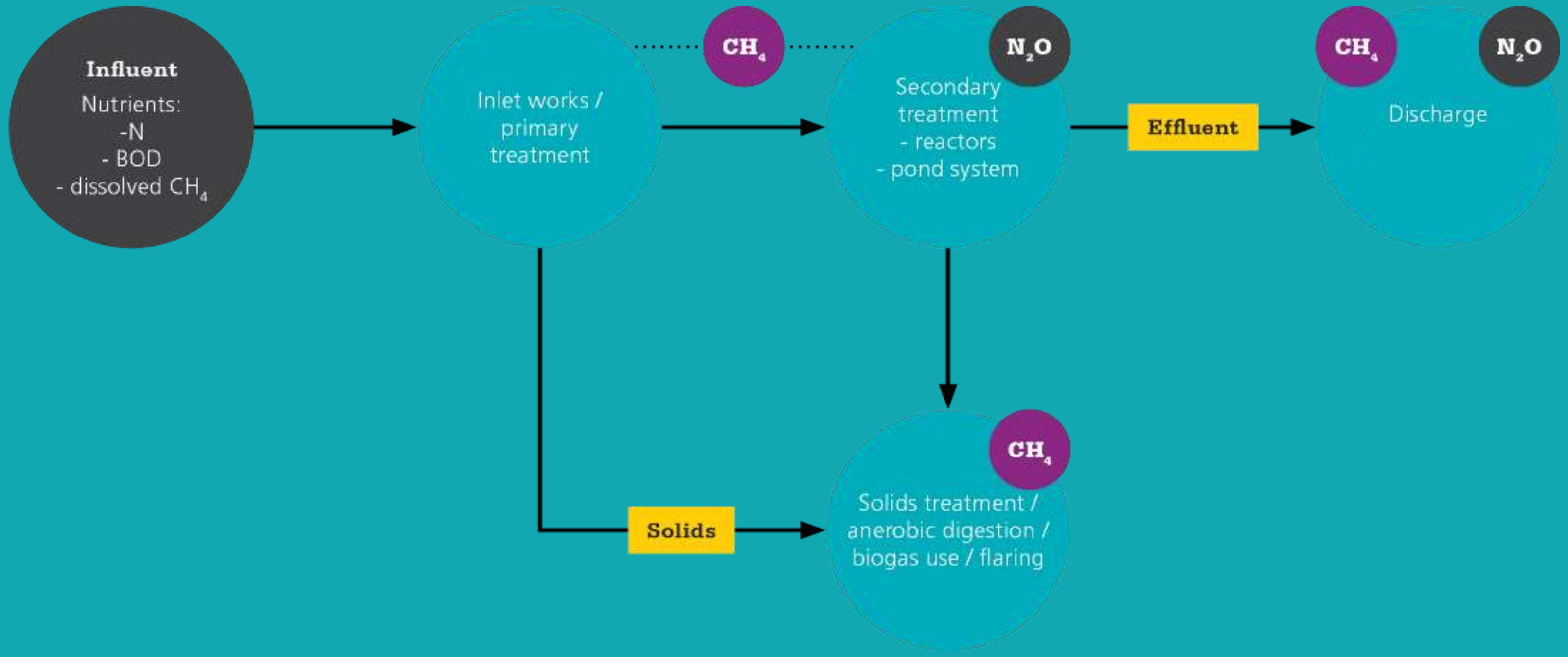
- Reduce quick-win and cost benefit emissions first

- Sludge/biosolids – sludge treatment, beneficial reuse
  - Reduced landfill emissions
  - Reduced transport emissions

What next?

- ***Reduction opportunities***

- N_2O – process changes
  - On-site testing and ongoing monitoring
  - Reducing power demand and emissions
    - South Australia Water – simultaneous nitrification denitrification
    - Anglian Water – anaerobic treatment, MABR, alternative ammonia removal processes
- Trade off – discharge N vs. N_2O released to atmosphere



Key Contacts

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