Derek Anderson

FACTORING GHG EMISSIONS INTO DESIGN OPTIONEERING: 90% REDUCTION FOR CAMBRIDGE WWTP

Pattle Delamore Partners Ltd.

water NEW ZEALAND
The New Zealand Water & Wastes Association Waiora Aotearoa

water NEW ZEALAND CONFERENCE & EXPO 17-19 OCTOBER 2023
Tākina, Te Whanganui-a-Tara Wellington

OUTLINE

01 INTRODUCTION

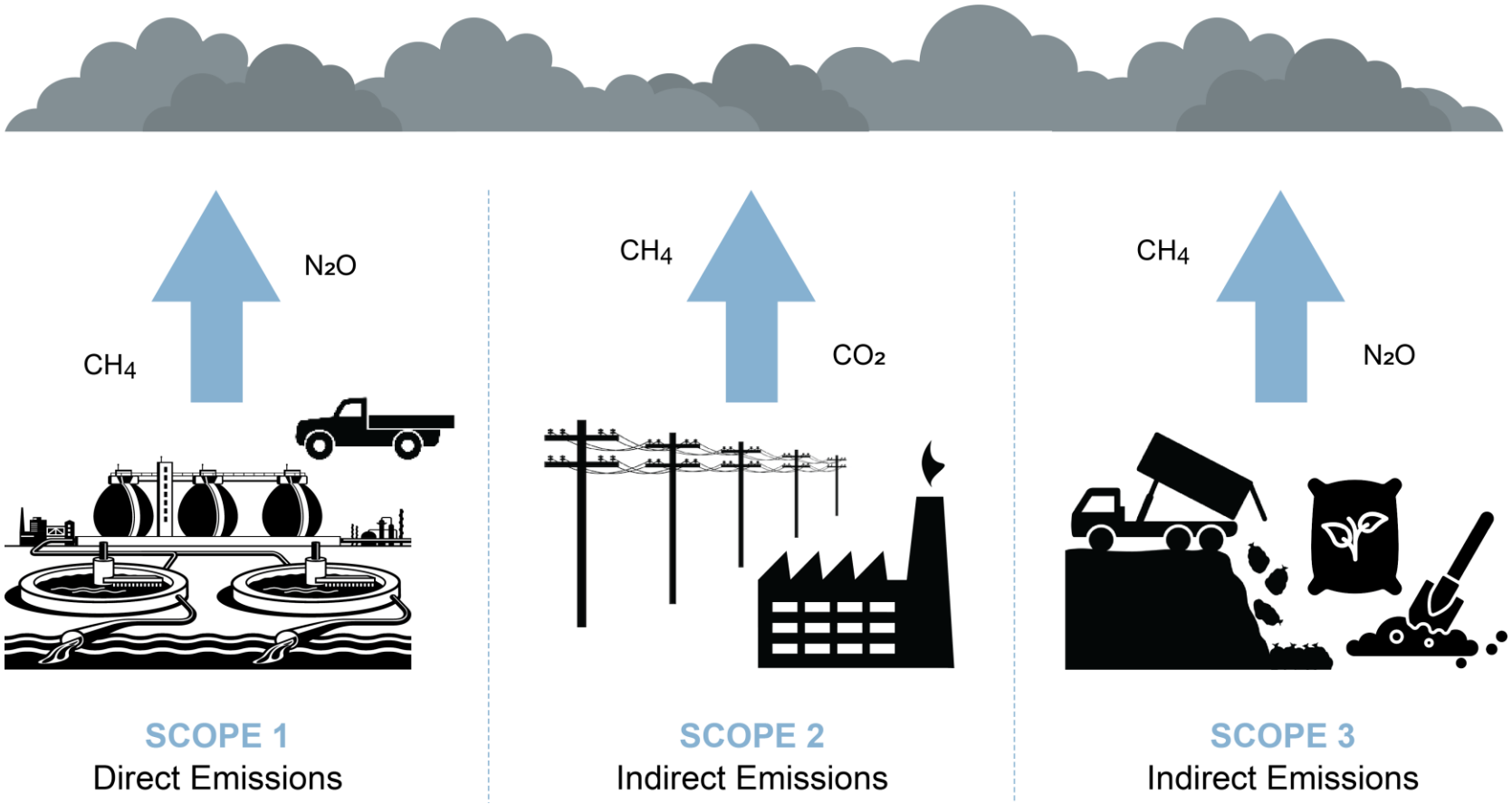
02 BACKGROUND
- GHG EMISSIONS FROM WWTPS
- CAMBRIDGE WWTP UPGRADE PHILOSOPHY
- LAGOON-BASED VERSUS MBR TREATMENT

03 CAMBRIDGE WWTP GHG EMISSIONS ASSESSMENT
- ASSESSMENT APPROACH
- DESIGN OPTIONEERING
- EMISSIONS REDUCTION ATTAINED

04 FURTHER RESEARCH AND VERIFICATION

05 CONCLUSION

GHG EMISSIONS FROM WWTPS



SCOPE 1
Direct Emissions

SCOPE 2
Indirect Emissions

SCOPE 3
Indirect Emissions

CAMBRIDGE WWTP UPGRADE PHILOSOPHY

- Accommodate future population growth
- Best for awa (river)
- Benchmarking the existing daily nutrient discharge loads as future limits

LAGOON-BASED VERSUS MBR TREATMENT

FACULTATIVE OXIDATION PONDS

Large, shallow basins containing populations of microorganisms which utilise biological processes to break-down contaminants

ANAEROBIC LAGOONS

Deeper basins which receive higher organic loads per surface area of lagoon, where anaerobic conditions are enhanced and prevail

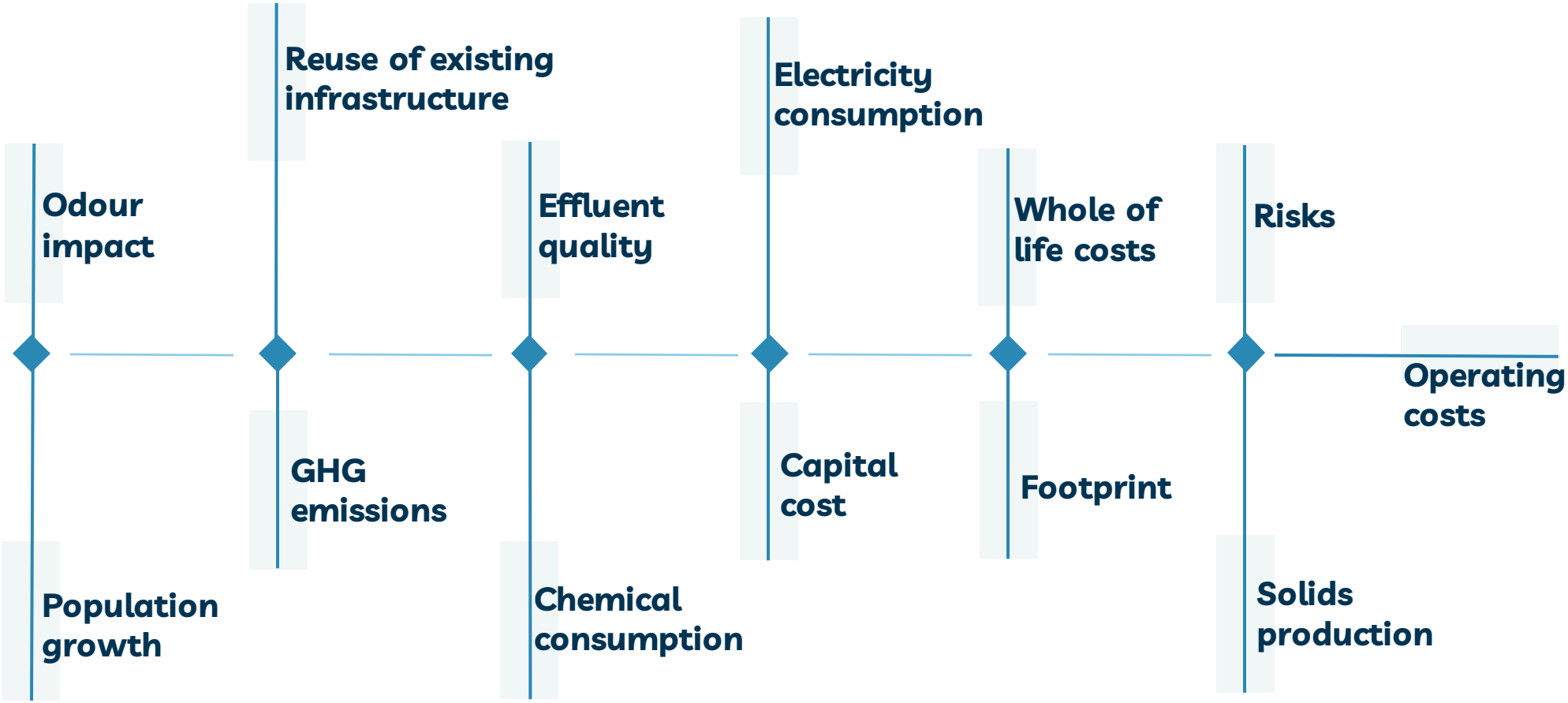
MEMBRANE BIOREACTOR

Activated sludge based Biological Nutrient Removal process in a Membrane Bioreactor to provide microfiltration

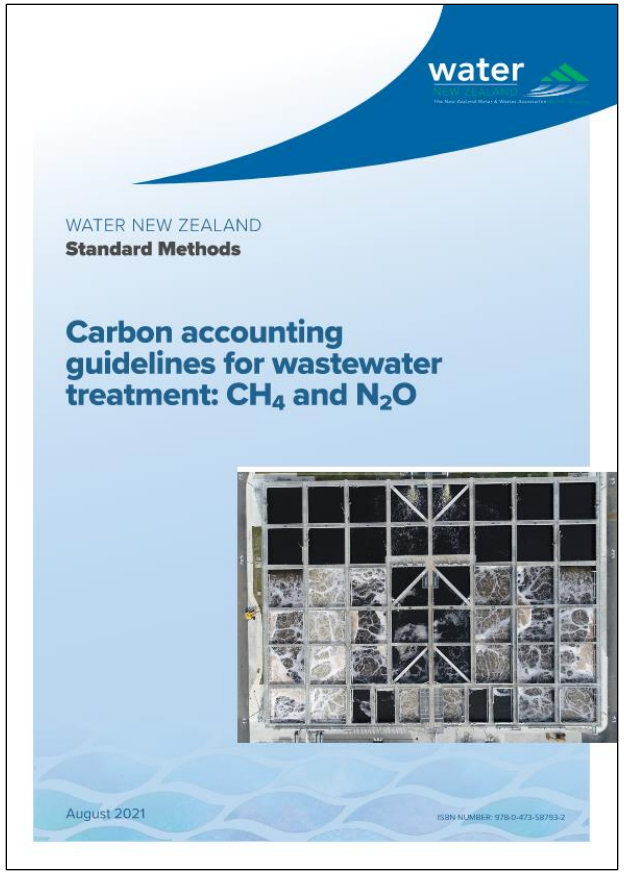
UPGRADE OPTIONS

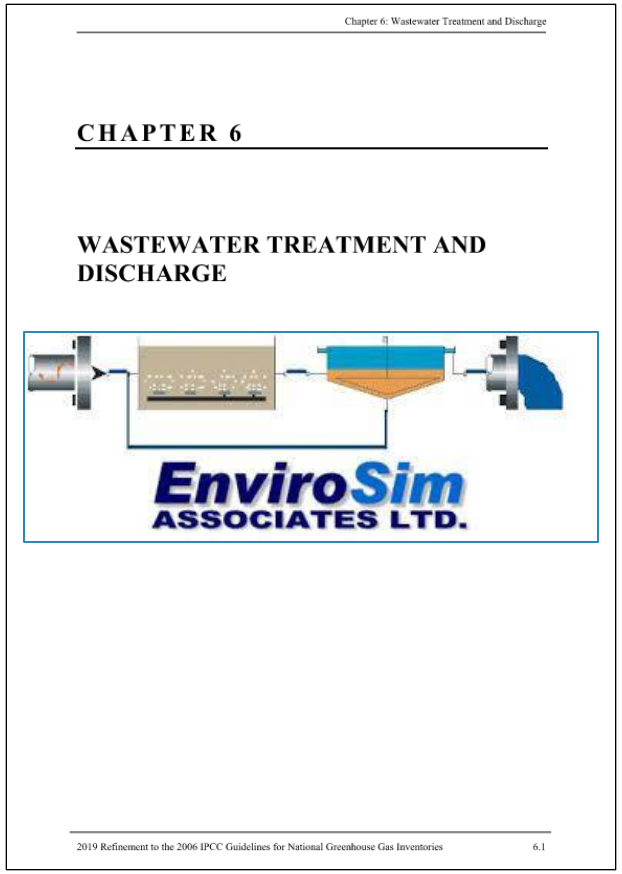
All variations of the MBR process, due to the stringent nitrogen consent limits proposed

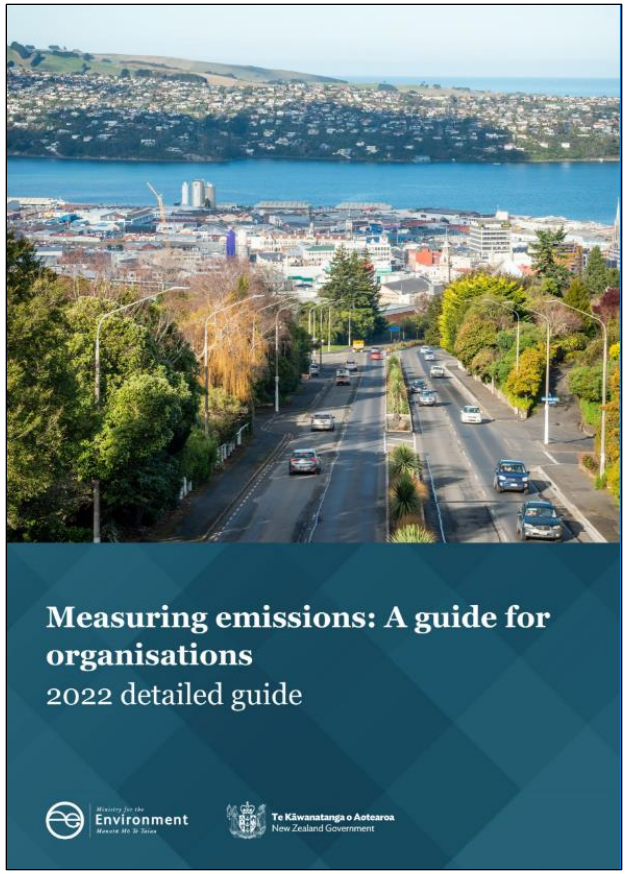
ASSESSMENT APPROACH



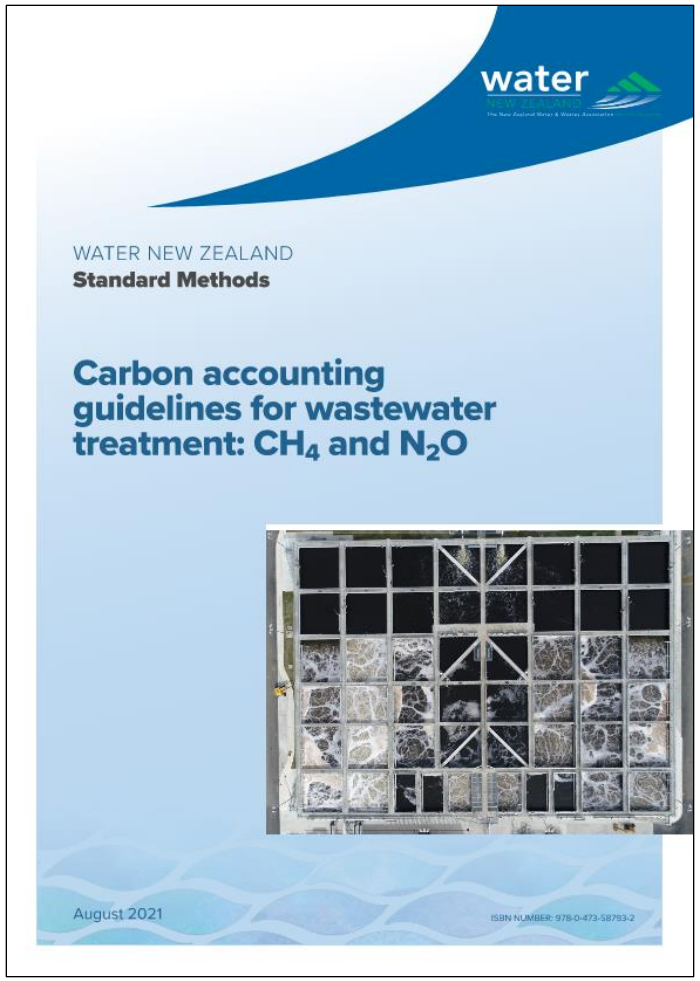
ASSESSMENT METHOD





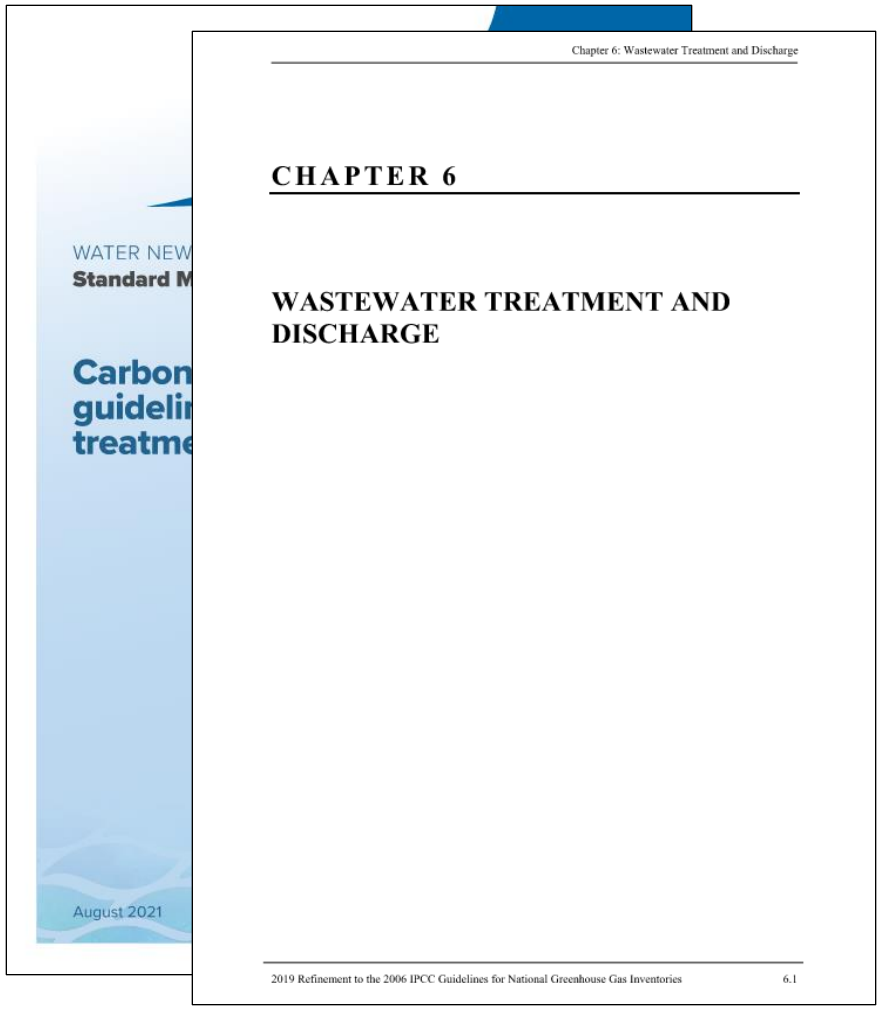


ASSESSMENT METHOD



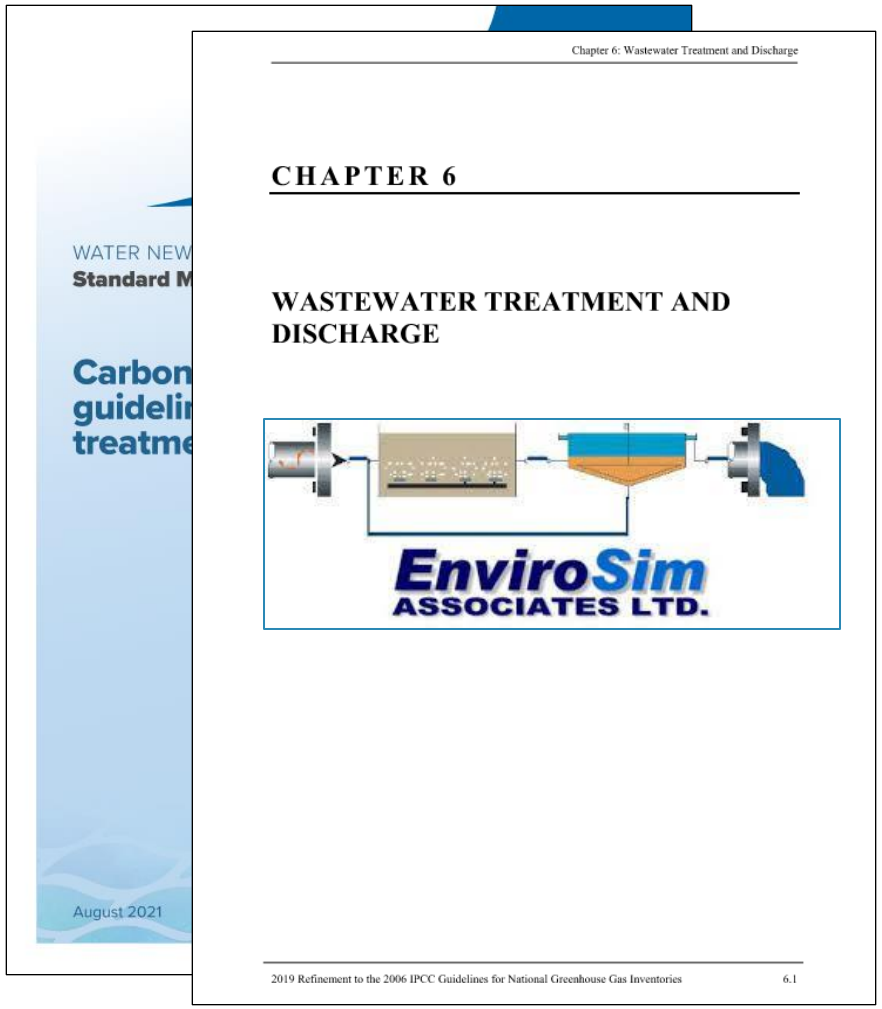
- CH_4 production in the receiving environment
- N_2O production in the receiving environment
- Emissions from biosolids decomposition in offsite vermicomposting facility managed by others

ASSESSMENT METHOD



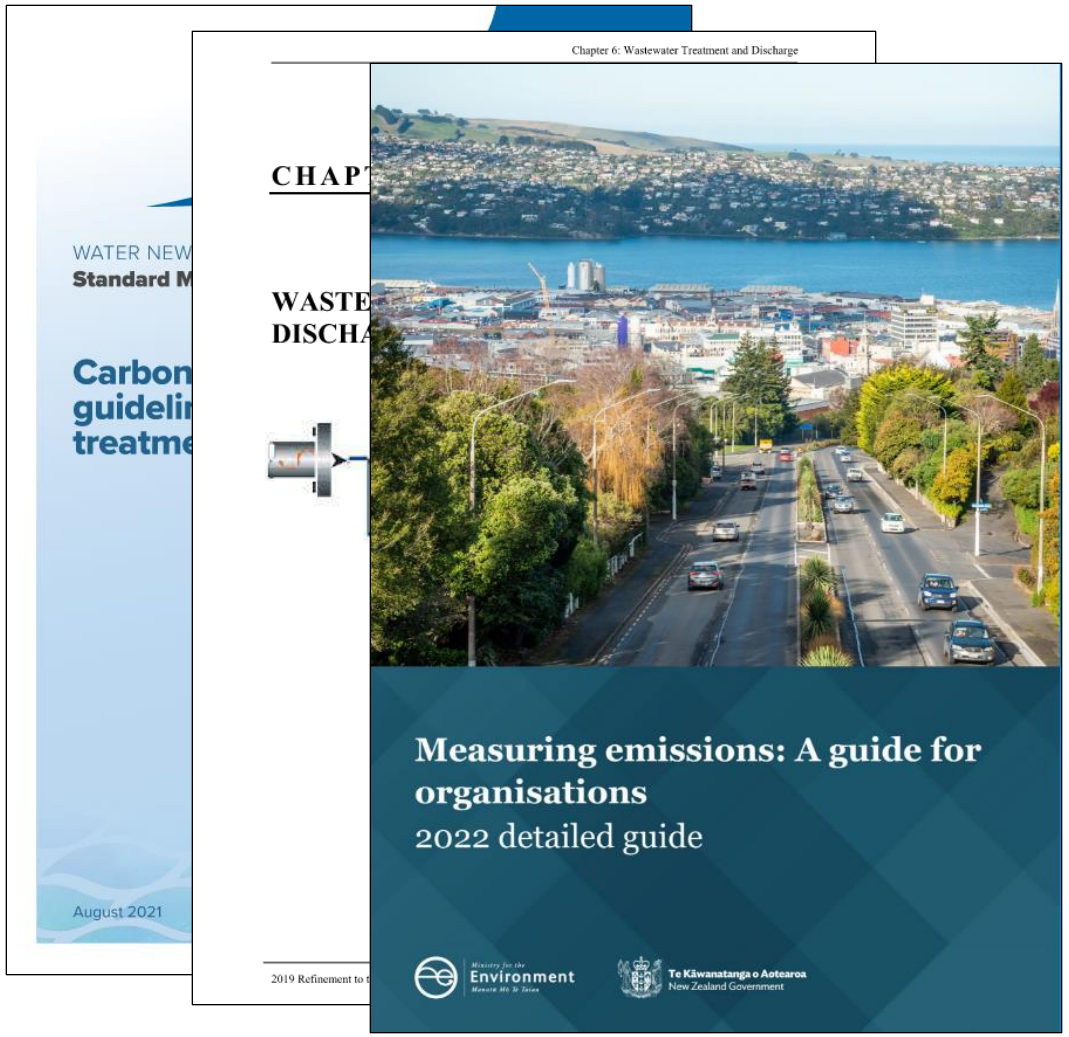
- Emissions from purchased electricity

ASSESSMENT METHOD



- Plant CO_2 emissions (excluded)
- Plant CH_4 emissions
- Plant N_2O emissions

ASSESSMENT METHOD



- Emissions from biosolids transport
- Emissions from electricity distribution losses

BIOWIN MODELLING

ENVIROSIM BIOWIN SOFTWARE

Version 6.2 released 2021

METHANE EMISSIONS

Estimated through the anaerobic digestion of waste

NITROUS OXIDE EMISSIONS

1 - Nitrification by-products:

The partial oxidation of ammonia to nitrous oxide, due to the conditions of limited oxygen or excess ammonia

2 - Nitrifier Denitrification:

Where free nitrous oxides are used as an electron accepter to remove nitrite, thereby producing nitrous oxide

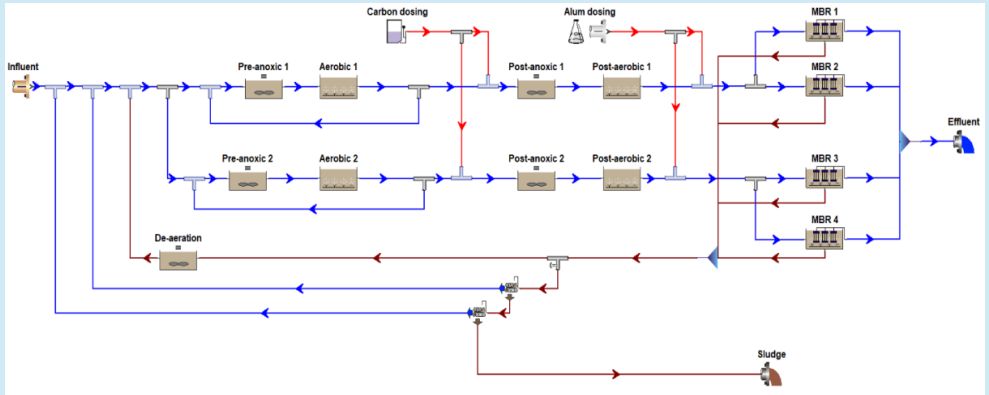
3 - Denitrification:

Where nitrous oxide is produced as a byproduct, due to incomplete denitrification

UPGRADE OPTIONS

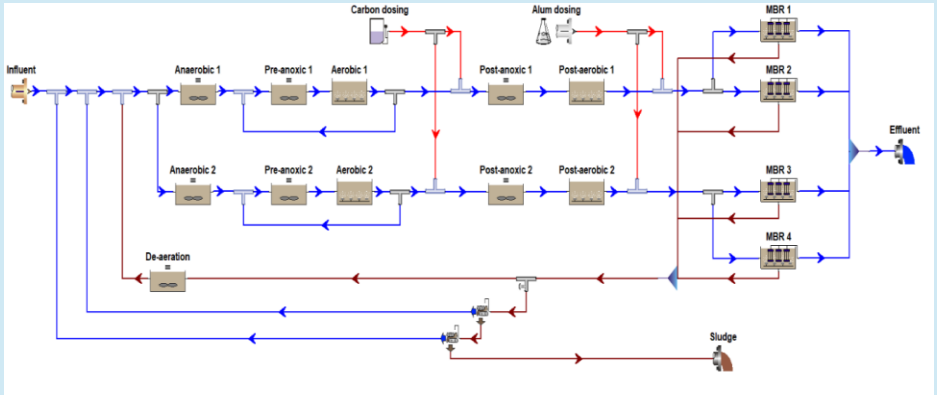
Option 1 (Selected WWTP Upgrade)

Membrane Bioreactor Configured for Enhanced Biological Nitrogen Removal



Option 2

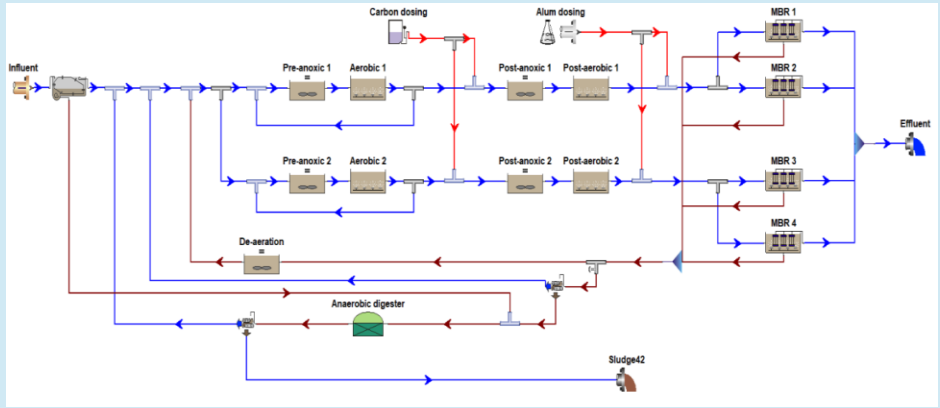
Membrane Bioreactor Configured for Enhanced Biological Phosphorous Removal



UPGRADE OPTIONS

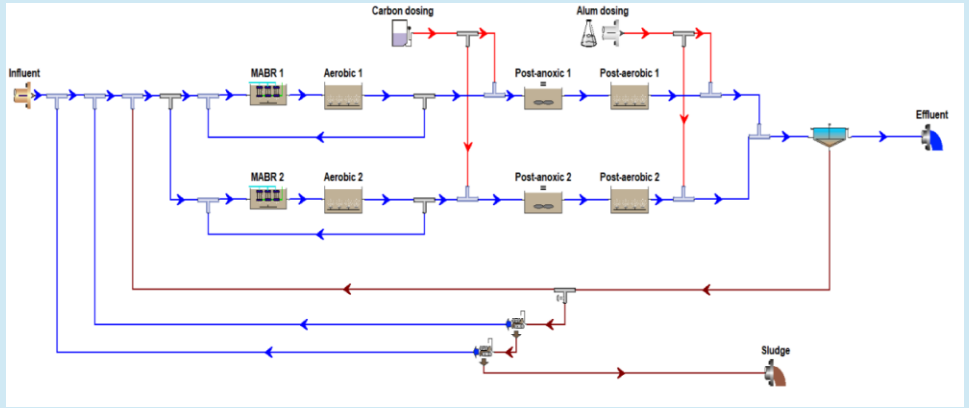
Option 3:

Membrane Bioreactor with Primary Sedimentation Tank, Anaerobic Digestion and Electricity and Heat Recovery via Biogas Combustion in a Combined Heat and Power Engine

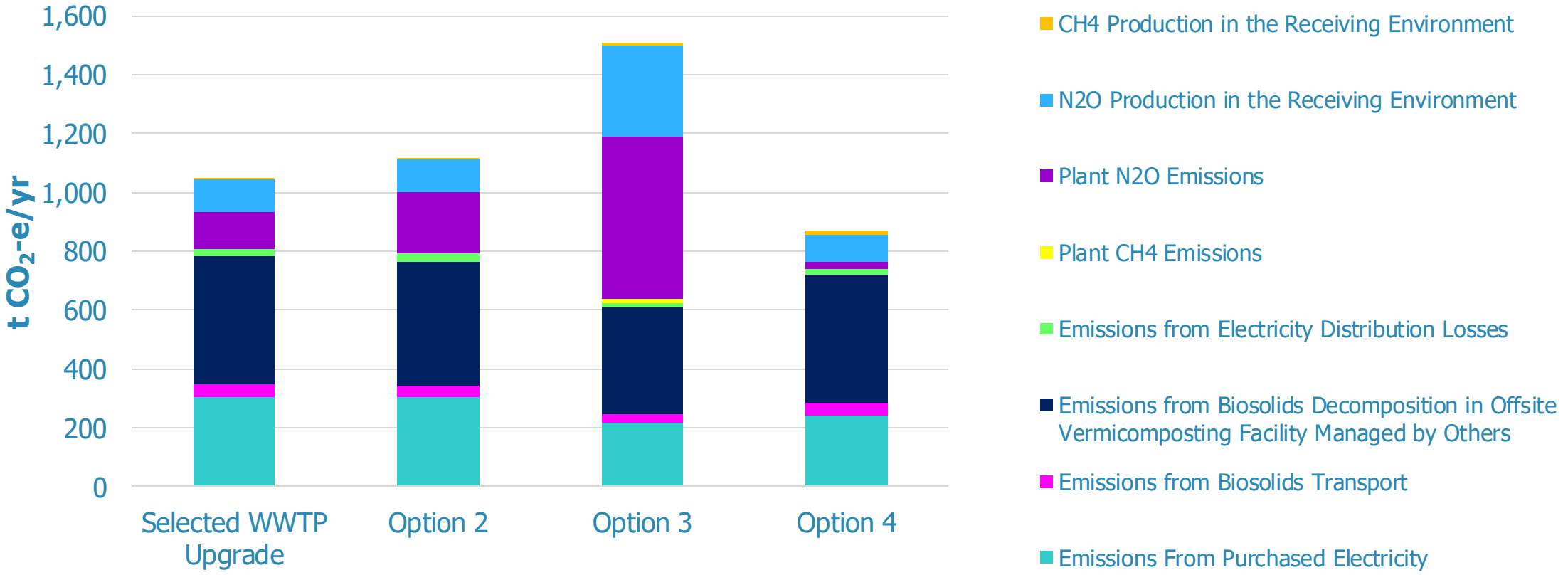


Option 4:

Membrane Aerated Biofilm Reactor with Tertiary Ultrafiltration

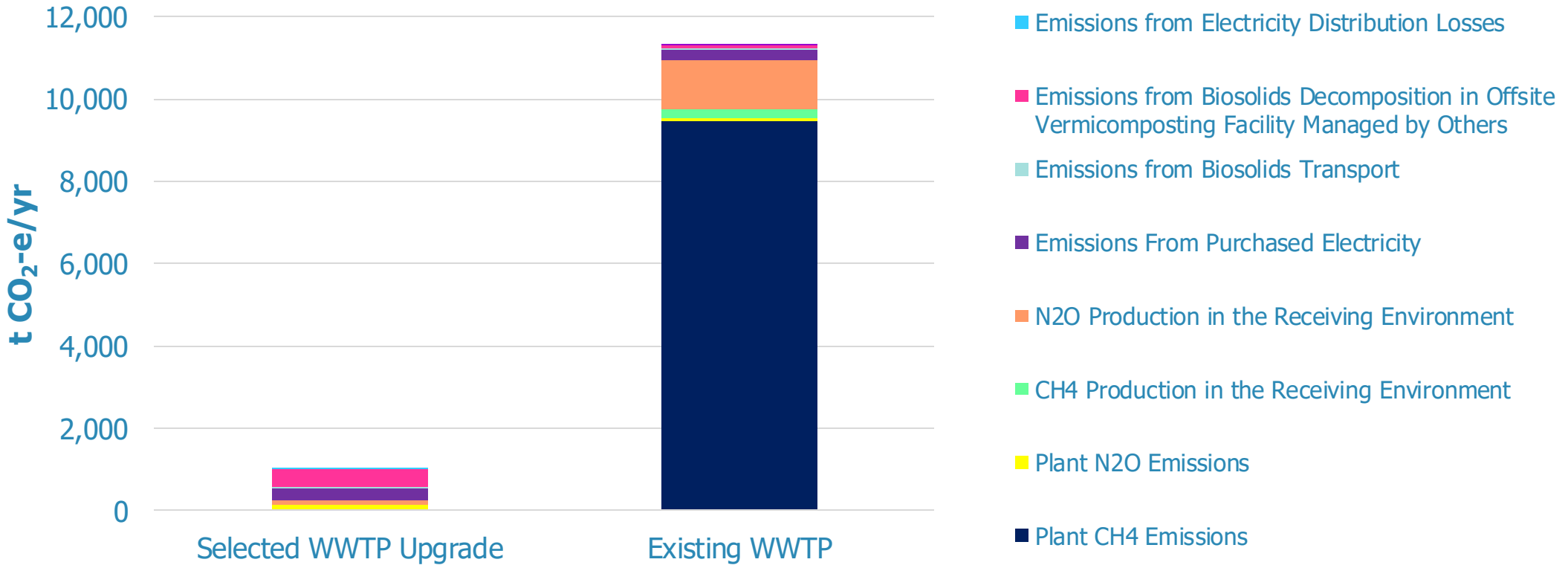


DESIGN OPTIONEERING



Cambridge WWTP Annual Operational GHG Emissions Comparison – Upgrade Options

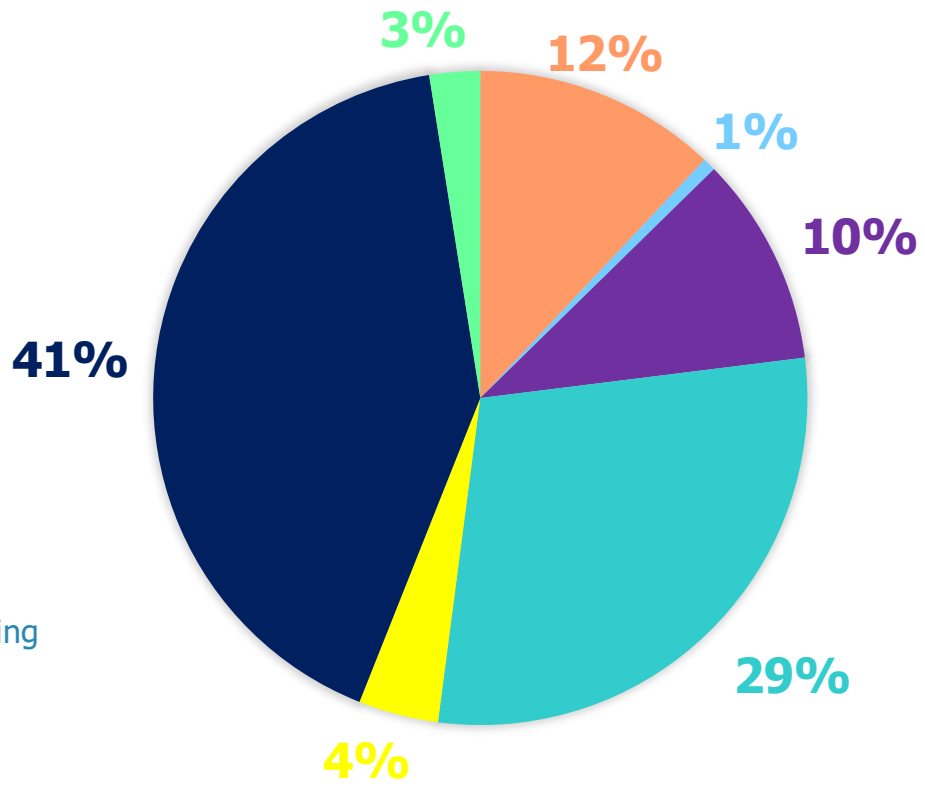
EMISSIONS REDUCTIONS ATTAINED



Cambridge WWTP Annual Operational GHG Emissions Comparison – Upgrade Options

EMISSIONS CONTRIBUTIONS

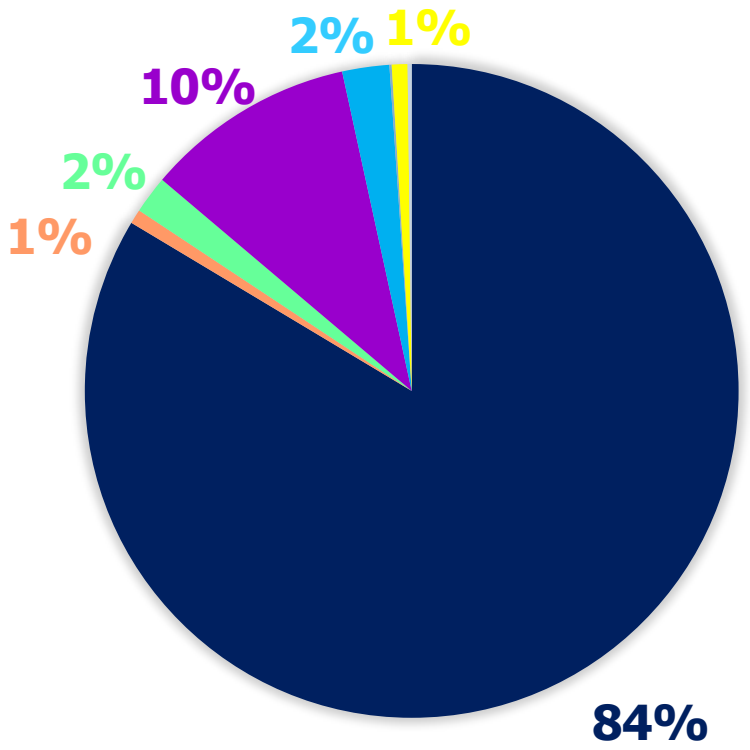
- Plant CH4 Emissions
- Plant N2O Emissions
- CH4 Production in the Receiving Environment
- N2O Production in the Receiving Environment
- Emissions From Purchased Electricity
- Emissions from Biosolids Transport
- Emissions from Biosolids Decomposition in Offsite Vermicomposting Facility Managed by Others
- Emissions from Electricity Distribution Losses



Selected WWTP Upgrade Operational GHG Emissions Summary

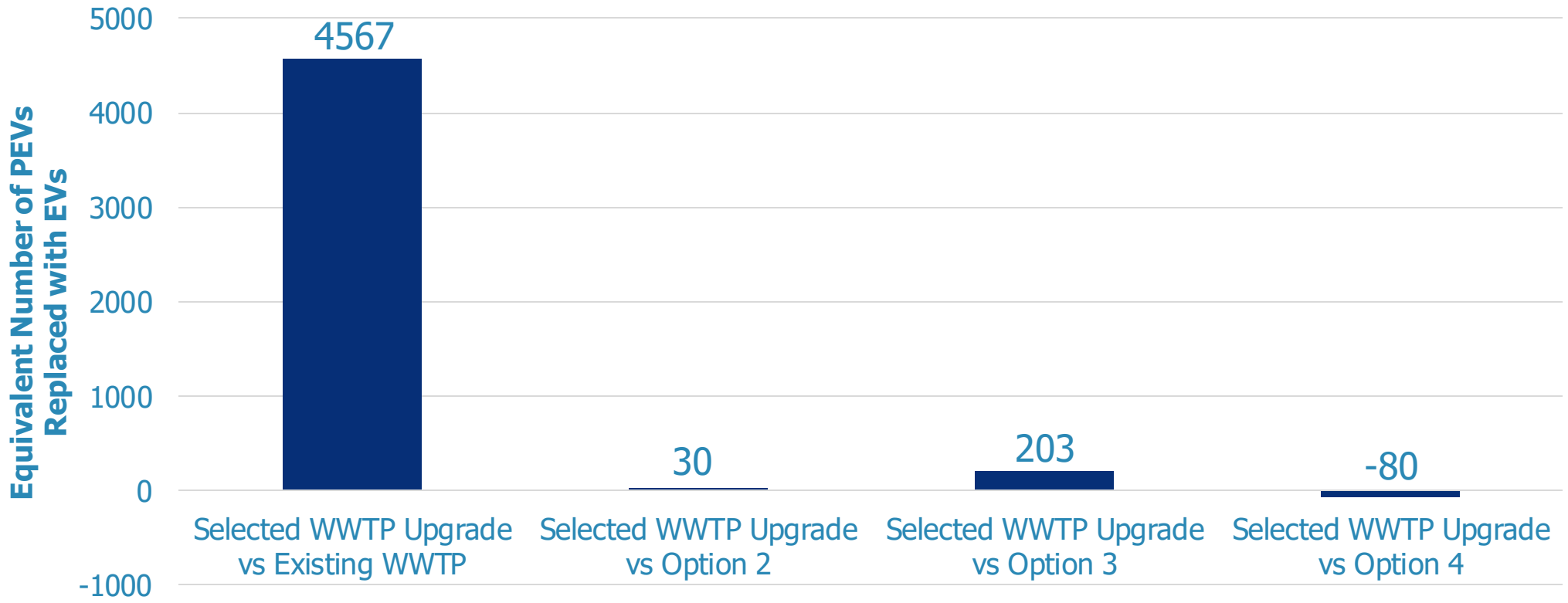
EMISSIONS CONTRIBUTIONS

- Plant CH4 Emissions
- Plant N2O Emissions
- CH4 Production in the Receiving Environment
- N2O Production in the Receiving Environment
- Emissions From Purchased Electricity
- Emissions from Biosolids Transport
- Emissions from Biosolids Decomposition in Offsite Vermicomposting Facility Managed by Others
- Emissions from Electricity Distribution Losses



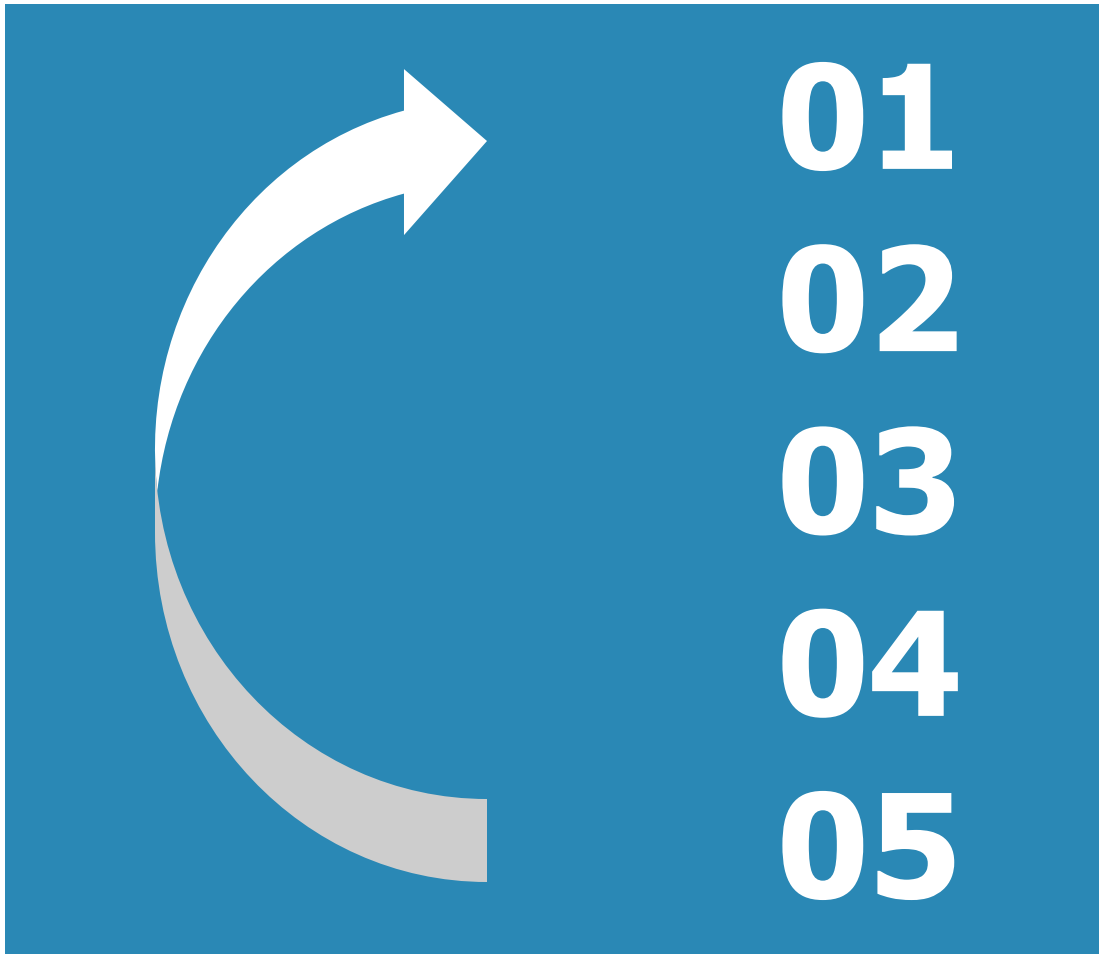
Existing WWTP Operational GHG Emissions Summary

EQUIVALENT REDUCTION



Equivalent Reduction of Replacing Petrol Engine Vehicles (PEVs) with Electric Vehicles (EVs)

FURTHER RESEARCH AND VERIFICATION



ESTIMATE

MEASURE

CALIBRATE AND VERIFY

REPORT

REPEAT

CONCLUSION

1 – THE PARIS AGREEMENT

Requires engineering design to consider GHG emissions in the **design optioneering phase** for all infrastructure projects

2 – WASTEWATER TREATMENT EMISSIONS

Direct emissions from wastewater treatment form **~1.6%** of total global emissions and **~0.4%** of NZ's total emissions, thus playing a critical role in both national and global emissions reduction strategies

3 – 90% REDUCTION FOR CAMBRIDGE WWTP

Shifting from lagoon-based to MBR treatment was estimated to reduce annual operational GHG emissions by **~90%** and represented a **"best for awa"** approach

4 – MOVING FORWARD

The Cambridge WWTP upgrade sets a clear **precedent** for, and **pathway** towards, GHG emissions reductions

5 – FURTHER RESEARCH AND VERIFICATION

Further research and monitoring are critical to verify the GHG emissions estimates developed, and **refine** both **existing guidelines** and **predictive models**

THANK YOU

Any pātai/questions?

Get in touch:

derek.anderson@pdp.co.nz