SIXTH FRAMEWORK PROGRAMME

Neptune FP6 Project

The Current State of the Art for GHG Models in WWTPs

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Water Technology Group

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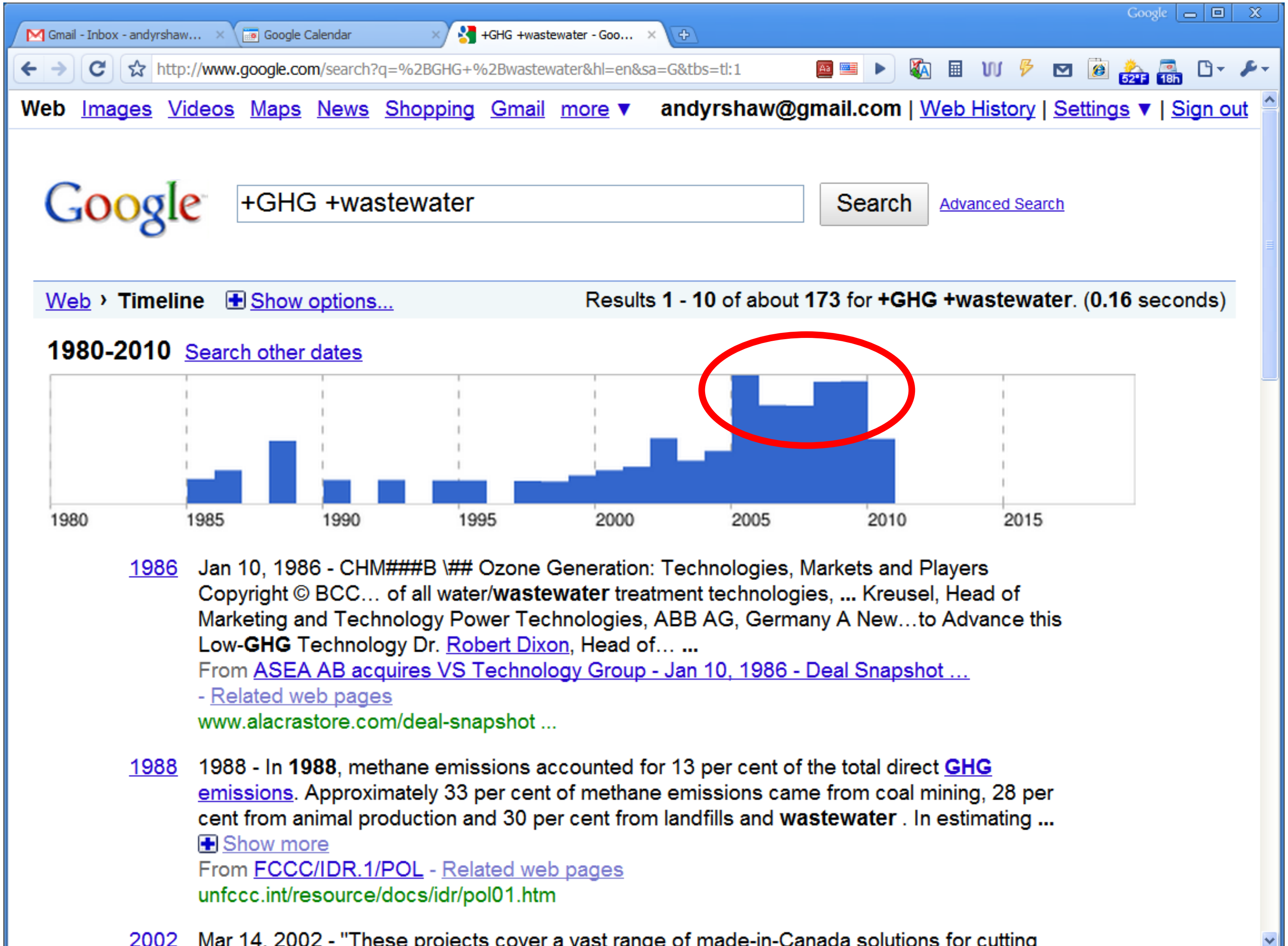
Outline

- Background
- Preview of WWTmod2010 Workshop
  - N_2O
  - Biosolids
  - Sewers
- Closing Thoughts

Background…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1980-2010 Search other dates
1980
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Jan 10, 1986 - CHM###B \## Ozone Generation: Technologies, Markets and Players Copyright © BCC… of all water/wastewater treatment technologies, ... Kreusel, Head of Marketing and Technology Power Technologies, ABB AG, Germany A New…to Advance this Low-GHG Technology Dr. Robert Dixon, Head of… ...
From ASEA AB acquires VS Technology Group - Jan 10, 1986 - Deal Snapshot ...
- Related web pages
www.alacrastore.com/deal-snapshot ...
1988
1988 - In 1988, methane emissions accounted for 13 per cent of the total direct GHG emissions. Approximately 33 per cent of methane emissions came from coal mining, 28 per cent from animal production and 30 per cent from landfills and wastewater . In estimating ...
Show more
From FCCC/IDR.1/POL - Related web pages
unfccc.int/resource/docs/idr/pol01.htm
2002
Mar 14, 2002 - "These projects cover a vast range of made-in-Canada solutions for cutting

Background…

- Recognition that Process ing Can Play a Role in GHG Est
  - California Wastewater Clim ange Group
  - IWA Task Group
    - Use of Water Quality an Process Models for Minimising Wastewater Utility GHG Footprints
  - WWTmod2010 Workshop
    - The Role of Modelling in Assessing Green House Gas (GHG) Emissions

2008

2010

2010

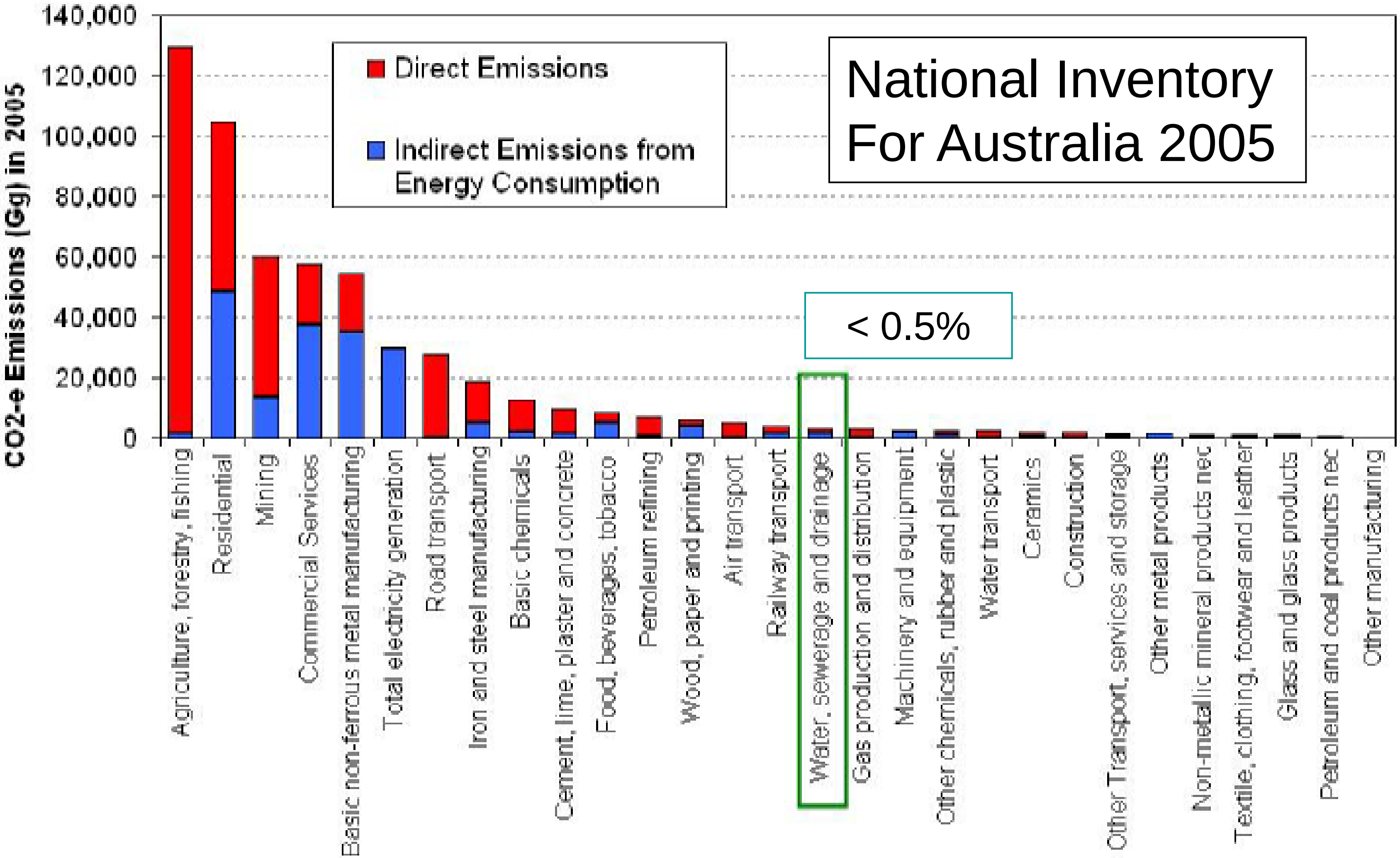
WWTmod2010 GHG Workshop

International Perspectives on Protocols and Methods for Estimating GHGs • Limitations of the Emission Factor Approach and the Need for Process Models	Pat Coleman Daniel Nolasco
Liquid Stream Treatment • Modelling Energy Use in Wastewater Treatment • Modelling Nitrous Oxide Emissions at WWTPs	Diego Rosso Dean Shiskowski Kartik Chandran Mark van Loosdrecht Dwight Houweling
Sludge and Biosolids • Sludge Treatment as a Source of Emissions or Green Energy • The Important Role of Biosolids Reuse and Disposal in the Carbon Cycle	John Willis Ned Beecher
Collection System • Modelling Sewer and Headworks Emissions	Zhiguo Yuan John Willis
Putting it all Together	*Andrew Shaw*
NEPTUNE – Assessment of environmental sustainability of technologies using Life Cycle Analysis	*Lluís Corominas* *Hansruedi Siegrist*
IWA GHG TG – Next Steps in Understanding and Modelling GHGs	*Jose Porro* *Ingmar Nopens*

Current Approach

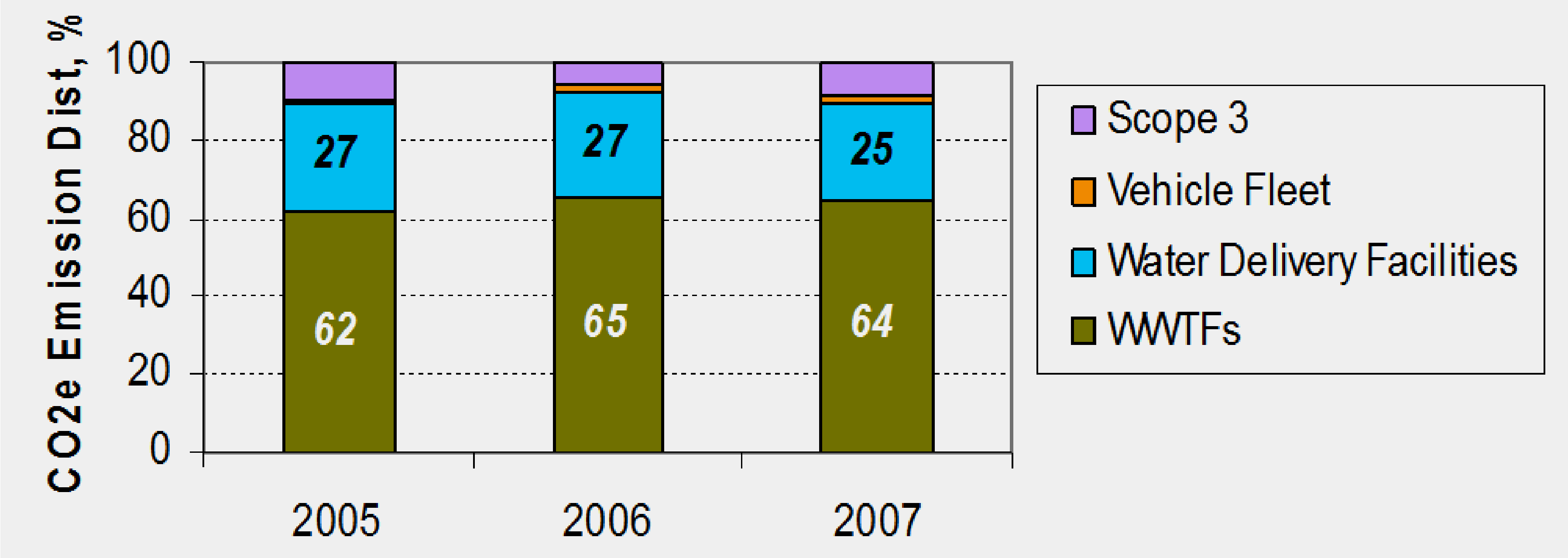
- Current Approach to Carbon Accounting
  - Simple EF x AD for National Inventories
  - Energy Focus for WWTP
    (And CH_4 for Anaerobic/Facultative Treatment)
- Considerations
  - Limited Data Behind Standard EF's
  - N_2O Emissions Poorly Defined
  - No Consideration of Sewer Emissions

WWTP GHGs *Insignificant* for a Nation (0 - 5%?)



Ref: Foley 2007

WWTP GHGs *Very Significant* for Individual Municipalities



DUS, City of Henderson

✓*WW treatment facilities accounted for > 60%*

Nitrous Oxide – WSAA 2009 (Australia)

- 7 Plants Surveyed
- N_2O Emissions Vary Widely
- 0.006 – 0.253 $kgN_2O\text{-}N.kgN^{-1}$ denitrified (average: 0.035 ± 0.027)
- N_2O associated with High NO_2-N
- Predominant Mechanism Not Identified

Full nitrification + "Full" Denite

=

Low N_2O

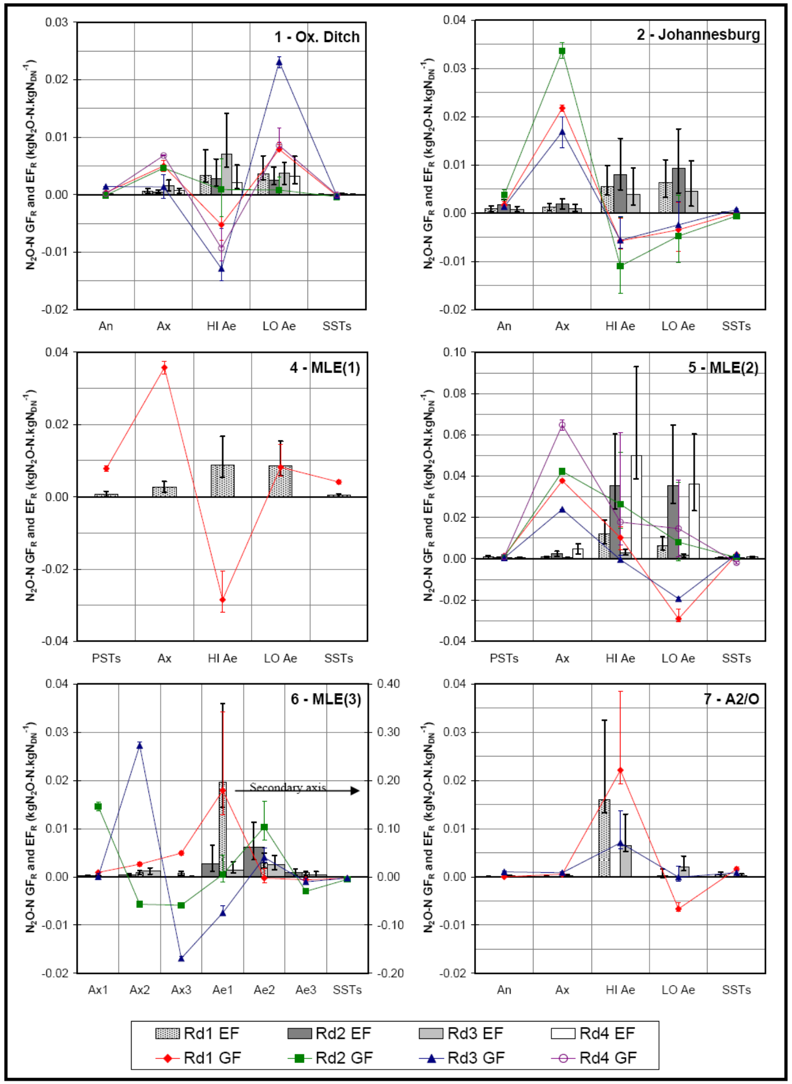
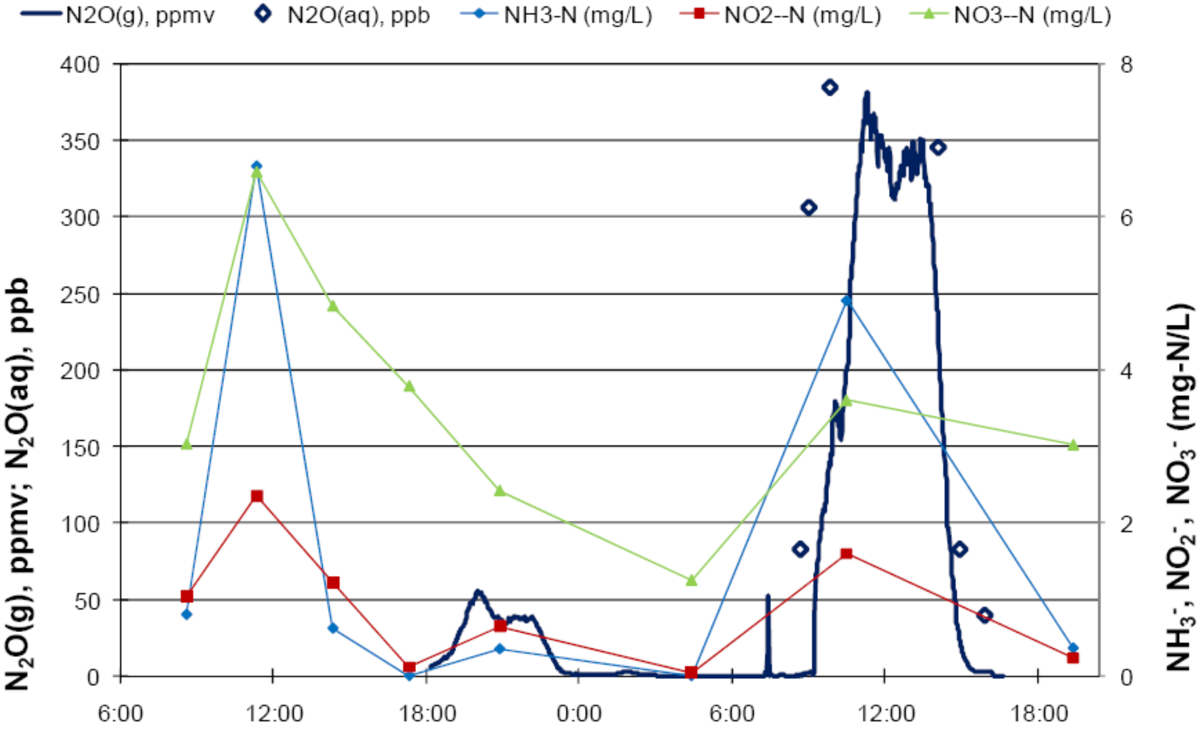


Figure 3.4. Net N_2O-N generation (GF_R) and mass transfer emissions (EF_R) profiles, per reactor zone, in each sampling round at the six continuous flow WWTPs. "An" – anaerobic zone, "Ax" – anoxic zone, "HI Ae" – highly aerated aerobic zone, "LO Ae" – less aerated aerobic zone, "PSTs" – primary

Ref: WSAA 2009

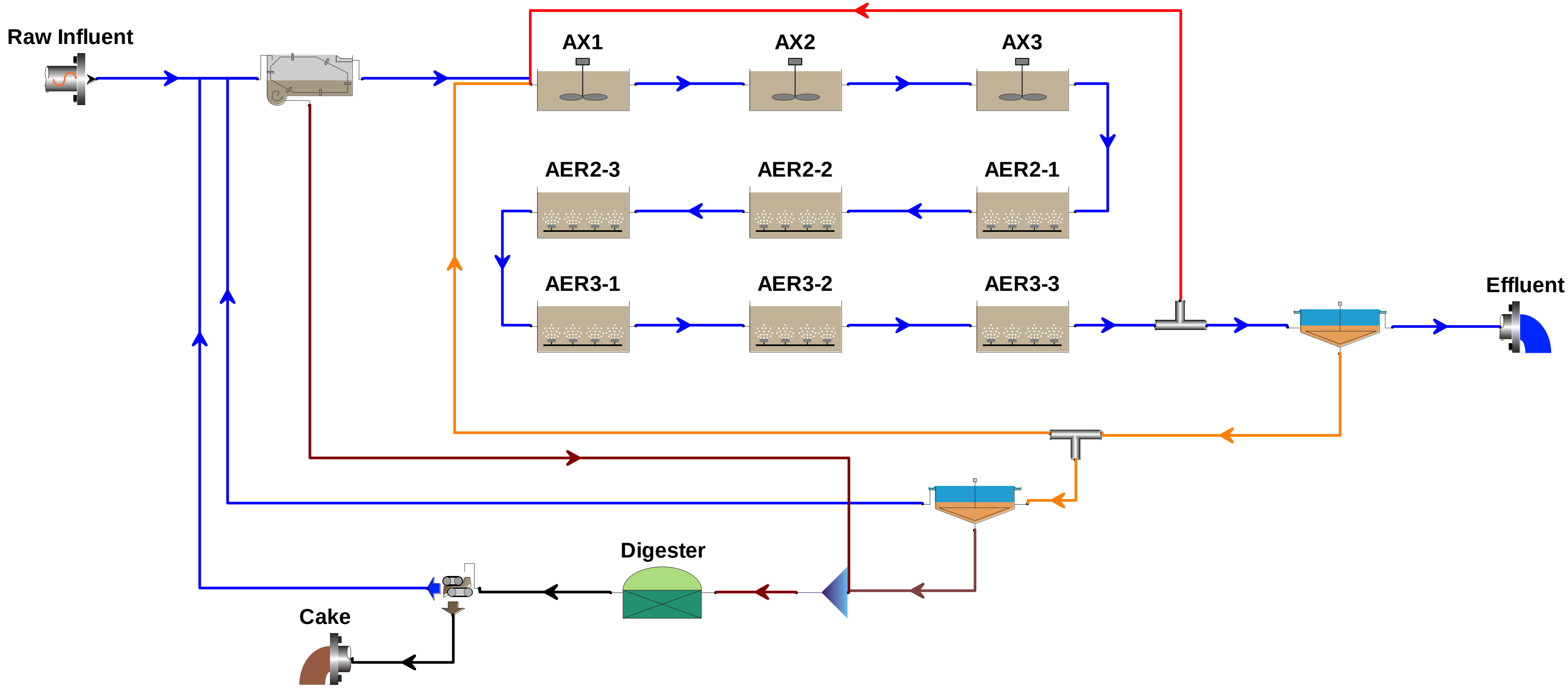
Nitrous Oxide – WERF 2009 (USA)



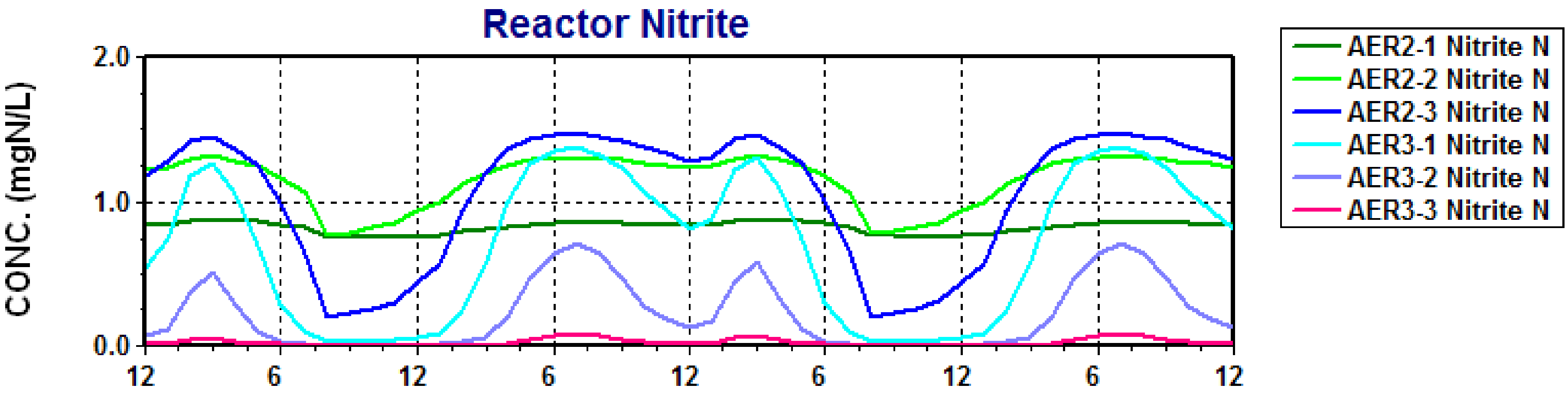
- 6 Plants Surveyed - N_2O Emissions Vary Widely!!
- 0.05 – 3.2 % of Influent TKN
- **Significant Temporal Variation**
- N_2O Production Identified with Nitrification
- Complete Nitrification (low ammonia) = Low N_2O

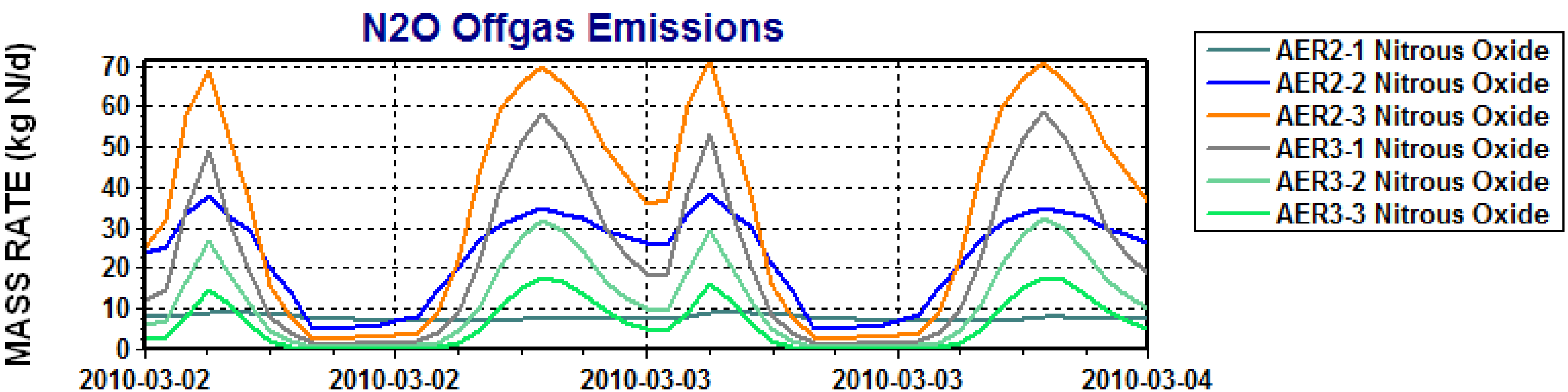
Dynamic N_2O Modelling (WWTmod2010 Workshop – Sneak Peak)

Welcome to Eauville!



Dynamic N_2O Modelling (WWTmod2010 Workshop – Sneak Peak)





Dynamic Modelling Summary

Eauville operational scenarios	N_2O as % of Influent TKN Load
Base Case with DO = 2 mg/L	0.4 %
1. Constant Airflow	2.2 %
2. Constant Airflow + Step Feed	0.9%
3. Constant Airflow + Sidestream Load	5.5 %

Biosolids

- BEAM -
  "Biosolids Emissions Assessment Model"
- Developed for the Canadian Council of Ministers for the Environment (CCME)
- State-of-the-art Equations to Estimate GHG Emissions from Various Biosolids Processes
- Free Excel-based Model: http://www.ccme.ca/ourwork/waste.html?category_id=137

BEAM – Sneak Peak

Summary of Wastewater Treatment Inputs and CO_2 Equivalent Totals

Jurisdiction:	Ville d'Eauville
Wastewater Treatment Plant:	Eauville Centrale
Date of calculation:	3/17/2010
Calculations by:	Ned Becher

WWT & Solids Characteristics

Treatment and Solids Characteristics	Inputs
Amount of Wastewater Treated (million liters/day or MLD)	75.00
Amount of Wastewater Treated (m^3/day)	75,000
Population served by Wastewater Treatment Plant	200,000
Influent BOD_5 (mg/L)	200
Location (by province)	ON
Weighted GHG Emissions for Power Generation by Province (g/kWh)	181

Key	
Input	0
Default from reference values	0
Data used to calculate default (FYI only)	0
Process output	**0**

CO_2eq Totals (Mg/year)

Unit Process	Enter "x" for all applicable processes:	Scope 1	Scope 2	Scope 1 & 2	Scope 3	Biomass combustion*	Total
Storage		NA	NA	NA	NA	NA	**NA**
Conditioning/Thickening	x	0	5	5	660	-	**665**
Aerobic Digestion		NA	NA	NA	NA	NA	**NA**
Anaerobic Digestion		NA	NA	NA	NA	NA	**NA**
Dewatering	x	0	12	12	660	-	**672**
Thermal Drying		NA	NA	NA	NA	NA	**NA**
Alkaline Stabilization		NA	NA	NA	NA	NA	**NA**
Composting		NA	NA	NA	NA	NA	**NA**
Landfill Disposal		NA	NA	NA	NA	NA	**NA**
Combustion	x	6,130	199	6,329	0	8,454	**6,329**
Land Application		NA	NA	NA	NA	NA	**NA**
Transportation		NA	NA	NA	NA	NA	**NA**
TOTALS		**6,130**	**216**	**6,346**	**1,321**	**8,454**	**7,666**

Sewer Modelling (UQ 2009)

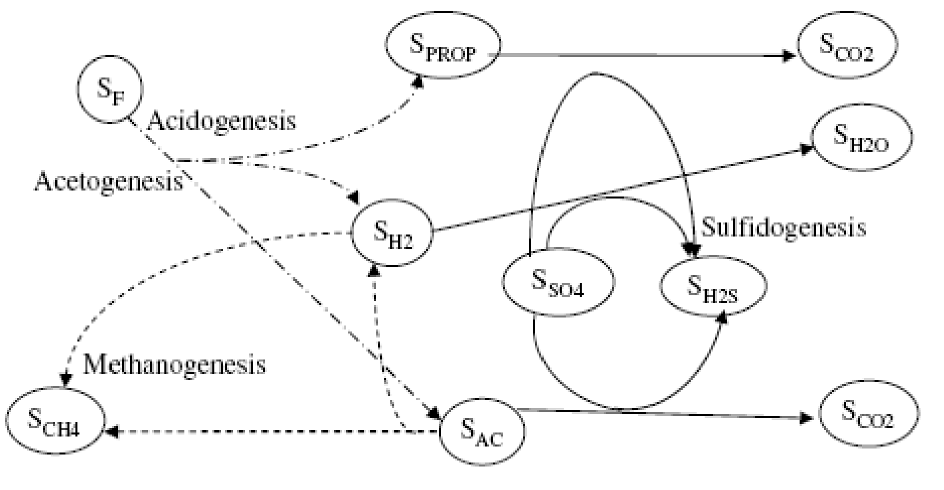


Fig. 1 – Schematic representation of the presented biological model. SRB processes (solid line), FB processes (dash–dotted line) and MA processes (dashed line).

Methanogenic archaea (MA), sulfate reducing bacteria (SRB) and fermentative bacteria (FB)

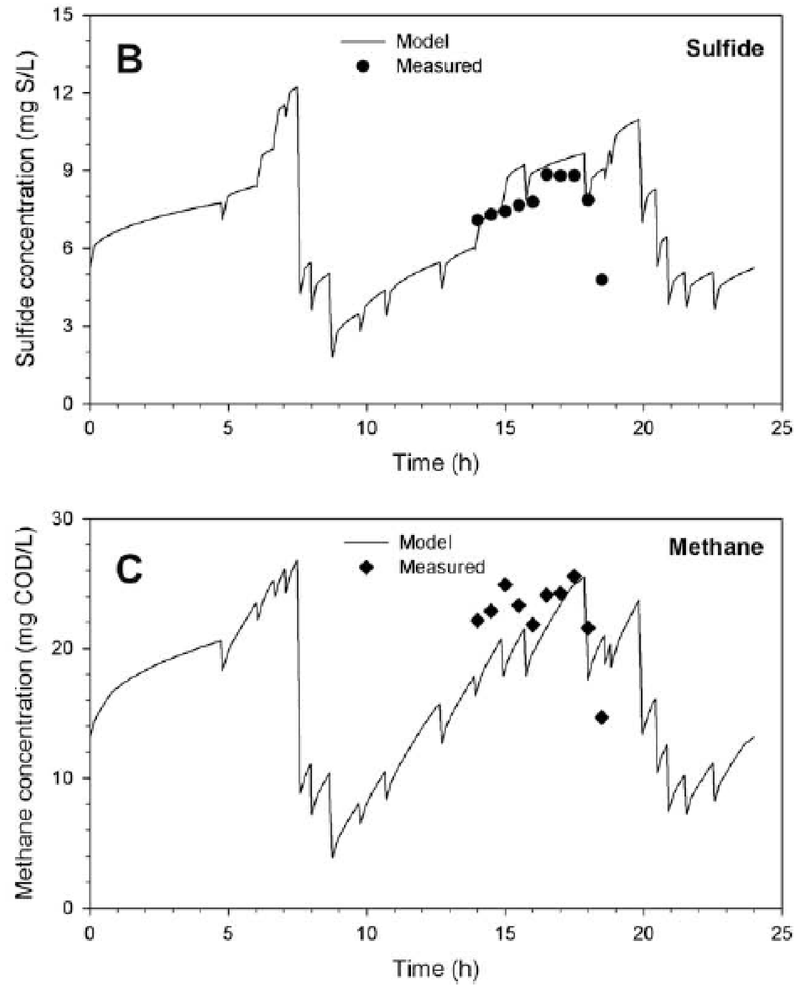


Fig. 6 – Model validation: comparison of modelling predictions for the UC09 rising main with field data obtained from this site (A) pumping events; (B) sulfide; and (C) methane.

Sewer Methane Production

- 20-30 mg/L of COD as CH_4 ~20% of Plant CF
- Previous Study Up to 100 mg/L ~65% of Plant CF

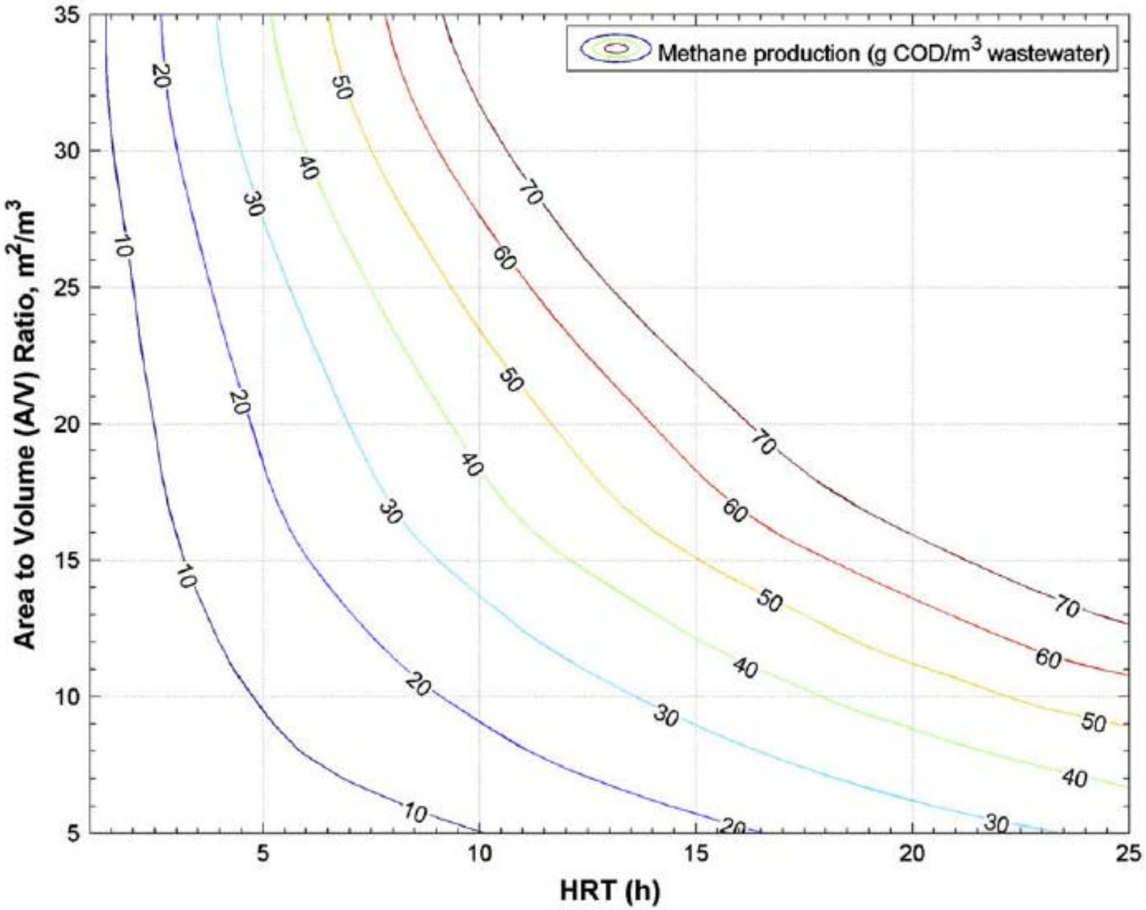


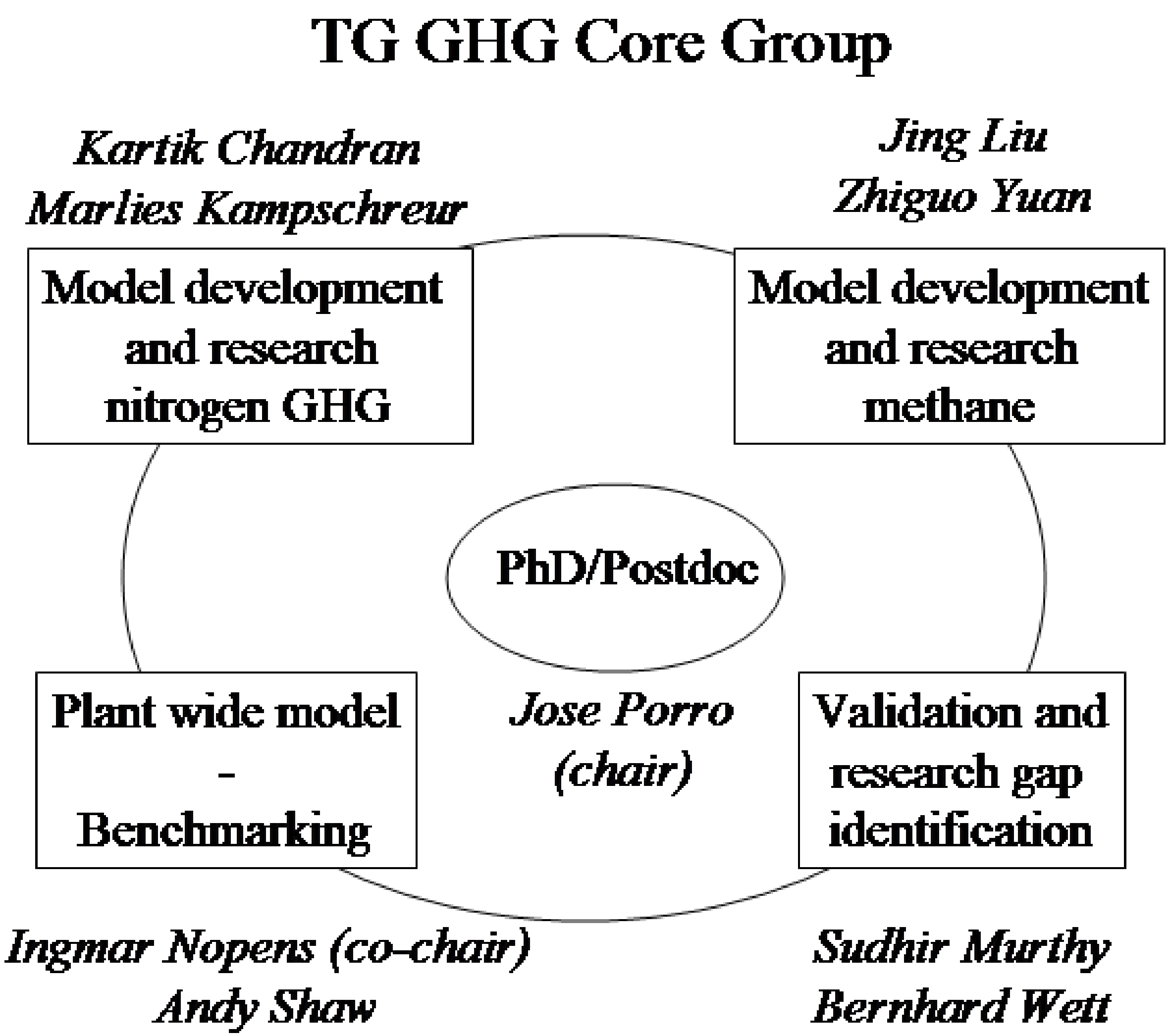
Fig. 7 – Contour graph of methane production as a function of HRT and A/V ratio.

IWA Task Group

IWA Task Group on the Use of Water Quality and Process Models for Minimizing Wastewater Utility Greenhouse Gas Footprints

- Understand the processes that are responsible for the major contributions to GHG emissions from WWTP and sewer systems (e.g. heterotrophic denitrification, autotrophic nitrification, autotrophic denitrification, methanogenesis, etc.)
- Translate this knowledge into mathematical models that can be embedded in system/plant-wide models allowing multi-criteria optimisation

IWA Task Group



Closing Thoughts

- More Data and Cases Needed
- Temporal Effects Important (especially sewer systems and N_2O)
- Process Models Can Aid in Understanding Dynamics
- Knowledge Slowly Building

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Closing Thoughts

- We're just getting started!!!!
  - GHG Workshop
  - IWA TG Meeting

Chateau Mont-Sainte-Anne

March 28th 2010 (Sunday!)

Presenter contact information

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