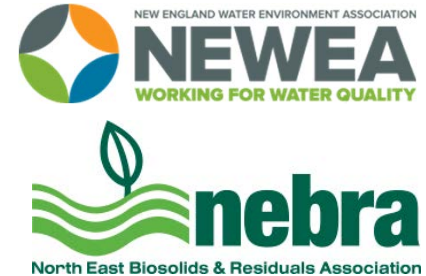


October 2021

Potential for carbon credits from biosolids land application



Bill Brower
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Overview

- GHG sources & sinks for WRRFs
- Carbon markets
- Additionality
- Other financing options



THE END OF NORMAL

“The climate system we have been observing for the past several years...is not our bleak future in preview....The devastation we are now seeing all around us is a beyond-best-case scenario for the future of warming and all the climate disasters it will bring.”

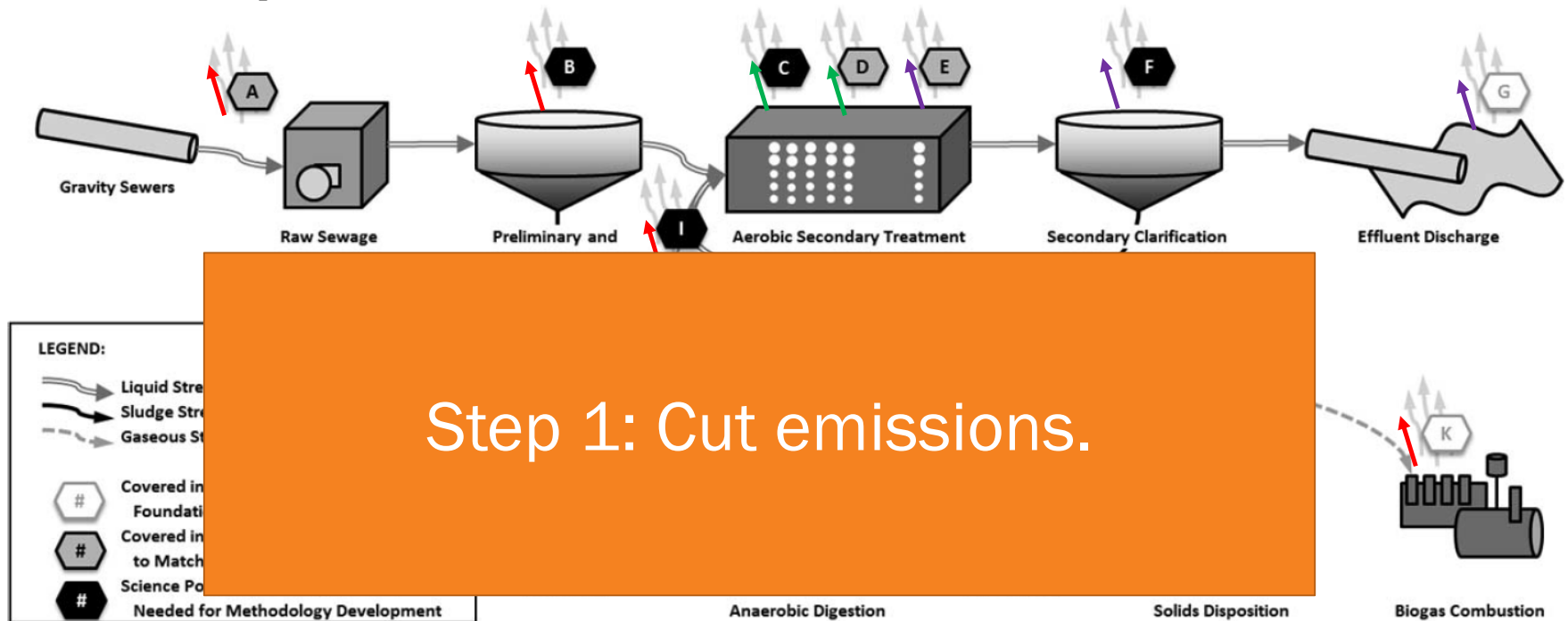
--“The Uninhabitable Earth: Life After Warming”
by David Wallace-Wells

Photo: climate.nasa.gov



GHG Sources & Sinks for WRRFs

Typical Scope 1 Process Emissions for a WRRF



- A: Sewer methane
- B: Preliminary/1° production & release
- C: Industrial discharge \rightarrow CO_2
- D: Carbon source \rightarrow CO_2
- E: N_2O from N removal
- F: N_2O from clarifiers

- G: N_2O from effluent
- H: Fugitive digester CH_4
- I: Dissolved solids CH_4
- J: Solids end-use N_2O , CH_4
- K: Uncombusted digester CH_4

Source: Willis, 2018

Brown and Caldwell

GHG inventory tools

- [BEAM](#) (being updated)
- [Ontario Water Consortium](#)
- GIZ/WaCCliM [Energy Performance and Carbon Emissions Assessment and Monitoring](#) (ECAM)
- Custom-made models

Potential offsets for a wastewater utility

- Waste heat (offsetting fossil fuel use)
- Carbon sequestration from biosolids end use
- Avoided N₂O emissions from use of inorganic fertilizers (offsets emissions from biosolids use)
- Avoided inorganic fertilizer production
- Avoided landfill methane emissions
- Reduced pumped irrigation

Sequestration Factor

- BEAM (original): 0.25 Mg CO₂ sequestered/dry-Mg of biosolids applied
- Northern Tilth and Dr. Sally Brown literature review average (incl. biomass): 0.66 Mg CO₂ sequestered/dry-Mg of biosolids applied
- Published early 2022: Virginia Tech Professors Greg Evanylo & Lee Daniels and post-doc Mike Badzmierowski conducting systematic review of sequestration rates (excluding biomass), including impact of:
 - geography
 - climate
 - biosolids processing (maybe)
 - biosolids characteristics (e.g. iron concentrations)
 - application method
 - land use & vegetation
 - soil types

Soil science rethink on long-term carbon storage

- “Computer models that predict the greenhouse gas impacts of farming practices — predictions that are being used in carbon markets — are probably overly optimistic about soil’s ability to trap and hold on to carbon.”
- “We don’t see any molecules in soil that are so recalcitrant that they can’t be broken down. Microbes will learn to break anything down — even really nasty chemicals.”
- “Studies of carbon isotopes have shown that a lot of carbon can stick around in soil for centuries or even longer. If humus isn’t doing the stabilizing, perhaps minerals and aggregates are.”



Other research gaps

- Biosolids-specific emissions factors are often not available
 - Protocols use manure or compost (or a single-type of biosolids) as a proxy
- Methane, nitrous oxide emissions from land app of biosolids
 - Incorporated vs. surface application



Carbon Markets

How Carbon Markets Work

- Distinct project reduces GHG emissions or sequesters carbon
- Registry verifies claims and pays Project Owner
- Buyer purchases carbon credits from Registry

Registries

- American Carbon Registry (ACR)
- Climate Action Reserve (CAR)
 - [Protocol](#) explicitly includes biosolids
- Verified Carbon Standard (VCS)
 - [Protocol](#) for soil carbon
- The Gold Standard

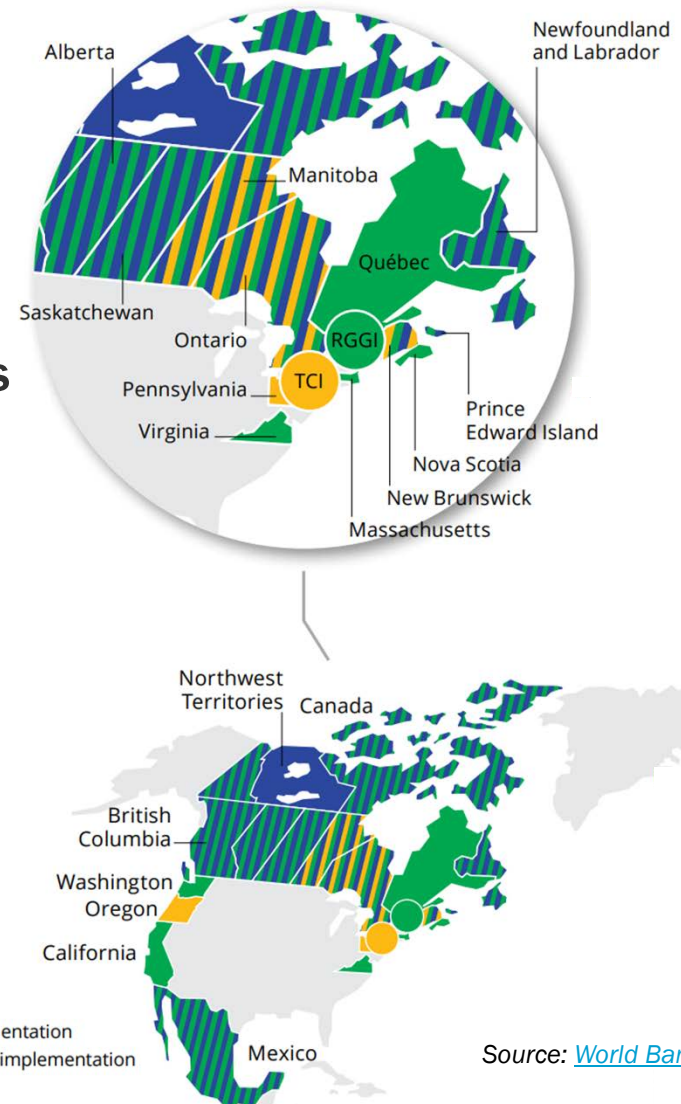
Types of Carbon Markets

- Voluntary – non-binding emissions reductions targets
 - Typical buyers are corporations, individuals
 - Not regulated
- Regulated – legal requirements to lower emissions
 - Typically established by governments
 - Economy-wide or sector-specific

Regional Carbon Markets

- Regional Greenhouse Gas Initiative ([RGGI](#))
 - Covers the power sector
 - Can obtain 3.3% of obligation through offsets
 - Limited offset categories*
- Transportation and Climate Initiative Program (TCI-P) – *in development*
 - Covers gasoline & diesel vehicles
 - Limited offset categories*

**None currently applicable to biosolids land application.
“Improved forest management” could be a possibility if TCI-P
does not include broadcast fertilization restrictions like RGGI*



CAR Soil Enrichment Protocol

- Eligible projects include:
 - Fertilizer application
 - Soil amendment application
- GHG Emission Reduction = Baseline Emissions - Project Emissions
 - Modeled: CH₄, N₂O, CO₂
 - Measured (initiation & every 5 yrs): soil organic carbon
- Reversible: SOC could change (e.g. fire, flood, land use change)
 - Project Owners contribute to “Buffer Pool” in case of reversals
- Additional with respect to the land
 - Practice cannot have been used in last three years
- 100-year timeframe
 - option to get fewer credits for shorter commitments

Calculations, factors need some work before this is ready for biosolids land app
(assumes high CH₄ emissions in the field based on manure research)

via CASA

Developing new projects

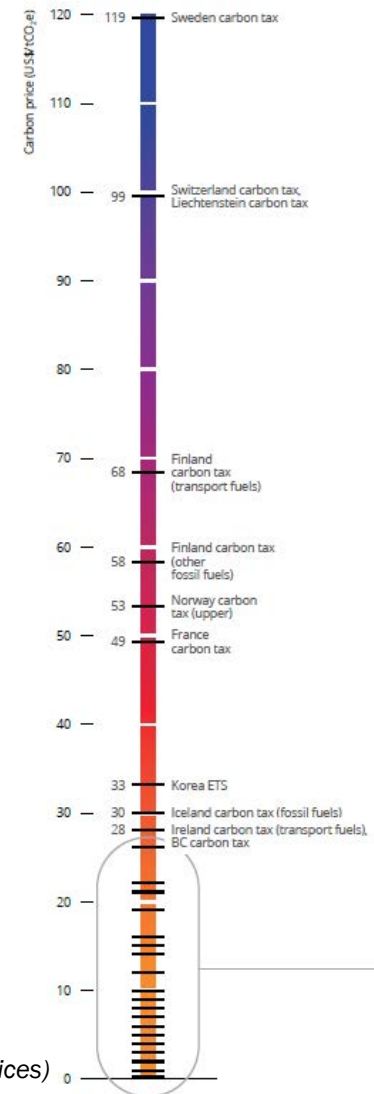
- ~\$50k* to initiate new projects
 - project developers can help with upfront costs
- ~\$20k/yr* during project (maintenance, verification)
- If new protocol needed:
 - Passive: Registry-driven
 - Active: Approach registry
 - Months to a year
 - Significant cost

Illustrative calculation

- 0.66 MTCO₂e/dry-MT biosolids applied (revised BEAM)
 - =0.1497 MTCO₂e/wet-ton at 25%TS

Carbon price	\$/wet-ton*
\$9.30/MTCO ₂ e (most recent RGGI auction price)	\$1.40/wt
\$10/MTCO ₂ e (terrapass voluntary “business” offset)	\$1.50/wt
\$17/MTCO ₂ e (current CA floor)	\$2.55/wt
\$100/MTCO ₂ e (Swiss carbon tax)	\$15/wt

*For illustrative purposes only. Protocol calculations are more complex.



Source: [World Bank](#)
(April 2020 nominal prices)



Additionality



Additionality

- Projects must be “additional” – i.e. they would not have happened without the carbon funding
- Cannot be for a regulated activity
- Purchaser is covering their emissions by purchasing offset
 - Emissions are real and so offset must be real

Additional to the planet

- Global Warming Potential: 100-year timeframe
 - Can we ensure soil will be undisturbed that whole time?
 - CAR protocol: can get credits for shorter periods
- Additional to whom?
 - ~~The landowner (e.g. a farmer)?~~
 - ~~The piece of land?~~
 - The utility?
 - The planet.



Additionality examples

DC Water

- All biosolids currently going to land app

Punished for prior good behavior?



Rochester, NY (Monroe Co. DES)

- All biosolids currently going to landfill
 - Cheap landfill tip fees





Other financing options

Green bonds

- Lower interest rates for capital projects
 - Not income so no direct funds to reinvest
- Nascent market
- Investors driving more rigorous assessment of projects
 - Not as stringent as credits requirements

Microsoft Carbon Dioxide Removal RFP

- On-going RFP
- “Soil improvement that results in additional carbon storage”
 - Approaches not prescribed
- Field measurements backed up by computer modeling
- Not verified through a registry
- Project owner specifies desired price (\$12/MTCO₂e listed in application)

Green grants: Example from California

Healthy Soils Program (HSP)

- CDFA's Office of Environmental Farming and Innovation grant program – in development
- “financial assistance for implementation of conservation management practices that improve soil health, sequester carbon, and reduce greenhouse gas (GHG) emissions”
- \$50 million in one-time funding for FY 2021-22
- “biosolids are allowed in the program under the fertilizer reduction practice, if inorganic fertilizer application is reduced by at least 15% and NRCS 590 is followed”

via CASA

Conclusion

Conclusions

- Some options, but still a lot of work to do
- Need to make sure offsets are real
 - Long-term
 - Additional

Want to get involved?

- WEF RBC Greenhouse Gas subcommittee
 - Contact Mahia Qureshi mqureshi@wef.org
- NEBRA Carbon & Nutrient Trading Committee
 - Contact Janine Burke-Wells janine@nebiosolids.org
- IWA Climate Smart utilities Community of Practice
 - More info: <https://climatesmartwater.org/> (must be IWA member)

Acknowledgements

- Saul Kinter, *DC Water*
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- Sally Brower, *University of Washington*
- Manon Fisher, *SFPUC*
- Christine Polo, Sarah Deslauriers, Greg Kester, *CASA*
- Keith Knudsen & Sheldon Fernandes, *BrightSpot*
- John Willis, *Brown and Caldwell*



Thank you.
Questions?

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Brown AND
Caldwell

Other offset factors

- Avoided inorganic fertilizer production by land applying biosolids (from BEAM)
 - 4 kg CO₂e saved/kg nitrogen
 - 2 kg CO₂e saved/kg of phosphorus

Additional Resource Links

- [How are WRRFs inventorying greenhouse gas emissions?](#) By: Christine Polo, Tracy Chouinard, Sarah Deslauriers, Bill Brower and Manon Fisher
- [Greenhouse Gas Sources and Sinks for Water Resource Recovery Facilities](#) By: Bill Brower, Mark Lang, John Willis

Protocols

- Climate Action Reserve Soil Enrichment Protocol: www.climateactionreserve.org/how/protocols/soil-enrichment/
- Alberta offset protocols: www.alberta.ca/alberta-emission-offset-system.aspx
- British Columbia offset protocols: www2.gov.bc.ca/gov/content/environment/climate-change/industry/offset-projects/develop