

Dioxins, Furans, Dioxin-Like PCBs (DL-PCBs) and Polybrominated Diphenyl Ethers (PBDEs) in Sewage Biosolids

Presented by: Sonya Kleywegt

Presented to: Water Environment Association of Ontario

December 13, 2006

Purpose of the Presentation

- To present the results from the 2004 survey of 25 Sewage Treatment Plants (STPs) for dioxins, furans, dioxin-like Polychlorinated biphenyls and Polybrominated diphenyl ethers in biosolids.

Outline of Presentation

- Background

 - Dioxin (PCDD) and Furans (PCDF)*

 - Dioxin Like –Polychlorinated biphenyls (DL-PCBs) and, Poly brominated diphenyl ethers (PBDEs)*

- Purpose of the Survey and Experimental Plan

- Results of Survey

- Conclusions

- MOE Current & Future Initiatives

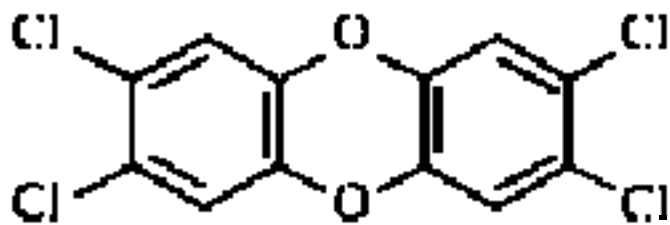
Dioxins, Furans and DL-PCBs

- Polychlorinated dibenzo-p-dioxins (PCDDs) and the polychlorinated dibenzofurans (PCDFs) are chlorinated, planar tricyclic aromatic hydrocarbons.
 - Dioxins and furans are ubiquitous in the environment and have no known use. Found as by-products of combustion of wood and organic materials, emissions, waste incineration and petroleum refining.
 - Polychlorinated biphenyls (PCBs) are chlorinated compounds that have been used as coolants and lubricant in transformers.
 - The WHO identified 12 PCBs as being similar toxicity to PCDD/Fs. All 12 DL-PCBs, and 17 PCDD/F congeners, have an assigned toxicity equivalence factor (WHO-TEF).
-

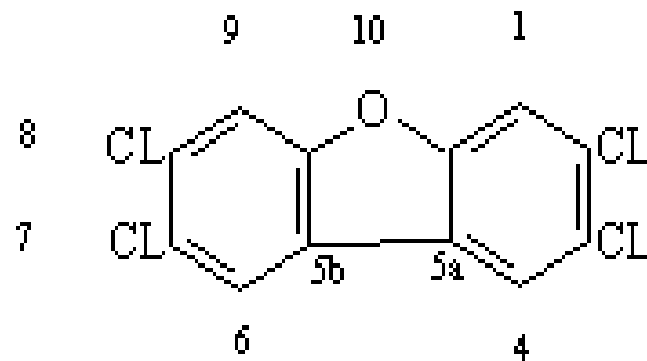
PBDEs

- Flame-retardant additives used in high-impact plastics, foams, textiles and as coatings on fabrics and furniture to slow the ignition and rate of fire growth.
- Commercial products consist predominantly of penta-, octa, and decabromodiphenyl ether (Penta-BDE, Octa-BDE and Deca-BDE) mixtures.
- There are 209 possible BDE congeners.
- Similar structure and physical properties as PCBs.

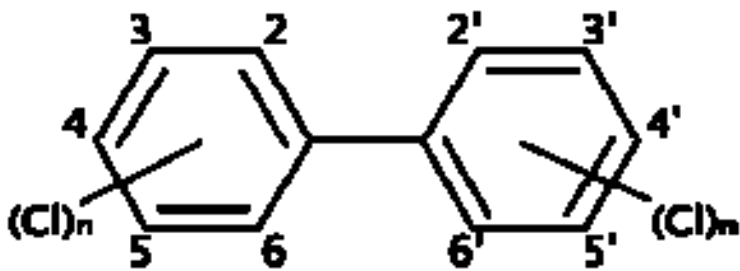
Chemical Structures



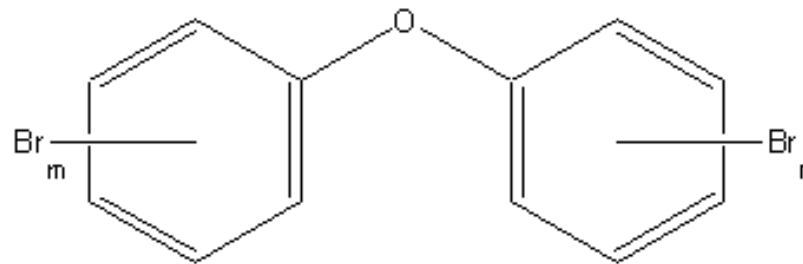
DIOXIN



FURAN



PCB



PBDE

Environmental Fate of PCDD/Fs and DL-PCBs

- PCDD/Fs and DL-PCBs are stable chemically, physically, biologically and are lipophilic.
 - Tend to concentrate in organic material in soil. Not expected to leach from soil into surface and ground water.
 - Little capability for transfer from soil to the roots of vegetables.
 - Half life in soil is about 10 years.
 - Half life in the human body is about 6 years.
-

Environmental Fate of PBDEs

- Indoor air concentrations are 15 to 50 times higher than in outdoor air.
- Trace levels have been detected in surface waters of the Great lakes and connecting channels.
- Concentrations in sediments have rapidly increased since the early 1980s. The highest concentrations of PBDEs have been found in Lake Michigan and Lake Ontario.
- PBDEs have been found in human blood, serum, adipose tissue, breast milk, and placental tissue (doubling time of four to five years).

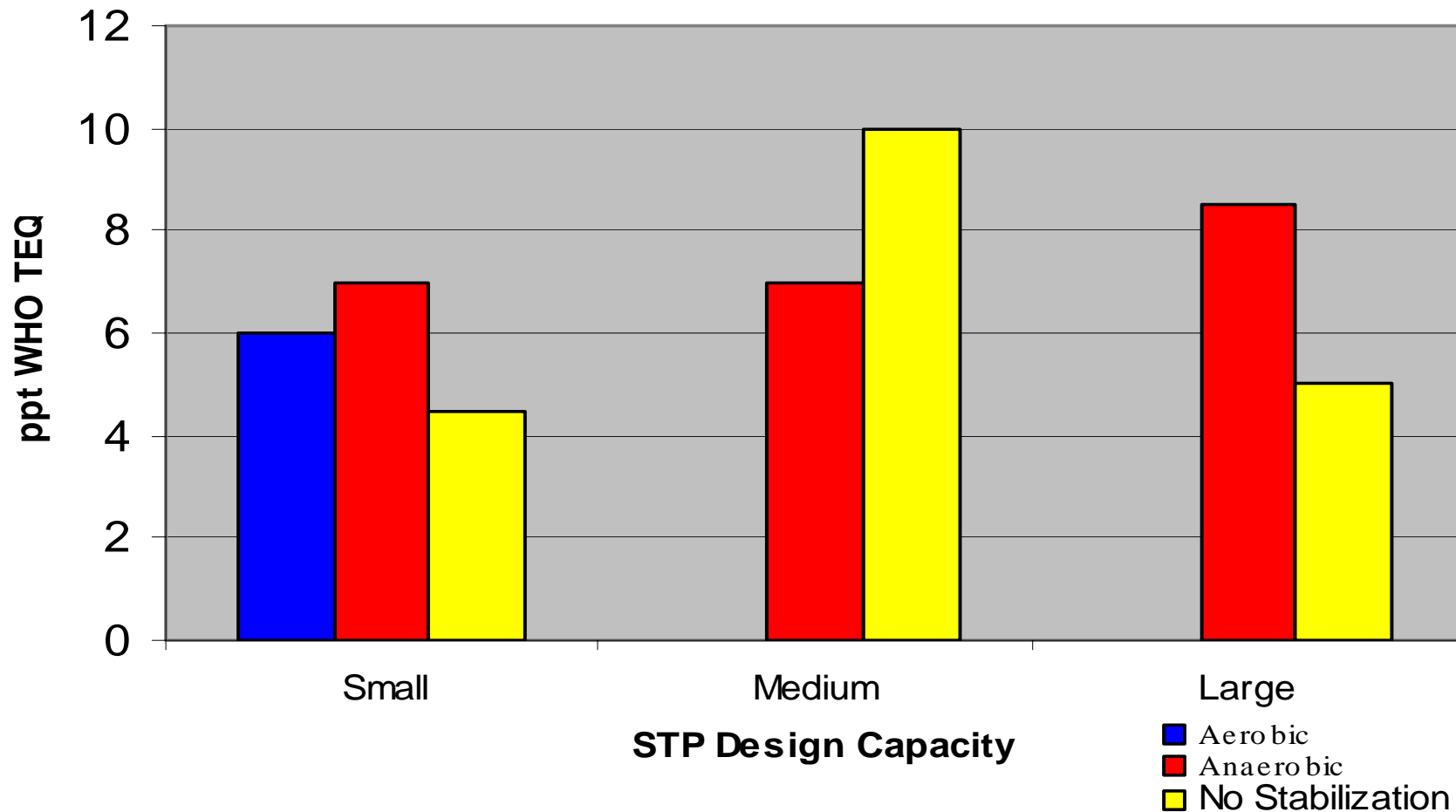
Survey Scope

- Last survey on sewage biosolids was conducted in 1998, with limited samples.
- Purpose of the survey was to determine:
 - The concentrations of DL-PCBs in sewage biosolids
 - Whether there had been a decrease or increase in the levels of dioxins / furans in sewage biosolids since 1998
 - The concentrations of PBDEs in Ontario sewage biosolids
 - Whether a standard for dioxin/furan or DL-PCBs was warranted under the *Nutrient Management Act*
- An ecological or human health risk Assessment was not part of the study

Experimental Plan

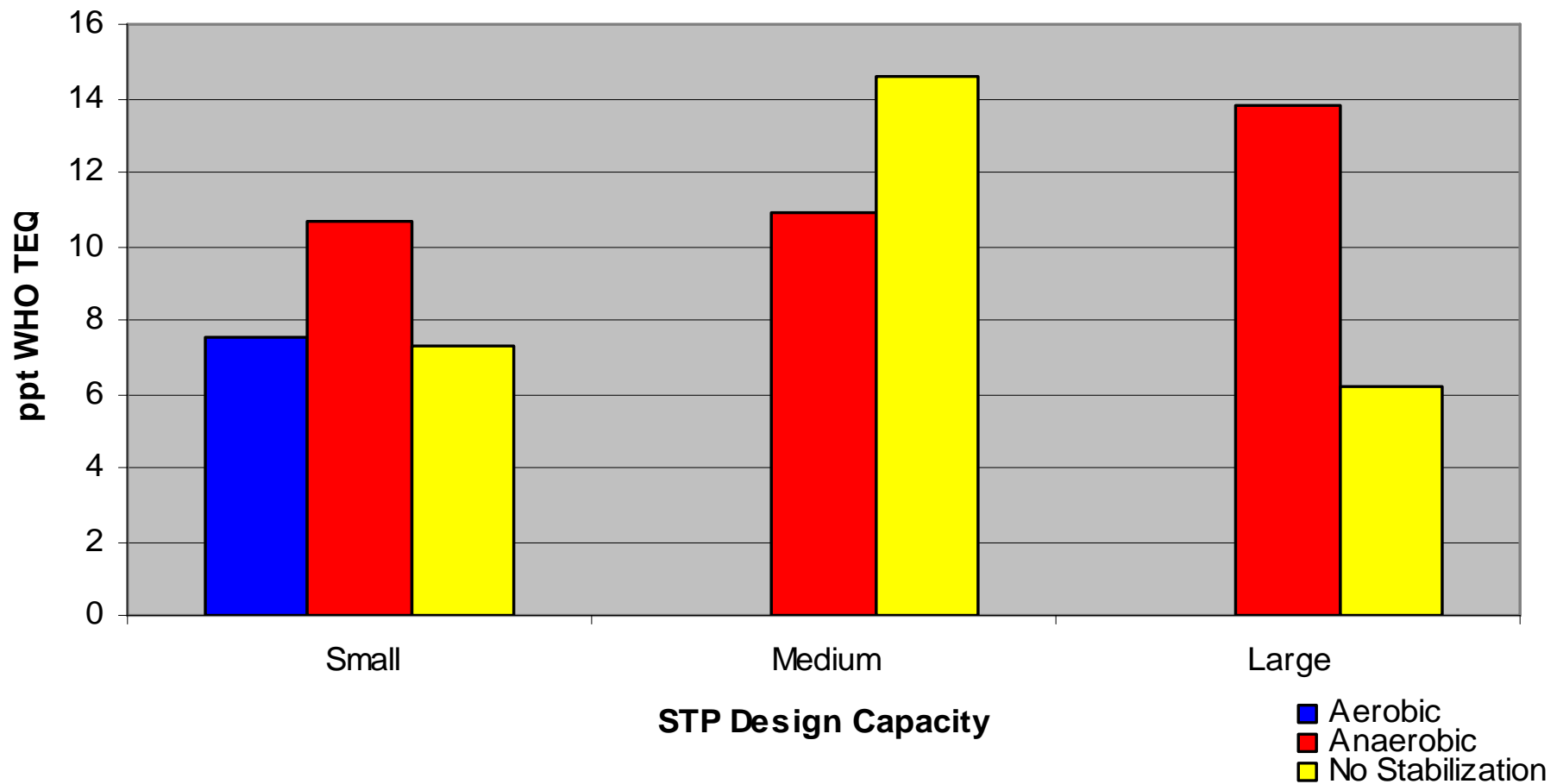
- 90 biosolid samples were collected from 25 STPs (Small, Medium, Large) in Ontario.
- Small STP – design capacity of 22,700 cubic meters per day or less (N=36).
- Medium STP - design capacity of greater than 22,700 cubic meters per day but less than 45,400 cubic meters per day (N=8).
- Large STP - design capacity of 45,400 or greater cubic meters per day or less (N=46).
- Samples were analyzed for dioxins, furans, dioxin-like PCBs, and PBDEs.

Results Dioxins & Furans



Results

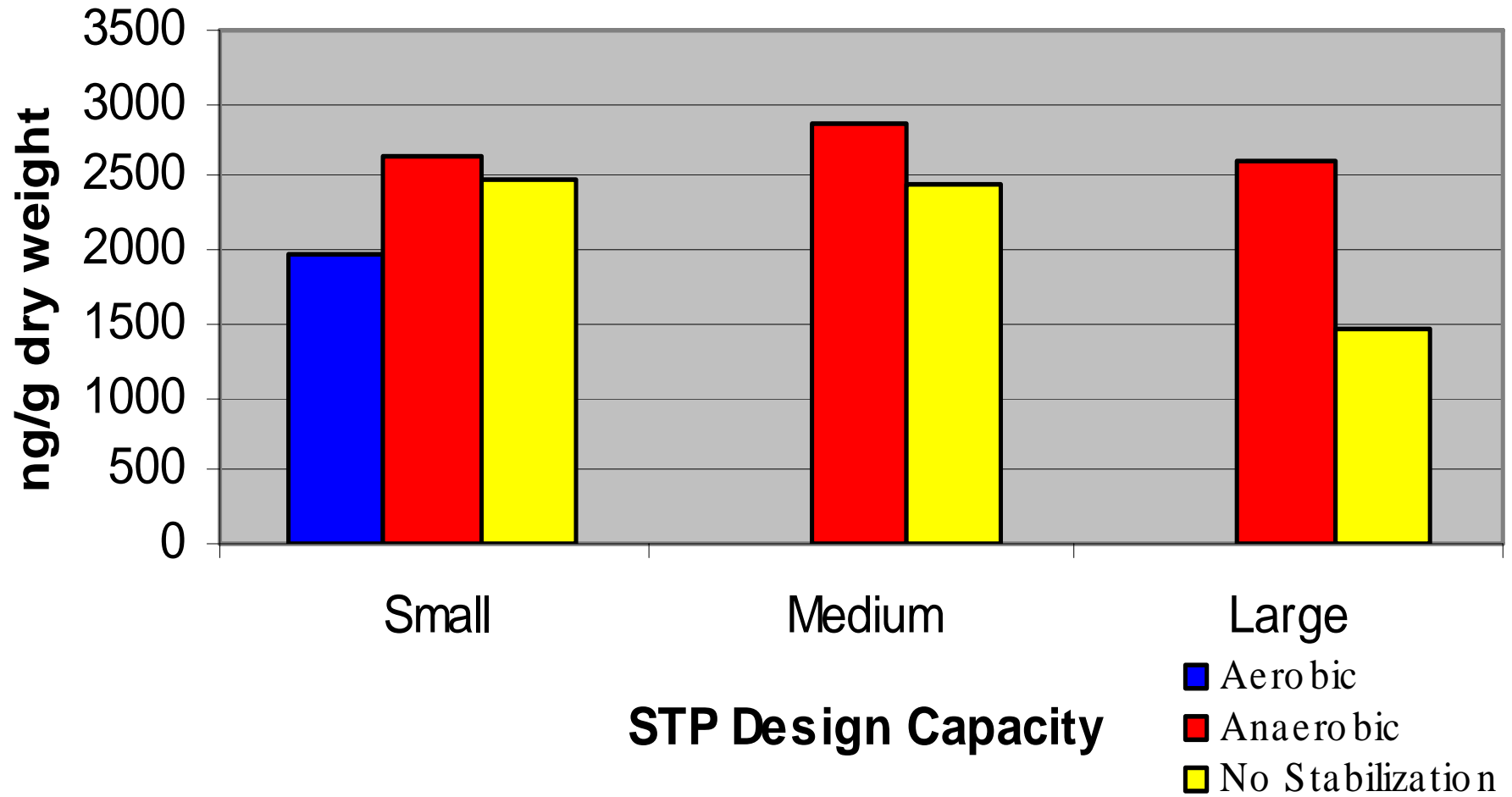
Dioxins, Furans and DL-PCBs



Results PCDD/Fs and DL-PCBs

- PCDD/Fs and DL-PCBs were detected in all biosolid samples (2 – 19 ppt, 1.5 – 10 ppt WHOTEQ respectively). The median value of 15 ppt WHOTEQ.
- Neither the size of the STP nor the biosolids treatment processes used appeared to have an impact on the concentration of PCDD/Fs in biosolids
- The contribution of DL-PCBs varied from 24%-34% of the total WHO TEQ for each sample.
- Based on the current guidelines for the land application of biosolids, the concentration of PCDD/Fs in soils which receive biosolids will never exceed the generic soil limit of 10 ppt I-TEQ

Results PBDEs



Results - PBDEs

- PBDEs were detected in all biosolid samples. The median value for PBDE was 3 ppm.
- Neither the community size or the biosolids treatment processes used significantly impacted the concentration of PBDEs in biosolids.
- Based on annual sewage biosolids generation and land application, it is estimated that sewage biosolids potentially increase soil concentration by 3 ppb per year.

Conclusions

- PCDD/Fs, DL-PCBs and PBDEs were detected in all sewage biosolid samples.
- PBDEs occurred at higher concentrations compared to the other organic chemicals tested.
- Neither the community size or biosolids treatment processes used appeared to have an impact on the concentrations of the organic chemicals tested.
- The MOE has determined that a standard for dioxins, furans or DL-PCBs is not warranted at this time.
- There are major information gaps on the environmental fate and persistence of PBDEs in soil and the risk to human health.

Current and Future Initiatives

- Development of a model to predict loadings of PBDEs to soil from atmospheric deposition and application of biosolids on agricultural land, persistence and mobility in soil.
- Determination of BMPs for the land application of sewage biosolids. Samples to be analyzed for PBDEs, Pharmaceuticals and Personal Care Products, Musks and Fluorinated Surfactants.
- Identification and quantification of PBDEs, Fluorinated Surfactants and Poly chlorinated Naphthalenes in different types of Pulp and Paper Mill Biosolids.

Questions?

- Contact information
 - Dr. S. Kleywegt (Sonya.Kleywegt@ontario.ca)
 - Dr. E. Reiner (Eric.Reiner@ontario.ca)
 - Dr. M. Alaei (Mehran.Alaei@ec.gc.ca)
 - Tony Ho (Tony.Ho@ontario.ca)