Comparing Urban Phosphorus Flow in the Phoenix-Metro Area and Assessing Potential Standard Adsorbents for Phosphate Removal from Synthetic Wastewater

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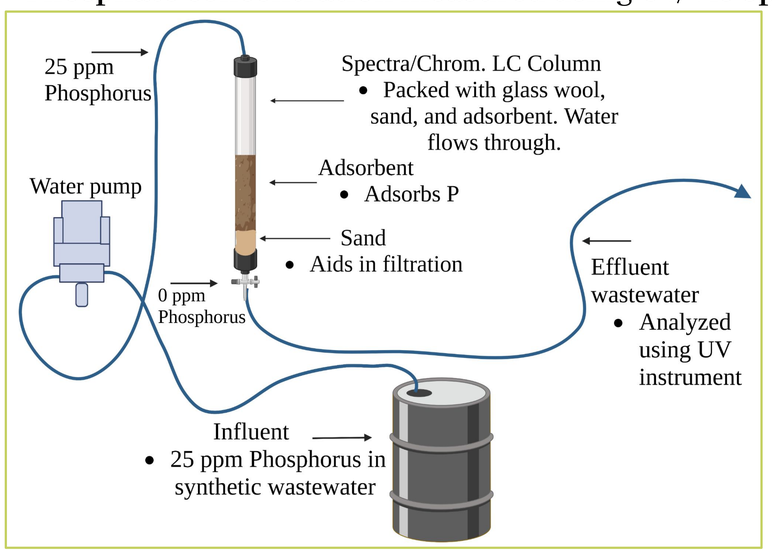
Introduction

Two important factors to consider for STEPS:

- **Phosphorus Sources**
  Goal: Update STEPS Urban TBL P-mass balance for the CAP-LTER site from 2000-2020 by focusing on pools and fluxes of pet waste.
- **Phosphate Removal:**
  Goal: Remove phosphate from synthetic water using adsorption. Develop standard flow through column tests for phosphate removal using commercial adsorbents.

Methods

- **Phosphorus Sources**
  - *# of dogs/cats*= (0.614)(Total # of households), (0.457)(Total # households)
  - *Pool of P in pets (kg P/yr/pet)*= (1% pet body mass of pet)
  - *P-flux of pet waste(kgP/yr)*= (# Dog/Cat)(P per dog/cat)
- **Phosphate Removal**
- Testing adsorption performance in columns of two commercially available adsorbents: granular ferric (hydr)oxide (E-33) and lanthanum-modified bentonite (Phoslock®)
- Test ran in duplicates: two columns, two barrels of water, etc.
- Phosphate concentration measured using UV/Vis Spectrophotometry



Parameters:
Empty Bed Contact Time (EBCT): 2 min

Flow rate: 14.8 mL/min

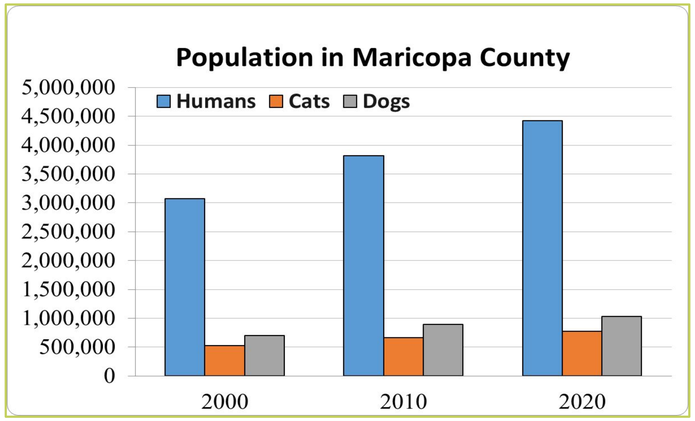
Volumetric loading rate: .75 gpm/ft²

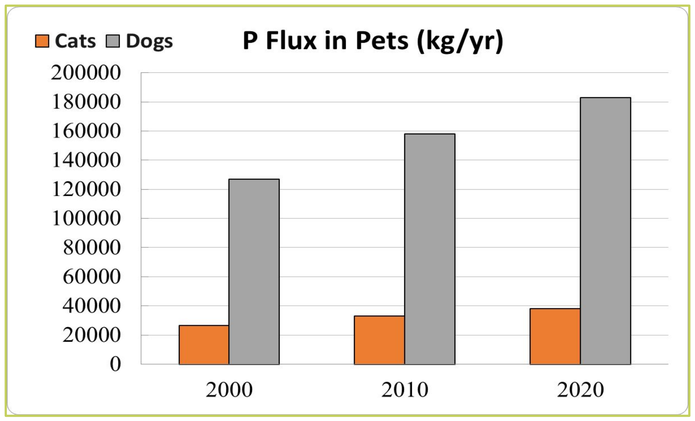
Volume of water per barrel: 44.45 L

Bed Volumes Treated: 1,500-5,000

Results

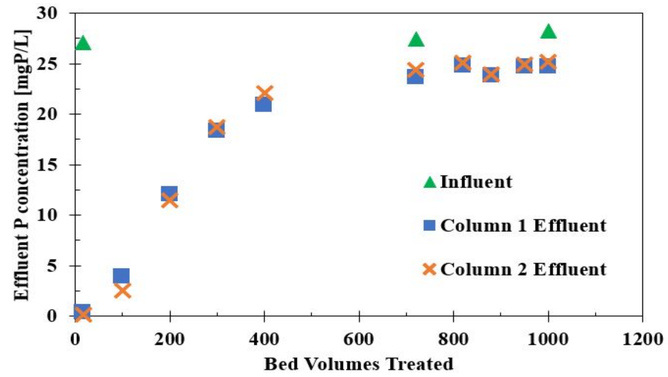
Phosphorus Sources:





Phosphate Removal:

Figure 1: Breakthrough Curve of Granular ferric (hydr)oxide (Bayoxide E-33)



- Adsorption Capacity of this media → Q=6.03-6.11 mgP/g E33
- Column Test with Granular ferric (hydr)oxide adsorbent media is highly reproducible

- **Lanthanum-modified bentonite (Phoslock®) not suitable for column testing**
  - Limited water flow as a result of pressure buildup
    - 10-130 psi
  - Structurally challenged in column test
    - Decomposes to clay
  - Batch and Isotherm Experiments are more suitable to characterize adsorbent properties of Phoslock®

Discussion

- **P-sources:**
  - P-flux study in CAP-LTER area for pets
  - In pet population, urban P-flux increased by ~40% from 2000-2020
- **P-removal:**
  - Standard column test for breakthrough behavior provide insight into P removal. Granular ferric (hydr)oxide has been proven to remove phosphate from synthetic water in flow through column, while Phoslock® proved challenging due to the bentonite-structure causing pressure limitation.
- **Future Work:**
  - Quantify phosphorus throughflow in municipal trash and in milk production and consumption
  - Test commercial adsorbents in more “challenging” influent water (e.g., high carbonate, sulfate, etc.)

Acknowledgements
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