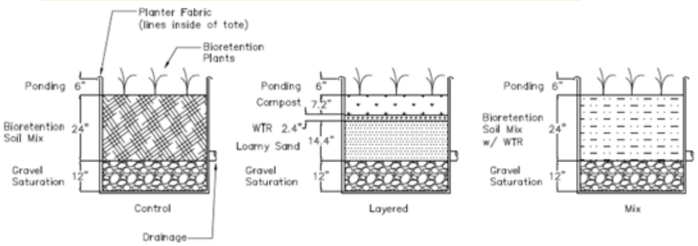
Evaluating the Effects of Water Treatment Residuals in Bioretention Soil Mixes

Cara Poor[1], Connor Mansberger[1], Jocelle Tade[1], Katie Conkle[1], Anne MacDonald[2], Kari Duncan[3].

[1] Shiley School of Engineering, University of Portland, [2] Clean Water Services, [3] City of Lake Oswego

Background

- Bioretention systems are used to passively treat stormwater as it infiltrates through engineered soil mixes. Organic amendments to engineered bioretention soil mixes (BSM) are specifically important for reducing toxicity of metals of concern (e.g., copper, zinc), mediating breakdown of hydrocarbons, and promoting infiltration of stormwater (McIntyre at al., 2015).
- Leaching of phosphorus from compost amendments is a common problem for bioretention systems (Herrera, 2015; Mullane et al., 2015). and of particular concern in some receiving water bodies such as Oswego Lake.
- The aluminum in water treatment residuals (WTRs) forms a precipitate with phosphate, which can potentially reduce phosphorus leaching.
- WTRs may also be useful in further reducing the toxicity of other metals of concern.

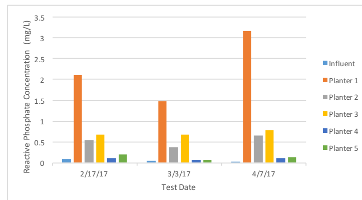


Design and Methods

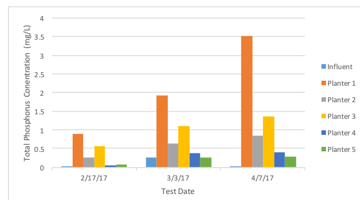
- WTRs were obtained from the Lake Oswego (LO) and the Joint Water Commission (JWC) water treatment plants. Both treatment plants add Alum in the treatment process
- Planters were constructed using City of Lake Oswego (LO) bioretention standards (City of Lake Oswego, 2016) with WTRs either mixed or layered:
  - Planter 1 – control
  - Planter 2 – mixed: BSM and LO WTR
  - Planter 3 – mixed: BSM and JWC WTR
  - Planter 4 – layered: compost, LO WTR, sand, gravel
  - Planter 5 – layered: compost, JWC WTR, sand, gravel
- City of Lake Oswego design storm volume (1 inch) was applied during each test with a runoff ratio of 9:1.
- 5 tests will be conducted to evaluate phosphorus retention over time. 3 of the 5 tests have been completed.
- Influent and effluent were analyzes for TP, PO_4^{3-}, TN, NO_3^-, NH_3, Zn, Cu, Al, Fe and Pb

Objective

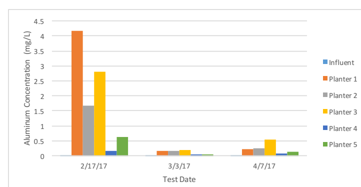
To investigate the use of water treatment residuals (WTRs) for retaining phosphorus in bioretention systems.



Phosphate Concentrations During Each Test



Total Phosphorus Concentrations During Each Test



Aluminum Concentrations During Each Test

Future Work

To confirm that WTRs are beneficial in bioretention systems, field scale studies are needed to further validate the beneficial use of WTRs. After testing is complete, we plan to pursue funding sources for such testing. Better understanding of the role that WTRs perform in metals complexation is also poised for additional consideration.

Results

- Total phosphorus (TP) and phosphate ($P0_4^{3-}$) concentrations were 74% and 81% lower in the planters with WTRs compared to the control, respectively
- The average TP and $P0_4^{3-}$ concentrations in the layered planters with WTRs was about 82% lower than the mixed planters with WTRs.
- Aluminum was present in the effluent for both the mixed planters and layered planters, although concentrations in the layered planters were 82% lower than the mixed planters. Aluminum concentrations in the effluent decreased significantly after the first test.
- Turbidity of effluent was 83% lower in the layered planters compared to the mixed planters. Turbidity of effluent was 62% lower in the planters with WTR compared to the control planter.
- Planters with WTRs reduced Cu and Zn concentrations by 57% and 44%, respectively.

Acknowledgements

We thank the Oregon Department of Transportation for letting us collect stormwater at their STTC facility, and Allen Hansen and Jacob Amos for providing assistance and materials. The City of Lake Oswego provided funding for this project.