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# Impact of WTRs in a Saturated Bioretention System

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# Impact of WTRs in a Saturated Bioretention System

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## Objectives

To evaluate equilibrium chemistry in bioretention systems with water treatment residuals ( WTRs) under saturated conditions.

## Background

- Bioretention is a common green stormwater system used to treat urban stormwater
- However, leaching occurs within the bioretention system soil mixture – mainly phosphorus
- The saturated zone helps remove nitrate (Palmer et al., 2013)
- There is very little research into how WTRs will impact chemistry particularly for saturated conditions

## Design and Methods

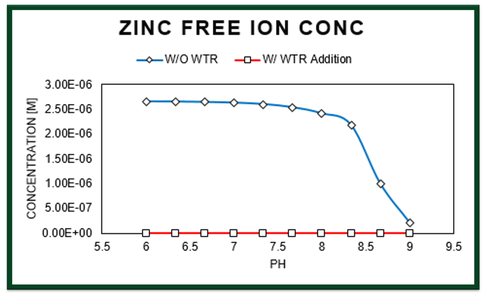
- MINEQL +, a chemical equilibrium modelling program, was used to create a total of four aerobic and anaerobic aquatic systems
    1. Aerobic
    2. Anaerobic
    3. Aerobic + WTR Addition
    4. Anaerobic + WTR Addition
- The urban stormwater ionic composition and concentrations mimics runoff conditions comparable to the Pacific Northwest
- To simulate the addition of a WTR, alum was introduced into the system using the chemical reaction below

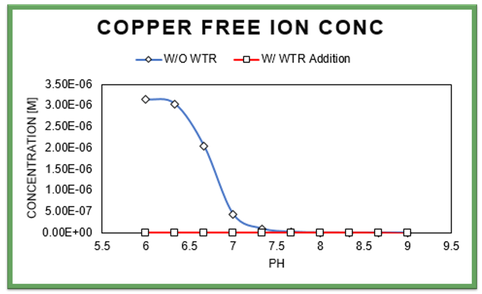
$$2Al^{3+} + 3(SO_4)^{2-} \rightarrow Al_2(SO_4)_3\ (s)$$

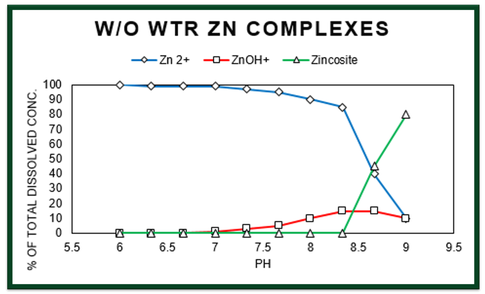
- Species and free ion formations of Zn, Cu, $PO_4^{3-}$, and Al were evaluated in the model over a range of pH

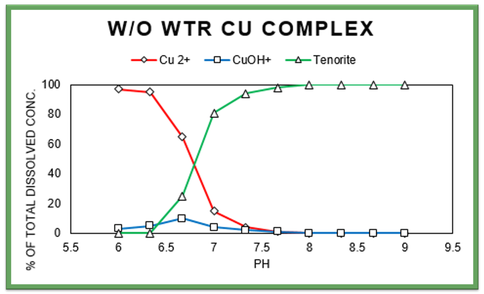
| Aerobic | Anaerobic |
|---|---|
| • $O_2$ available<br>• Equilibrated with atm @ 21% $O_2$ | • Anoxic; W/O $O_2$<br>• Partial pressure of $O_2$ set to 0<br>• Oxidation reactions were removed |

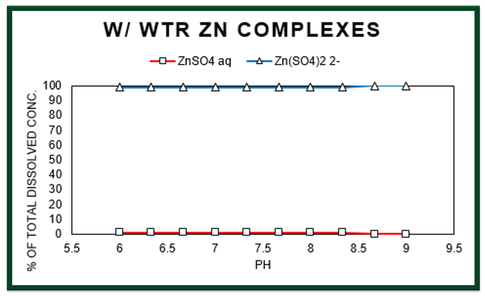
| Cations | Anions |
|---|---|
| $Ca^{2+}$ $K^{+}$<br>$Mg^{2+}$ $Na^{+}$<br>$NH_4^{+}$ $Zn^{2+}$<br>$Cu^{2+}$ $Pb^{2+}$ | $Cl^{-}$ $NO_3^{-}$<br>$PO_4^{3-}$ |

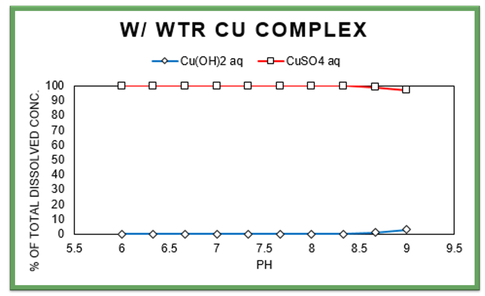


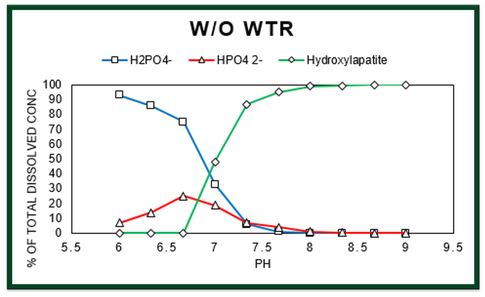



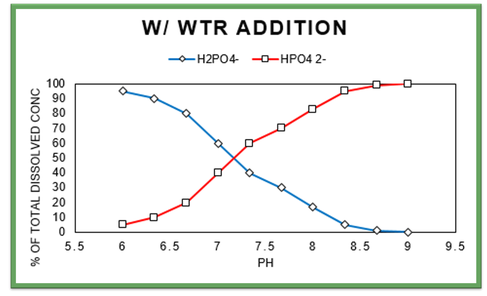



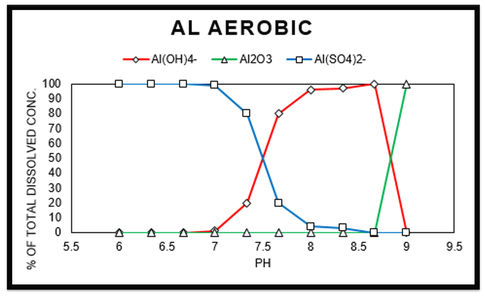



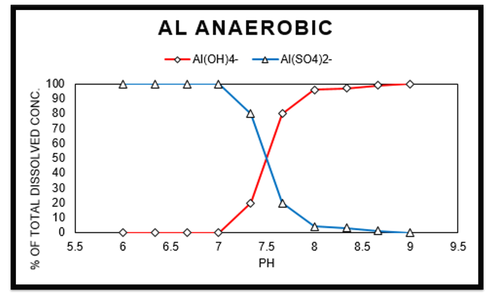




## Results and Discussion

- Copper and Zinc free ion concentration was significantly higher in the systems without the WTR
- With of addition to WTR, Cu and Zn sorption to sulfate was dominant
- Significant retention of $PO_4^{3-}$ resulted with added WTRs
- Aerobic and anaerobic conditions shared similar Al free ion exchange until above a pH 8.5 where $Al_2O_3$ precipitates and gets removed in the soil
- The addition of WTRs with a saturated zone showed an increase in Cu and Zn complexes, reducing the free ion concentration

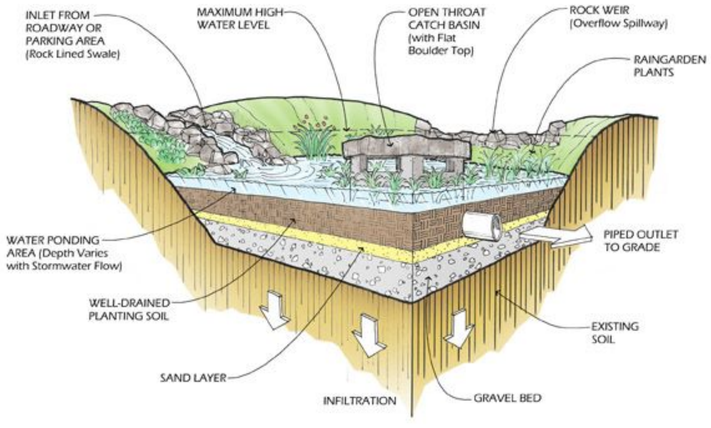
## Future Work

To confirm the benefits of using a WTR in bioretention, more research and experimenting with anaerobic conditions is needed to confirm the chemical equilibrium results in this study.

## Acknowledgements

We thank the Oregon Community Foundation and Shiley School of Engineering for providing funding for this project.

### Cross Section of Bioretention System




**Source:** https://bluegrasslawn.com/the-importance-of-bioretention-systems