

An aerial photograph of a marsh at sunset. The sky is a gradient of orange and yellow, transitioning into a dark blue. The marsh is a complex network of water channels and land parcels, with the water reflecting the warm colors of the sky. The land parcels are dark and irregularly shaped, creating a maze-like pattern. The overall scene is serene and captures the natural beauty of a coastal wetland.

Biosolids as Marsh Creation Amendment

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University of New Orleans
Partnering for Impact in California
May 5, 2021

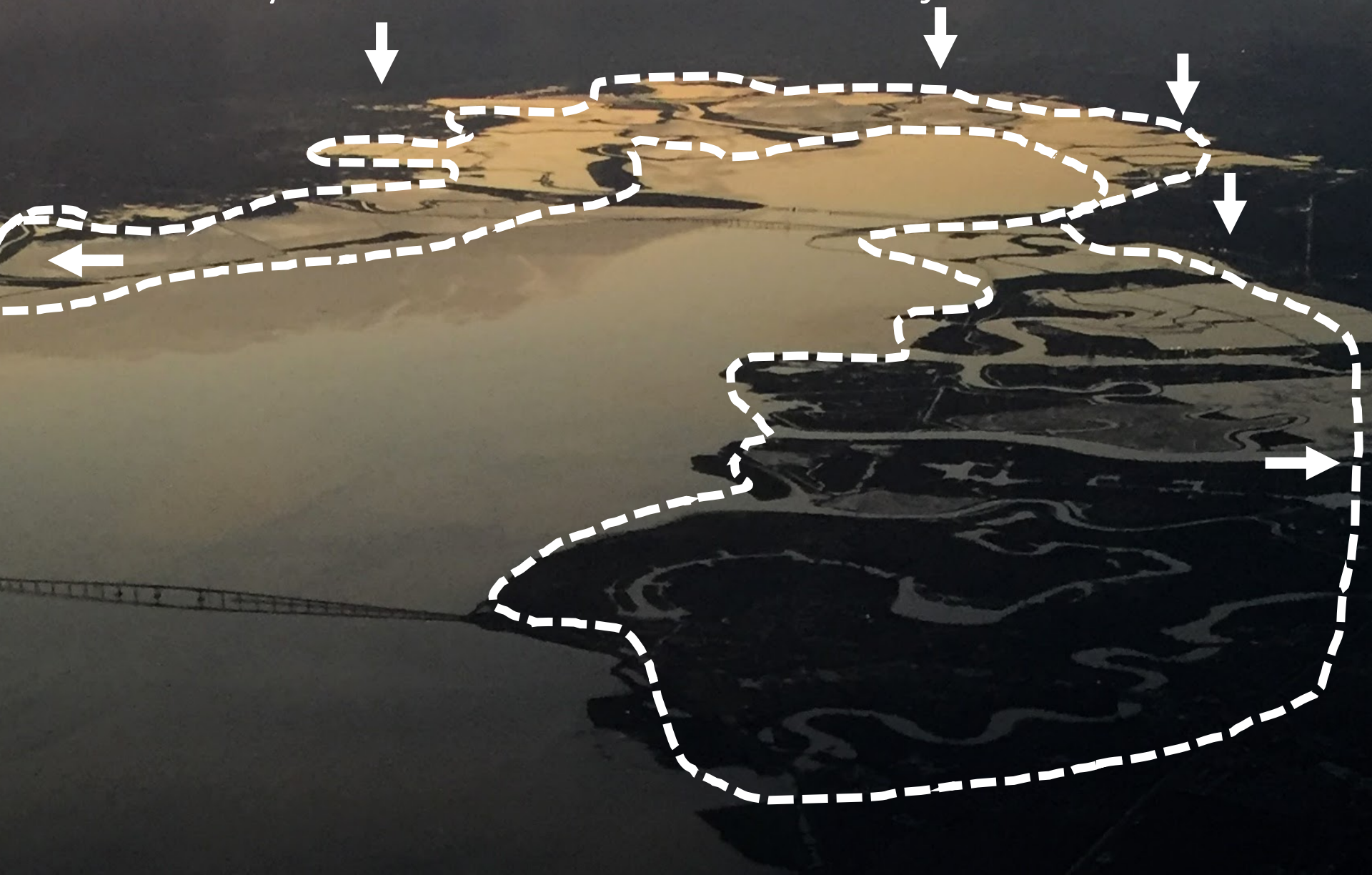
South San Francisco Bay



6 Wastewater Facilities



South Bay Salt Pond Restoration Project





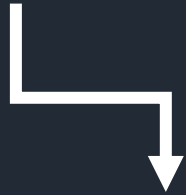
Can we link them?

Why?

Biosolids = Wetland Amendment

Why?

Wetland perspective



Biosolids = Wetland Amendment

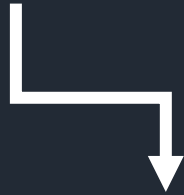


Biosolids perspective

Why?

Wetland perspective:

Wetland restoration or creation projects require sediment.



Biosolids = Wetland Amendment



Biosolids perspective



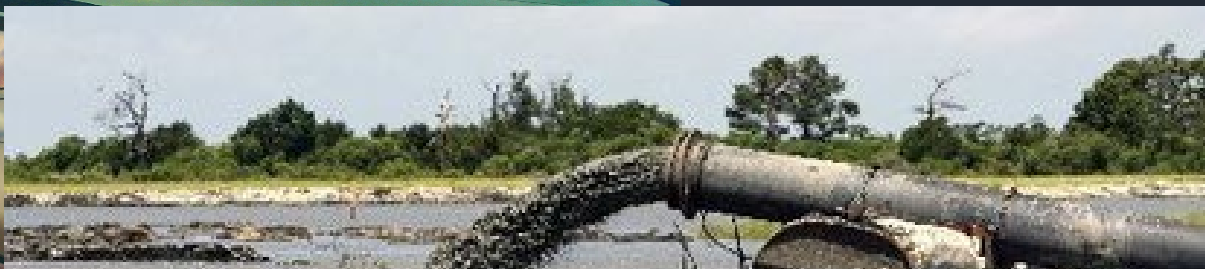
Source: Jitze Couperus via State of CA CC



Source:



Source: Ellis Lucia, The Time Picayune



Source:



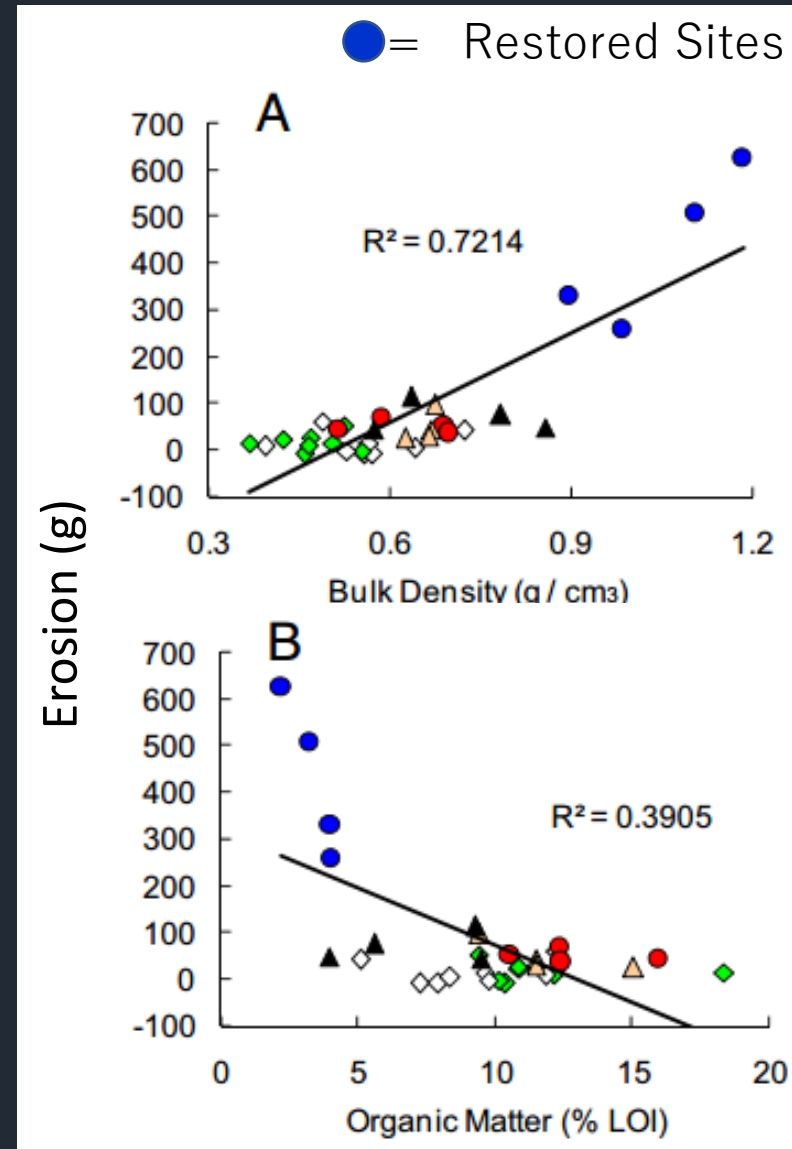
Source: Ellis L



Source: Evan Variano

New Marshes < Established

- Less resilient to sea level rise
- More prone to erosion
- Less belowground biomass
- Different soil properties:
 - Less soil moisture
 - Less nutrients
 - Less organic matter
 - Higher bulk density





New Marshes < Established

Biosolids contain:

- Organic matter
- Nutrients



New Marshes < Established

Biosolids contain:

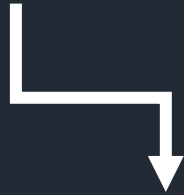
- Organic matter
- Nutrients

Could biosolids jumpstart
soil-vegetation feedbacks?

Why?

Wetland perspective:

Wetland restoration or creation projects require sediment.



Biosolids = Wetland Amendment



Biosolids perspective

Why?

Wetland perspective:

Wetland restoration or creation projects require **reliable sources** of sediment, **preferably sediment similar to established wetland soil**.



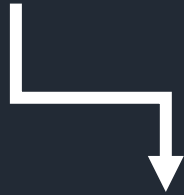
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Biosolids = Wetland Amendment



Biosolids perspective

Treatment plants need disposal sites and reuse options.

SB 1383



<https://scripps.ucsd.edu>

SB 1383



<https://scripps.ucsd.edu>

Divert organic waste from landfills
Reduce short-lived climate-pollutant emissions

SB 1383



<https://scripps.ucsd.edu>

CASA website has more information

Transport: \$\$\$ & GHG Emissions

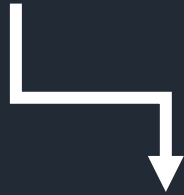


<http://www.synagro.com/wp-content/uploads/2016/08/sidebar-disposal-truck.jpg>

Why?

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Biosolids = Wetland Amendment

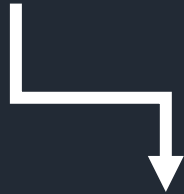


Biosolids perspective
Treatment plants need disposal sites and reuse options.

Why?

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Biosolids = Wetland Amendment

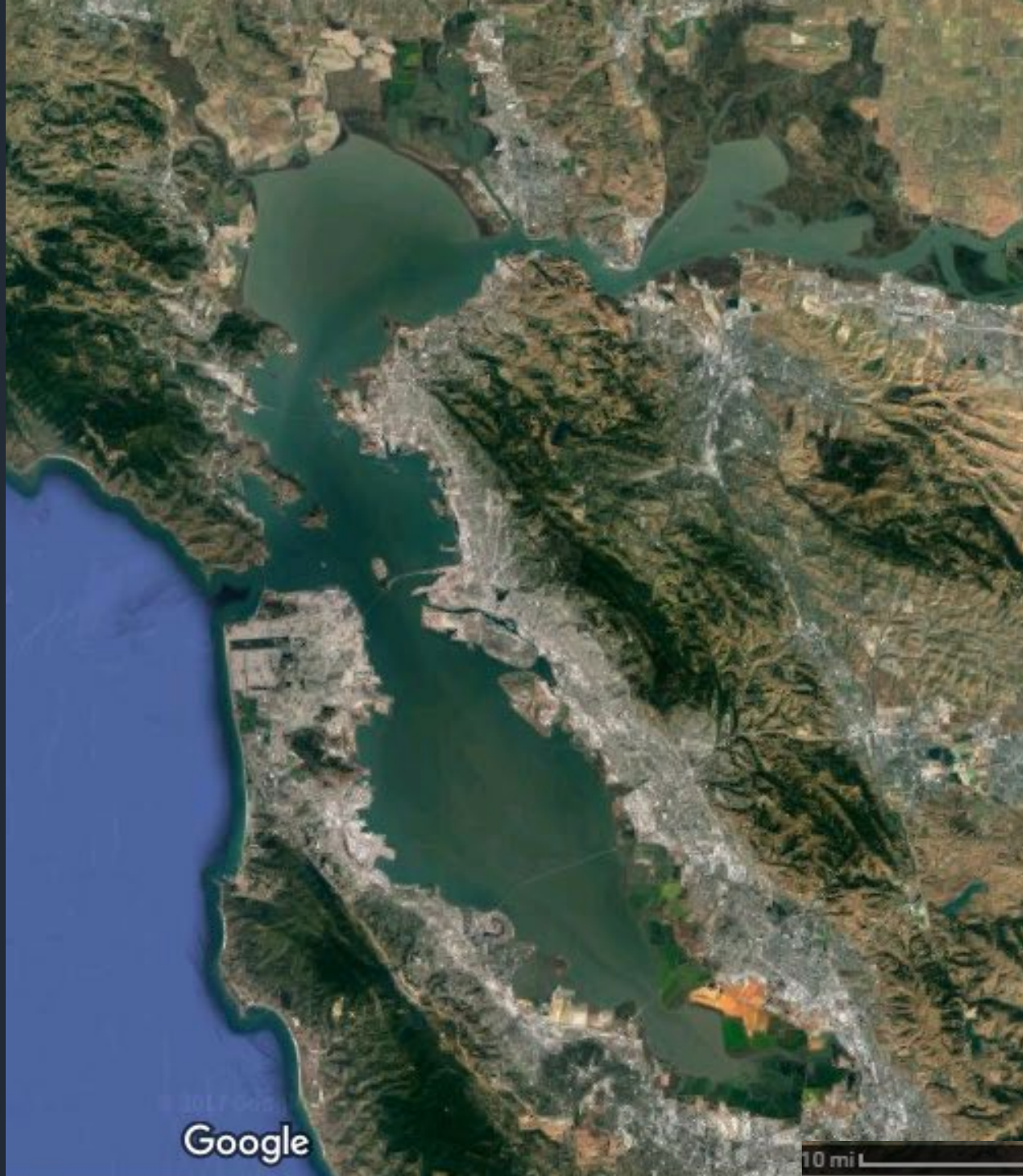


Biosolids perspective

Treatment plants need **local and non-landfill** disposal sites and reuse options.

Does it work?
Ecologically feasible?

Case Study in San Francisco Bay



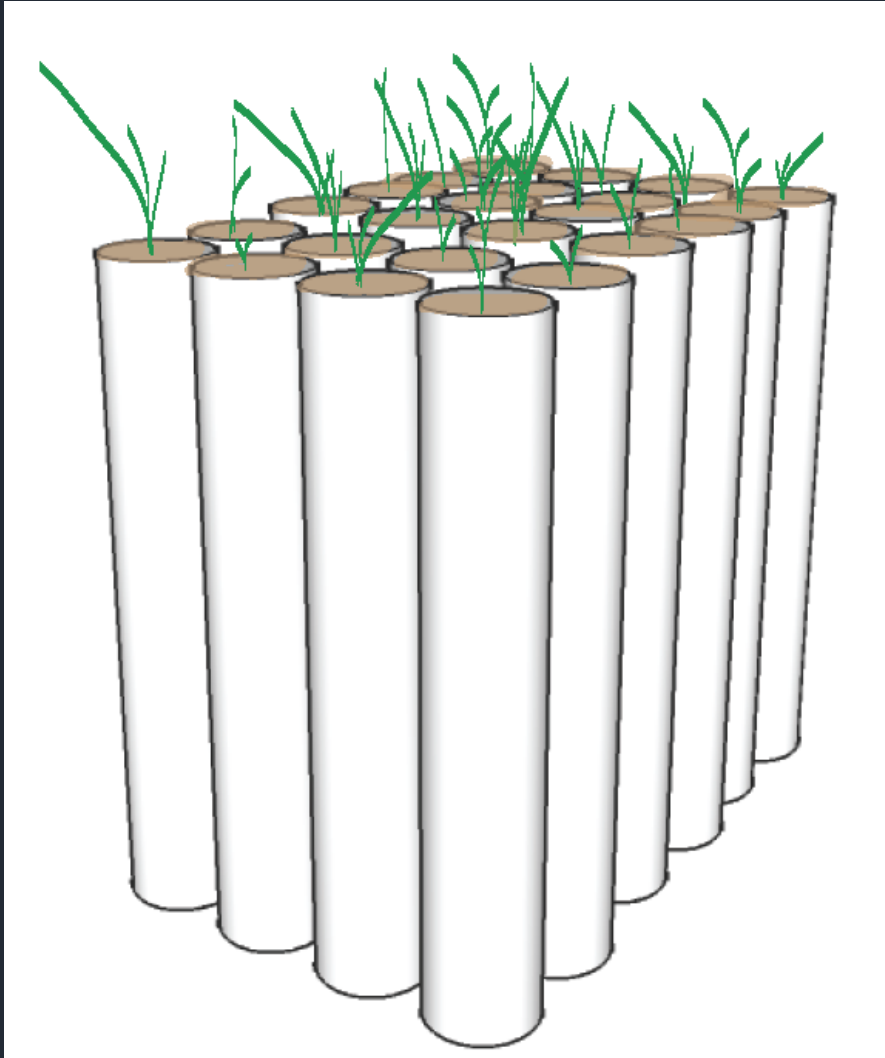
A satellite map showing a coastal area with a large body of water on the left and a marshy area on the right. A yellow circle marks a specific location in the marsh. The text 'Stege Marsh Richmond, CA' is overlaid on the right side of the map.

Stege Marsh
Richmond, CA

Google

10 mi

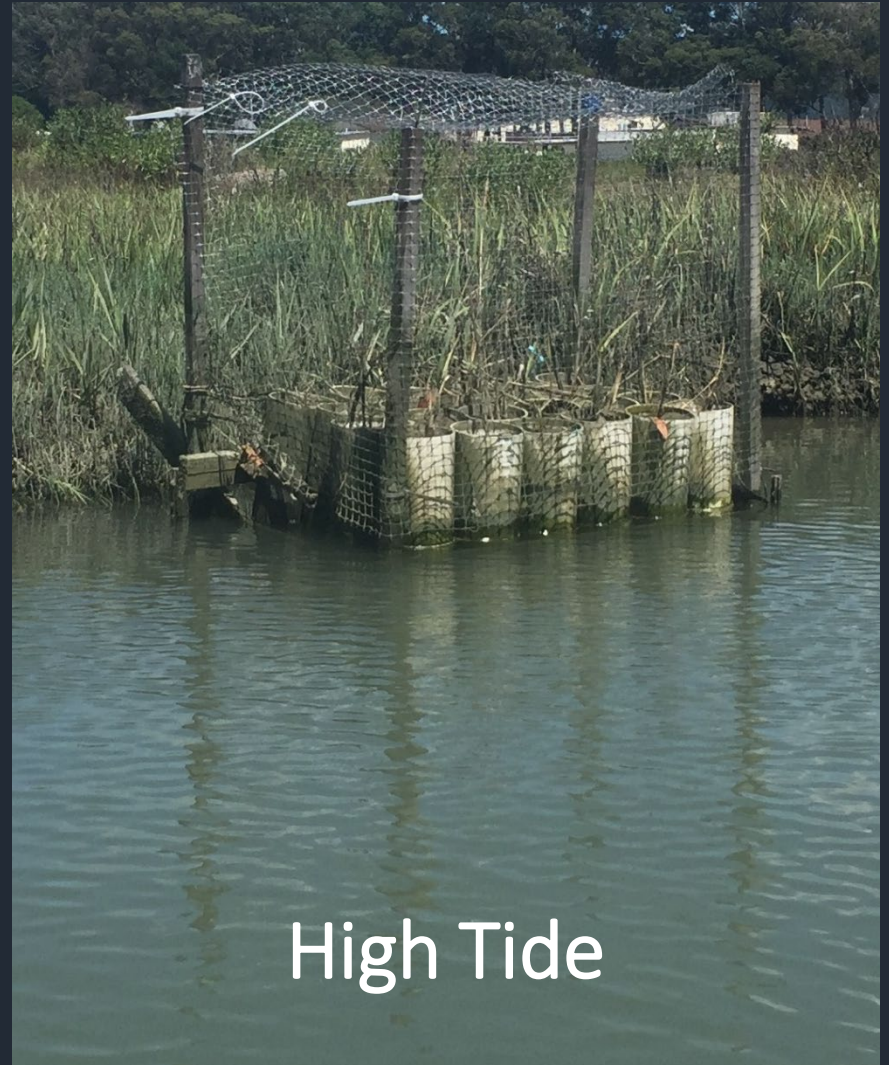
Experimental Treatments



Experimental Setup: Marsh Organ

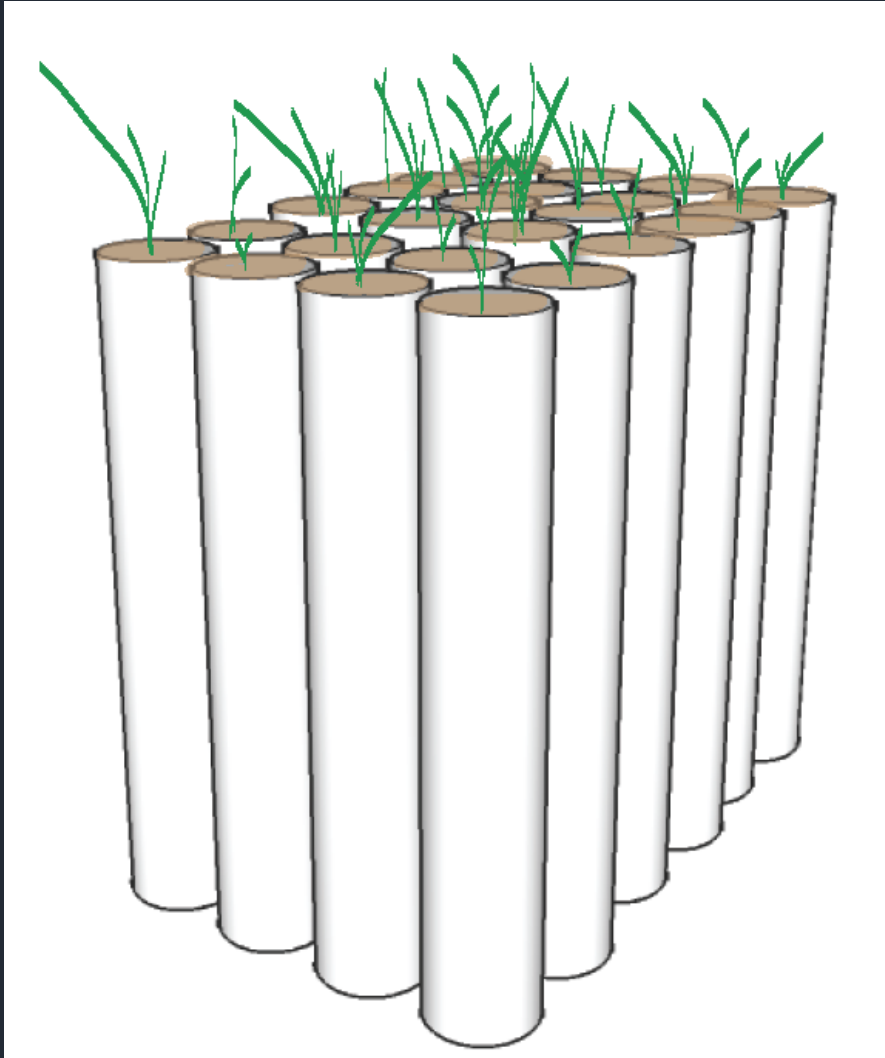


Low Tide

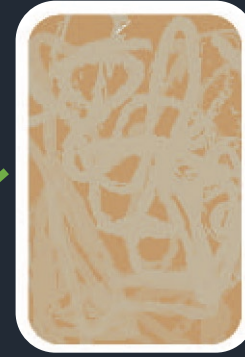
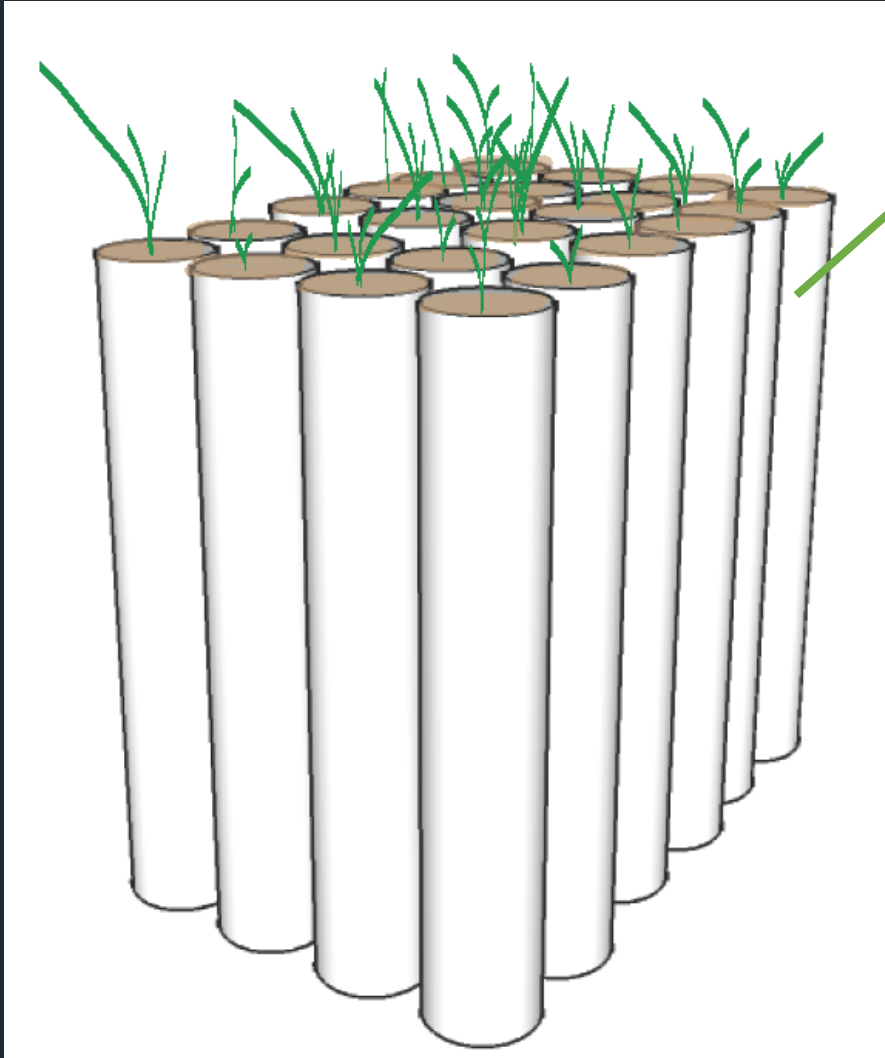


High Tide

Experimental Treatments

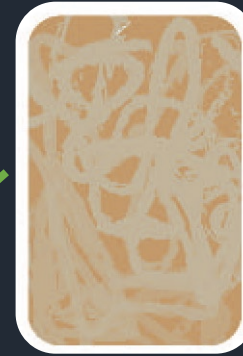
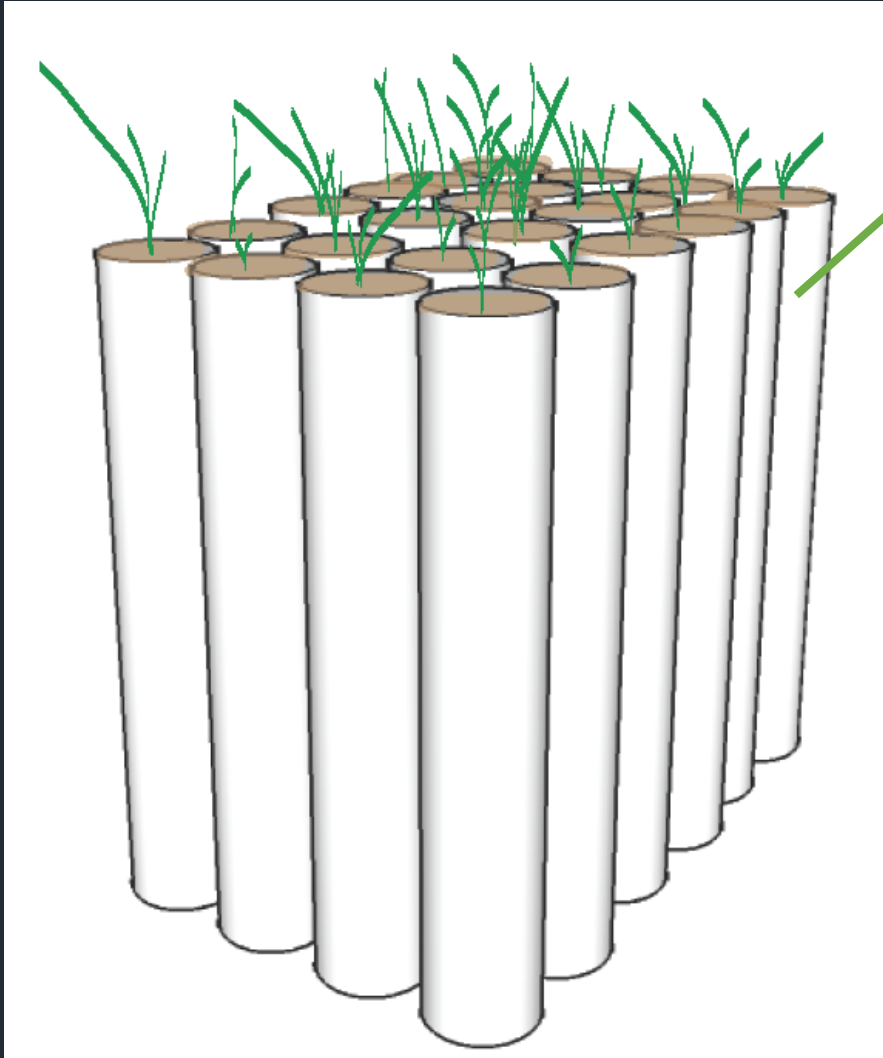


Experimental Treatments



Control:
Dredge
Material

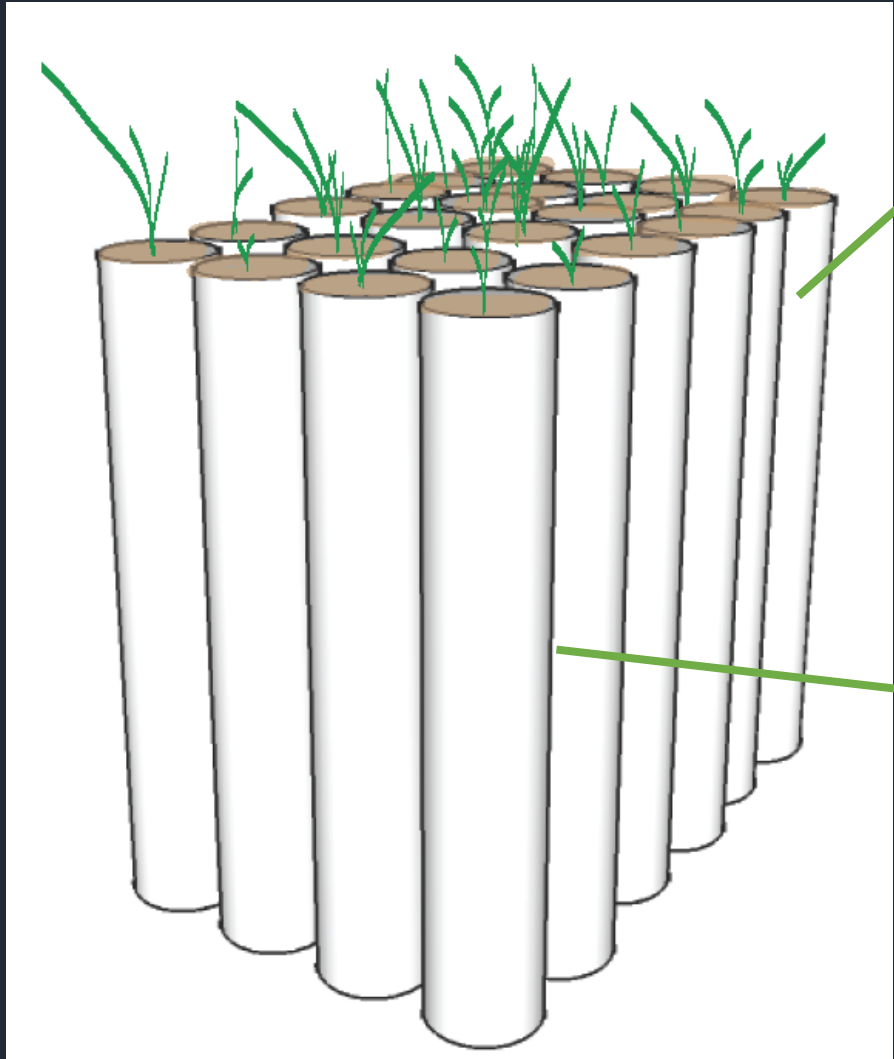
Experimental Treatments



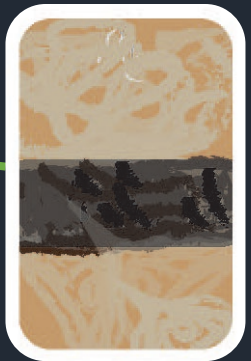
Control:
Dredge
Material

- Material used for current marsh projects
- Sourced from the Port of Oakland deepening project

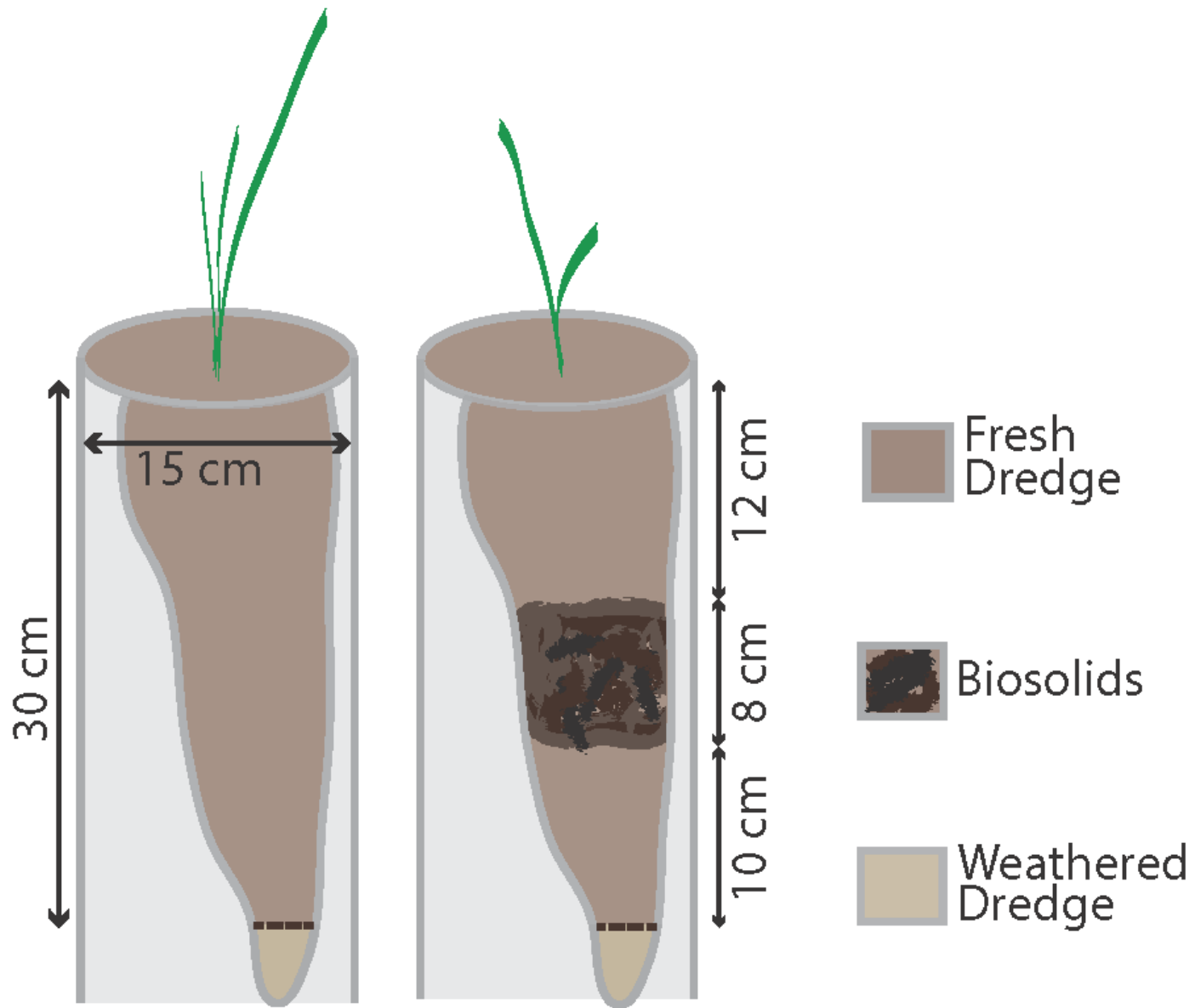
Experimental Treatments

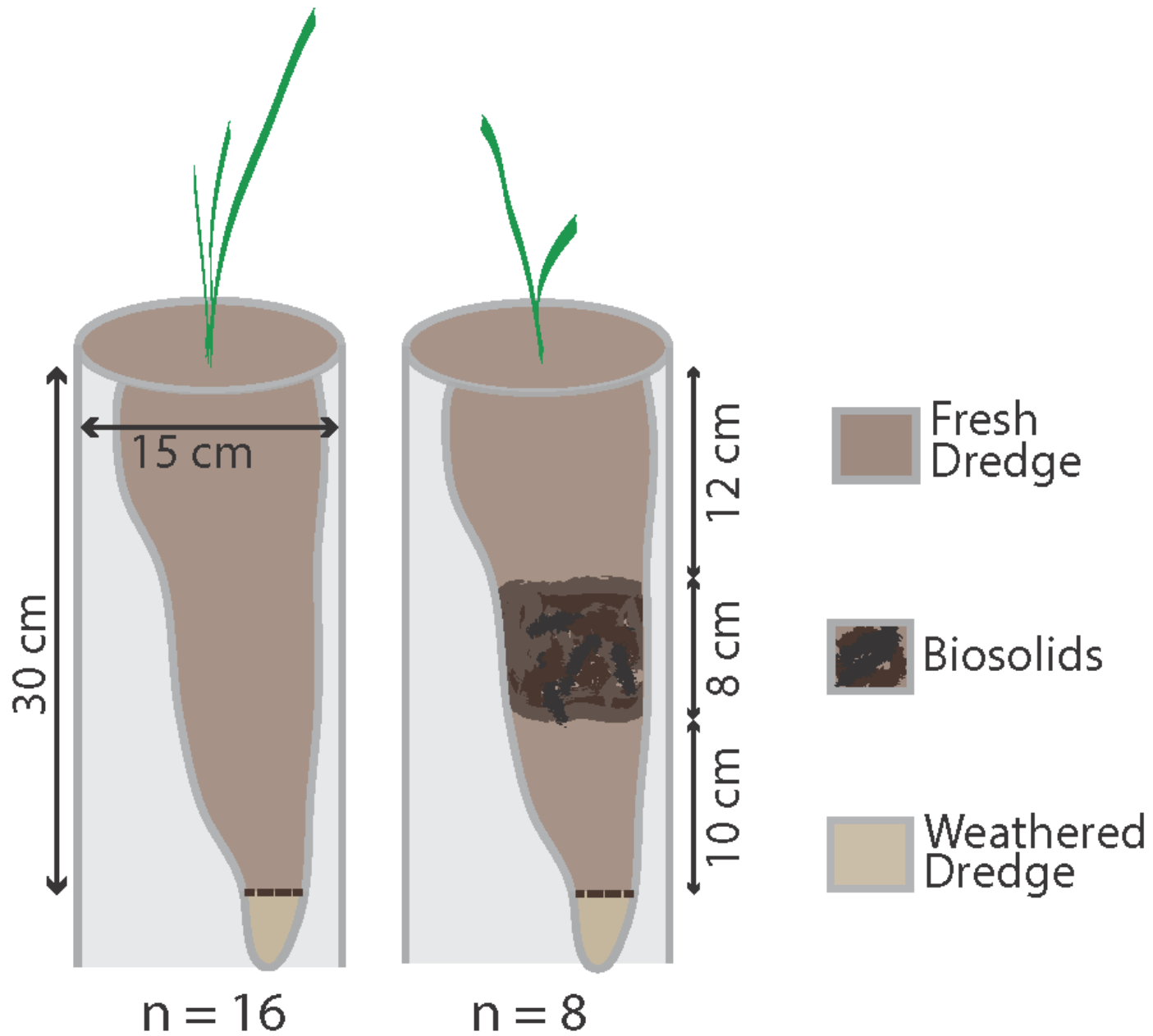


Control:
Dredge
Material



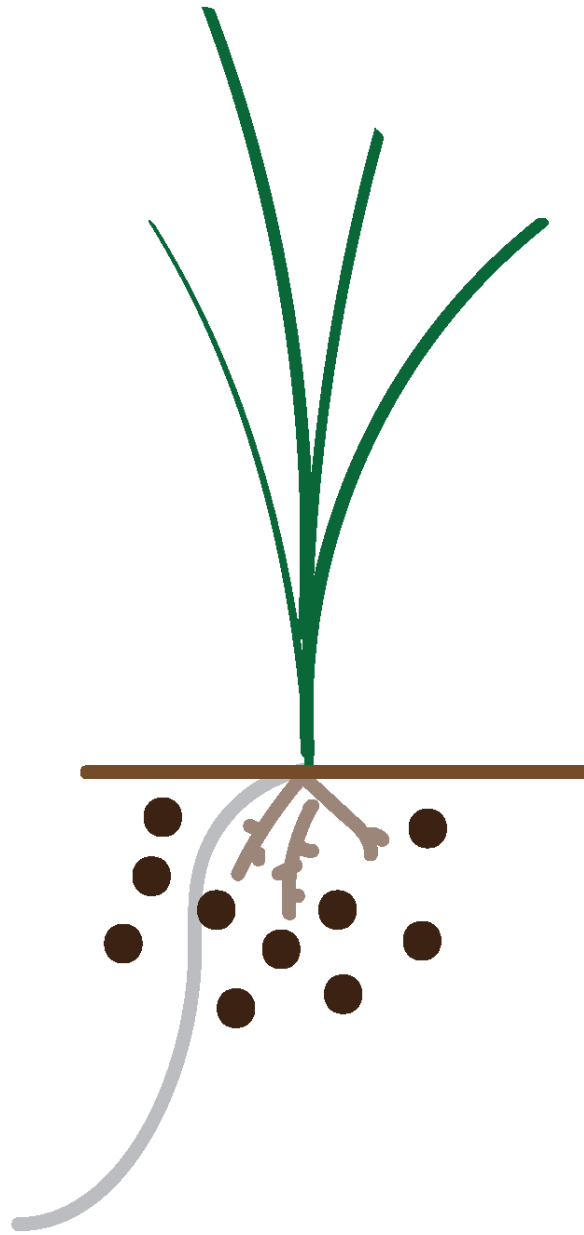
Treatment:
Layer of
"Cake"
Biosolids

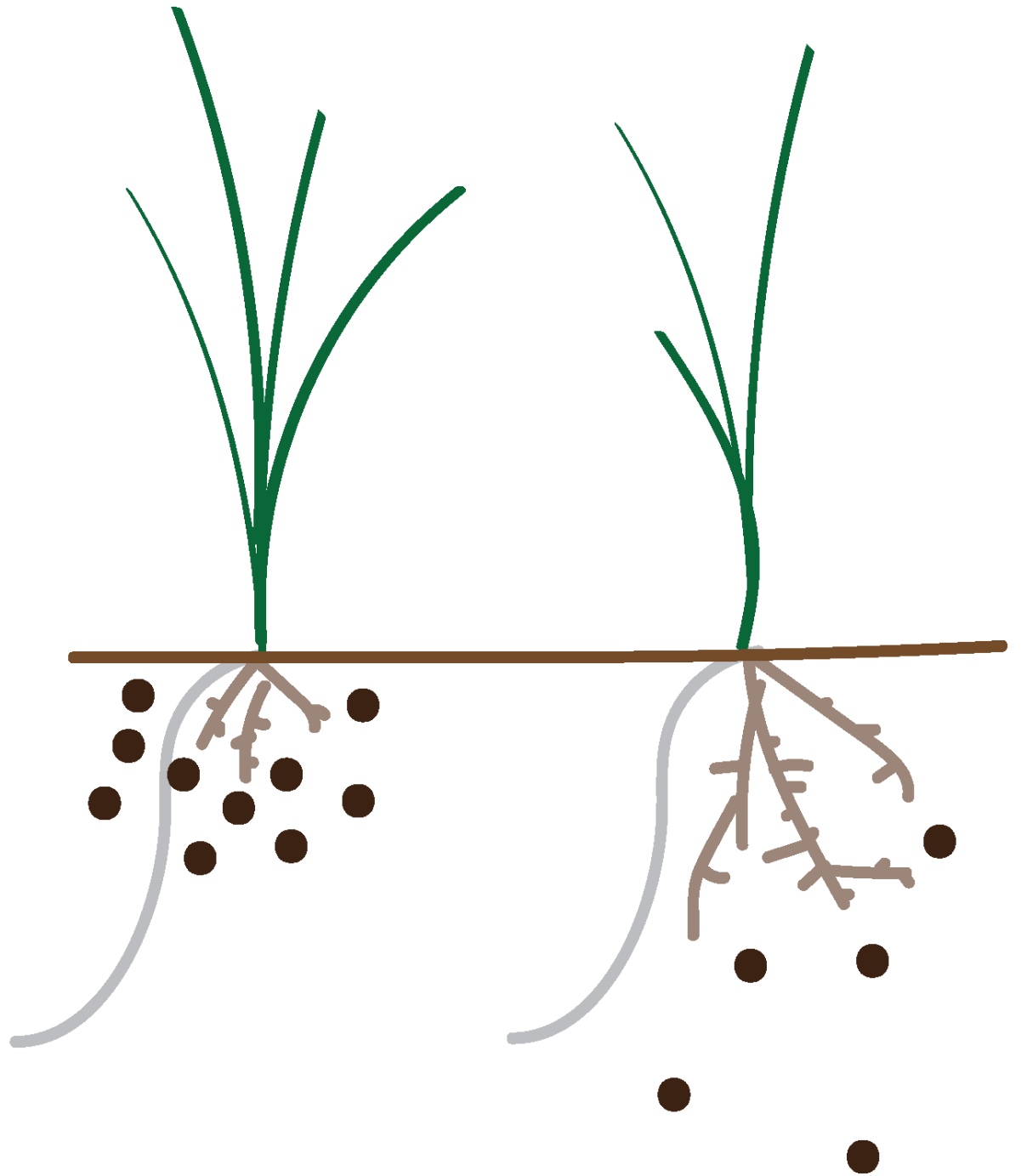




Biosolids Treatment: Why the layer?

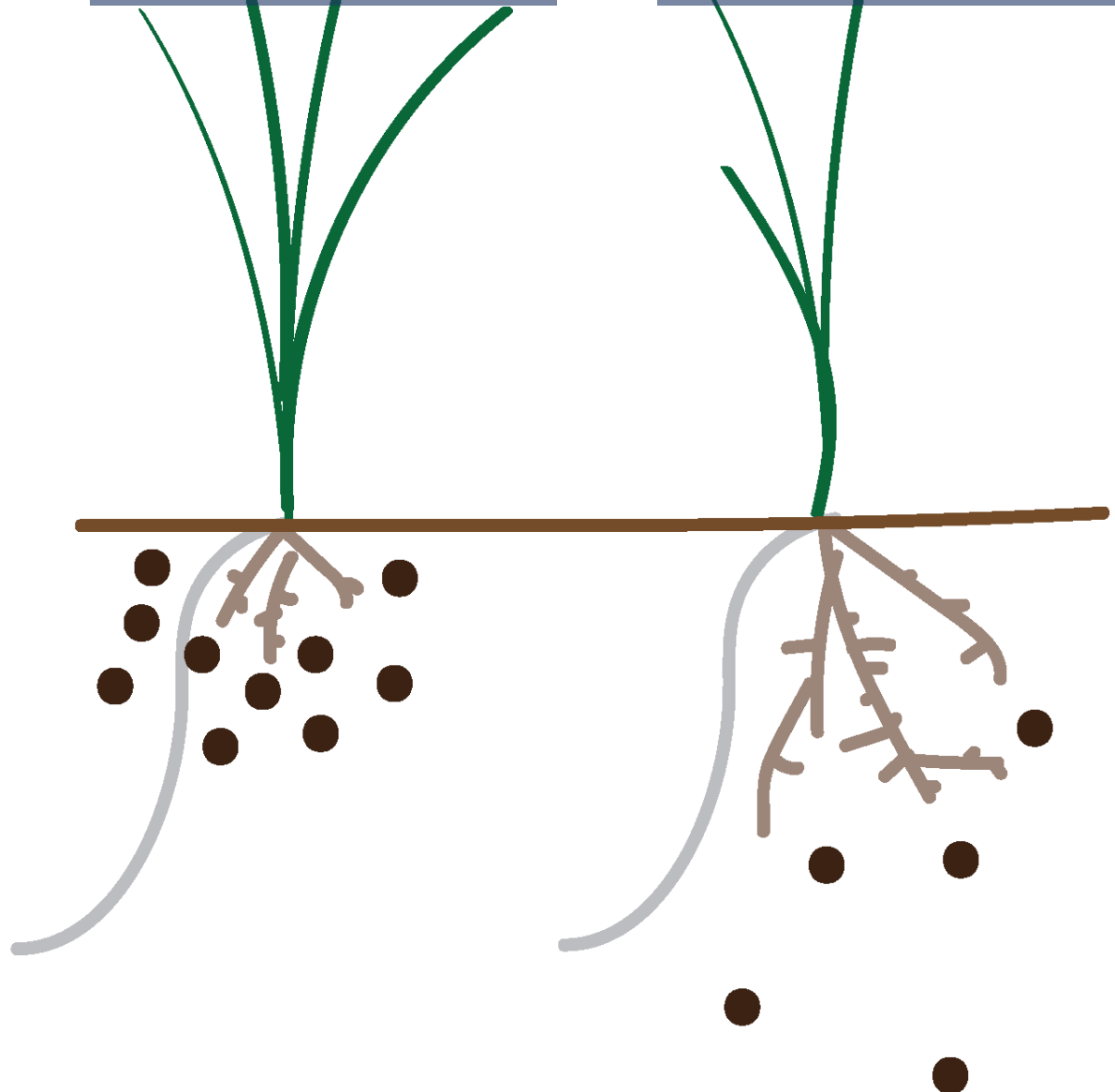
1. Mixing multiple soil types is expensive at scale
2. Prevent rapid nutrient loss
3. Biomass allocation theory





Smaller
root:shoot

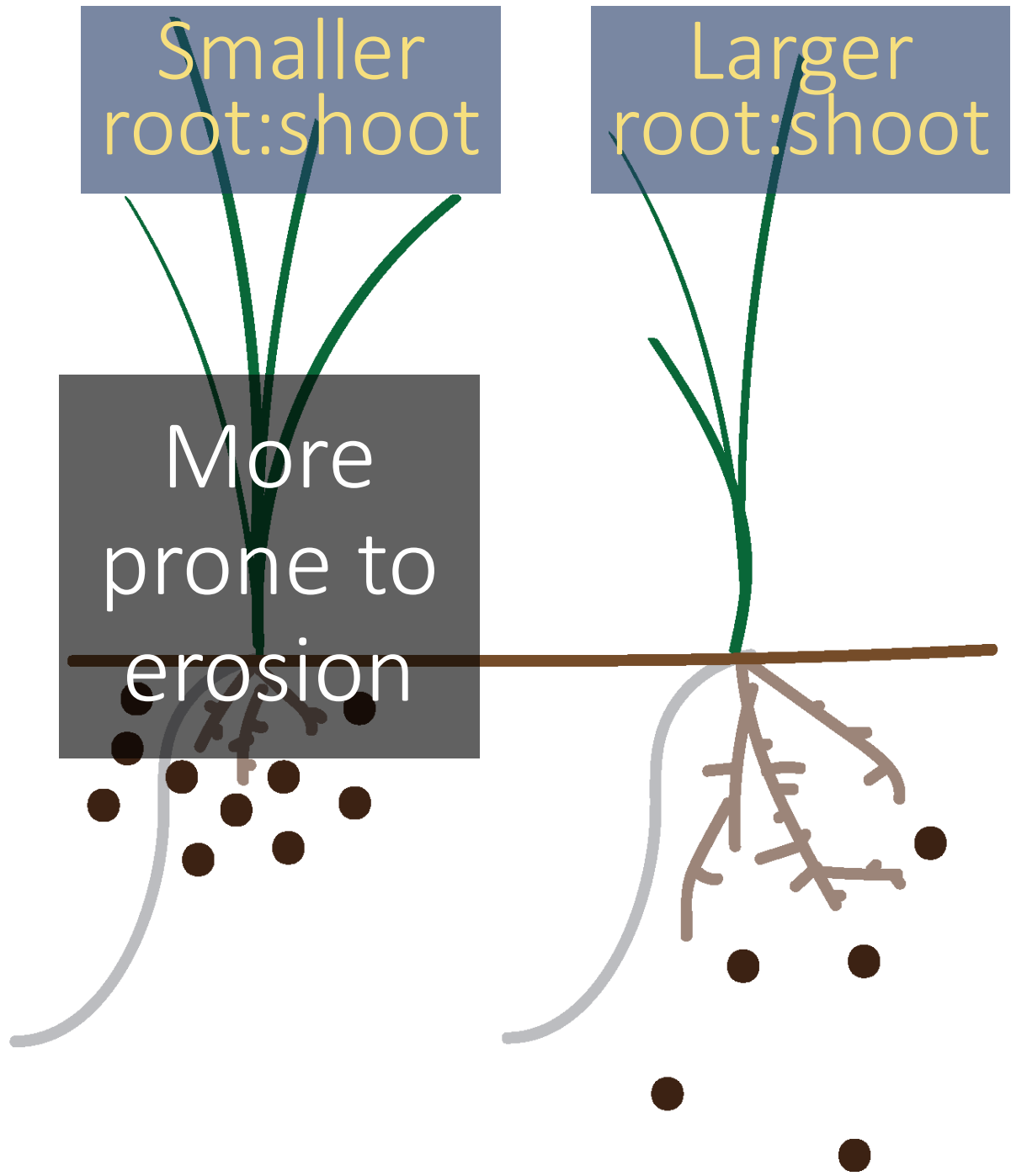
Larger
root:shoot



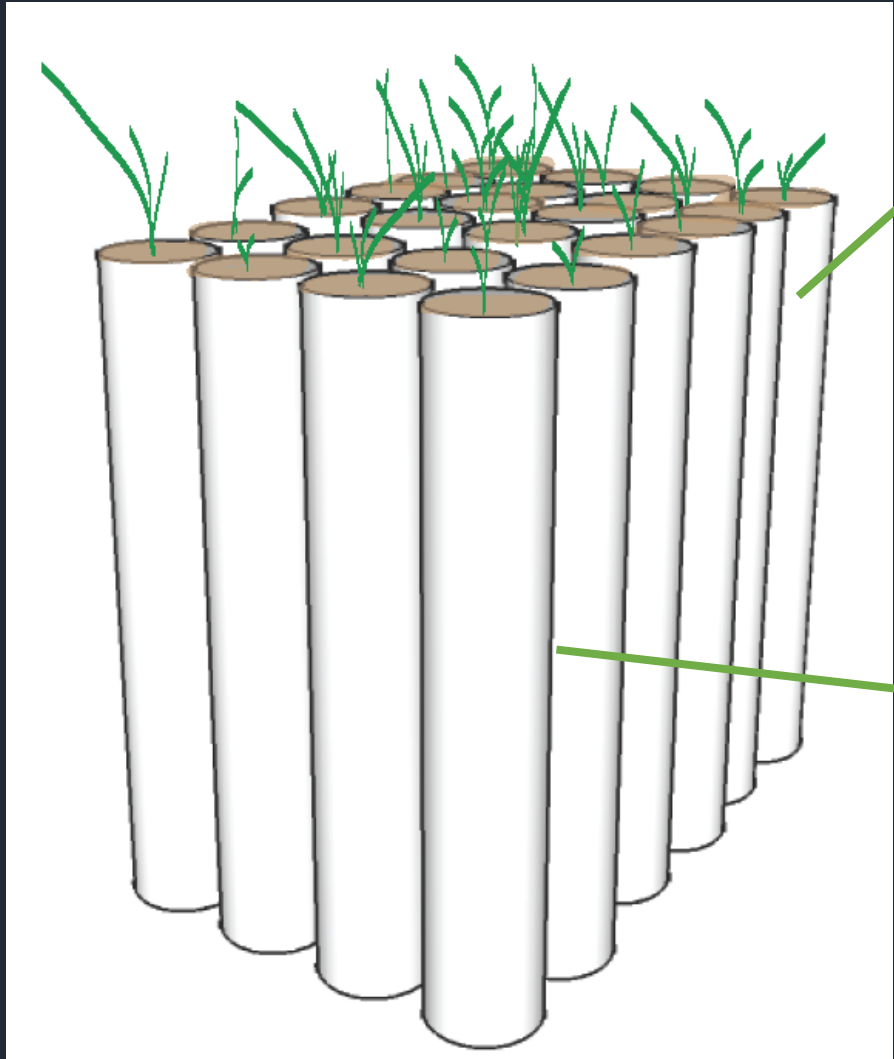
Smaller
root:shoot

Larger
root:shoot

More
prone to
erosion

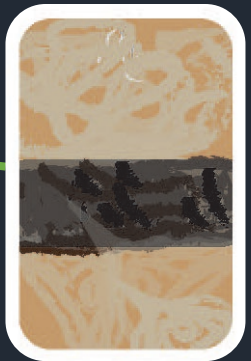


Experimental Treatments



Control:
Dredge
Material

 $n = 16$

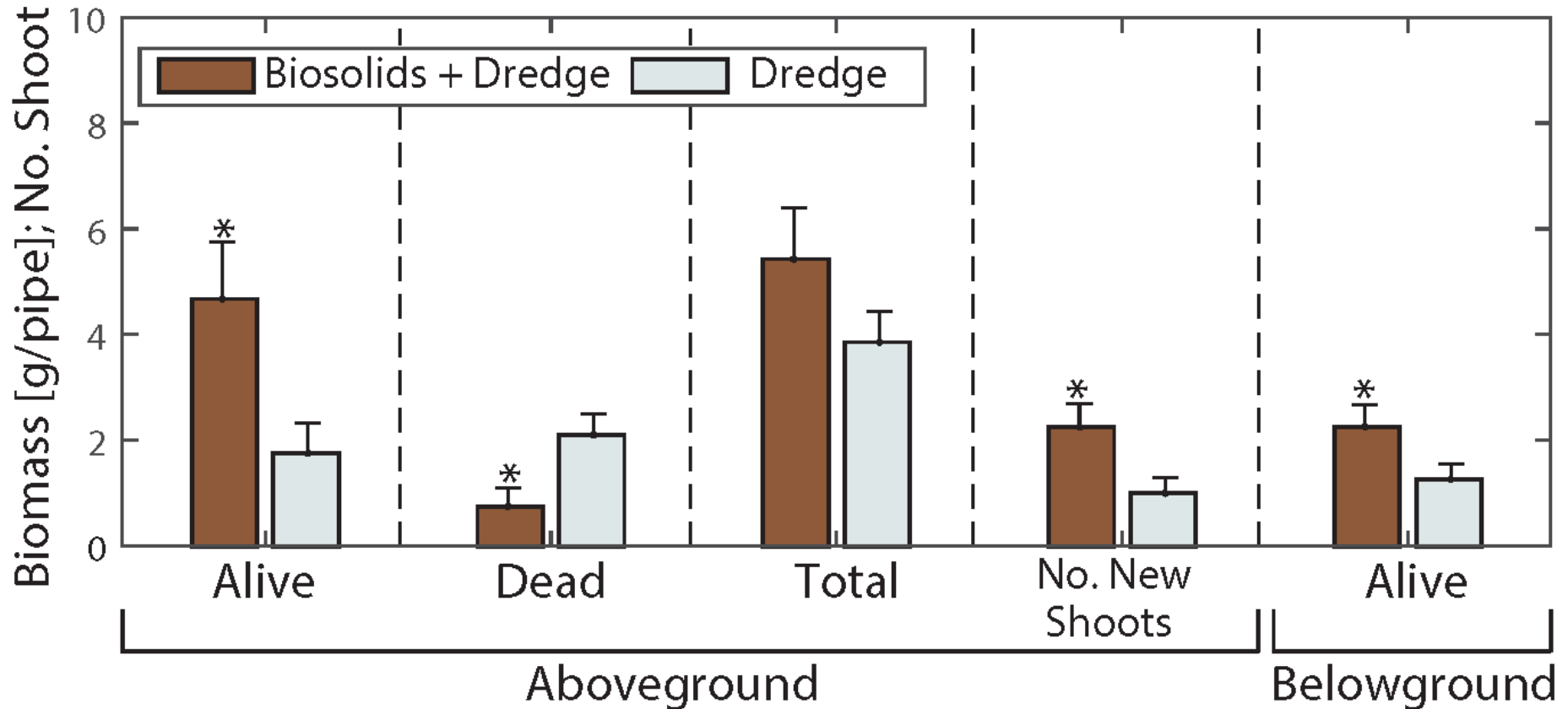


Treatment:
Layer of
"Cake"
Biosolids

 $n = 8$

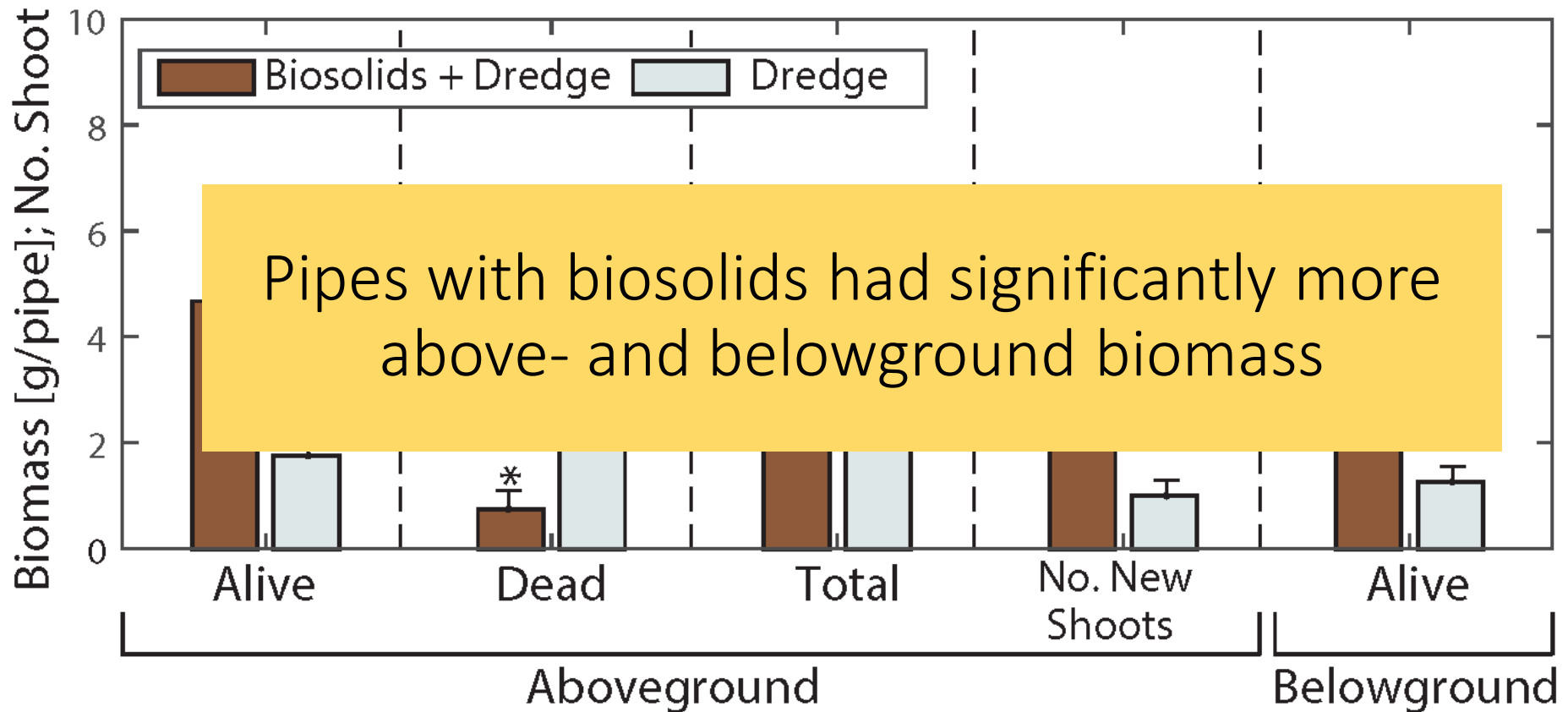
Experimental Results

Experimental Results



Foster-Martinez and Variano (2018)

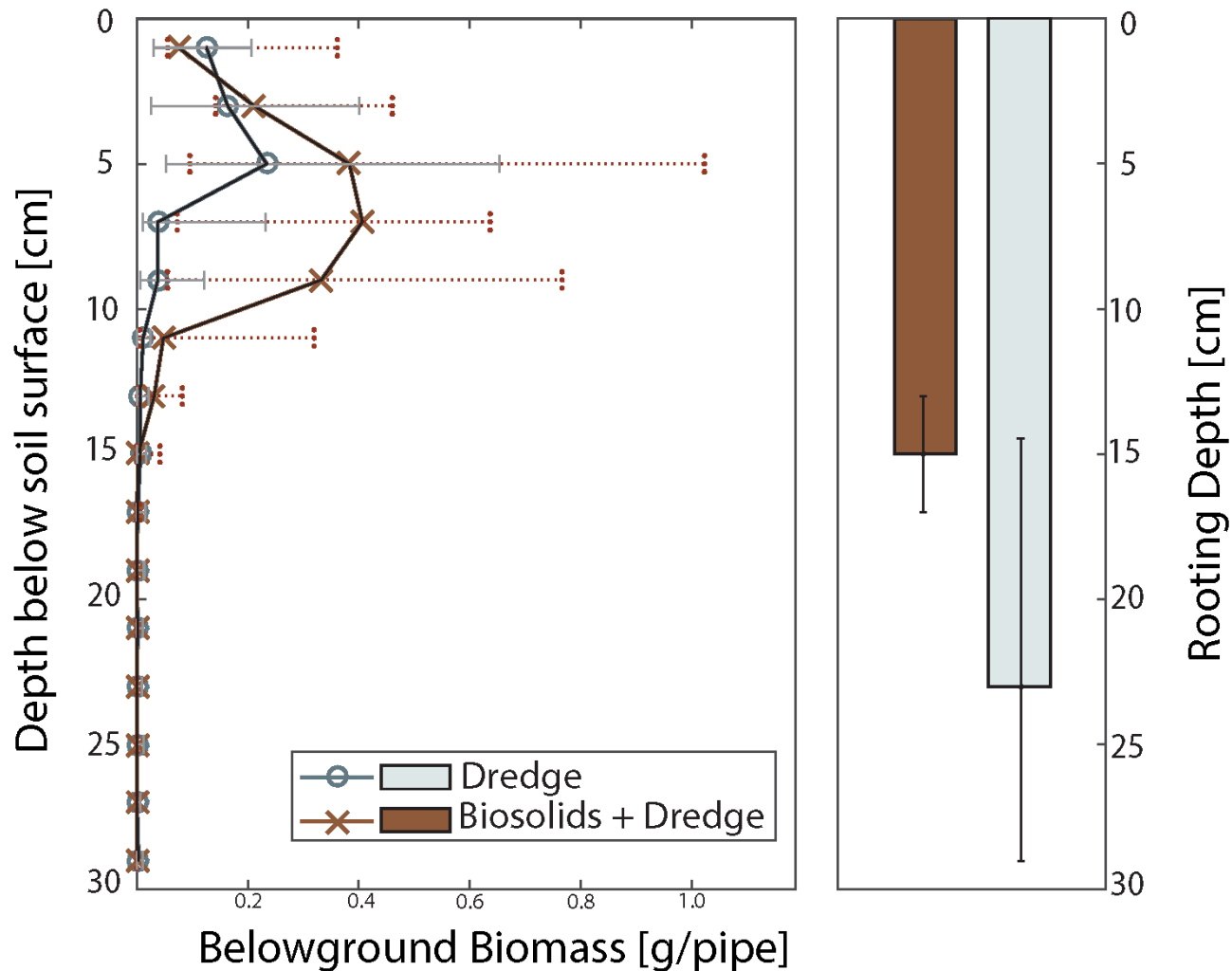
Experimental Results



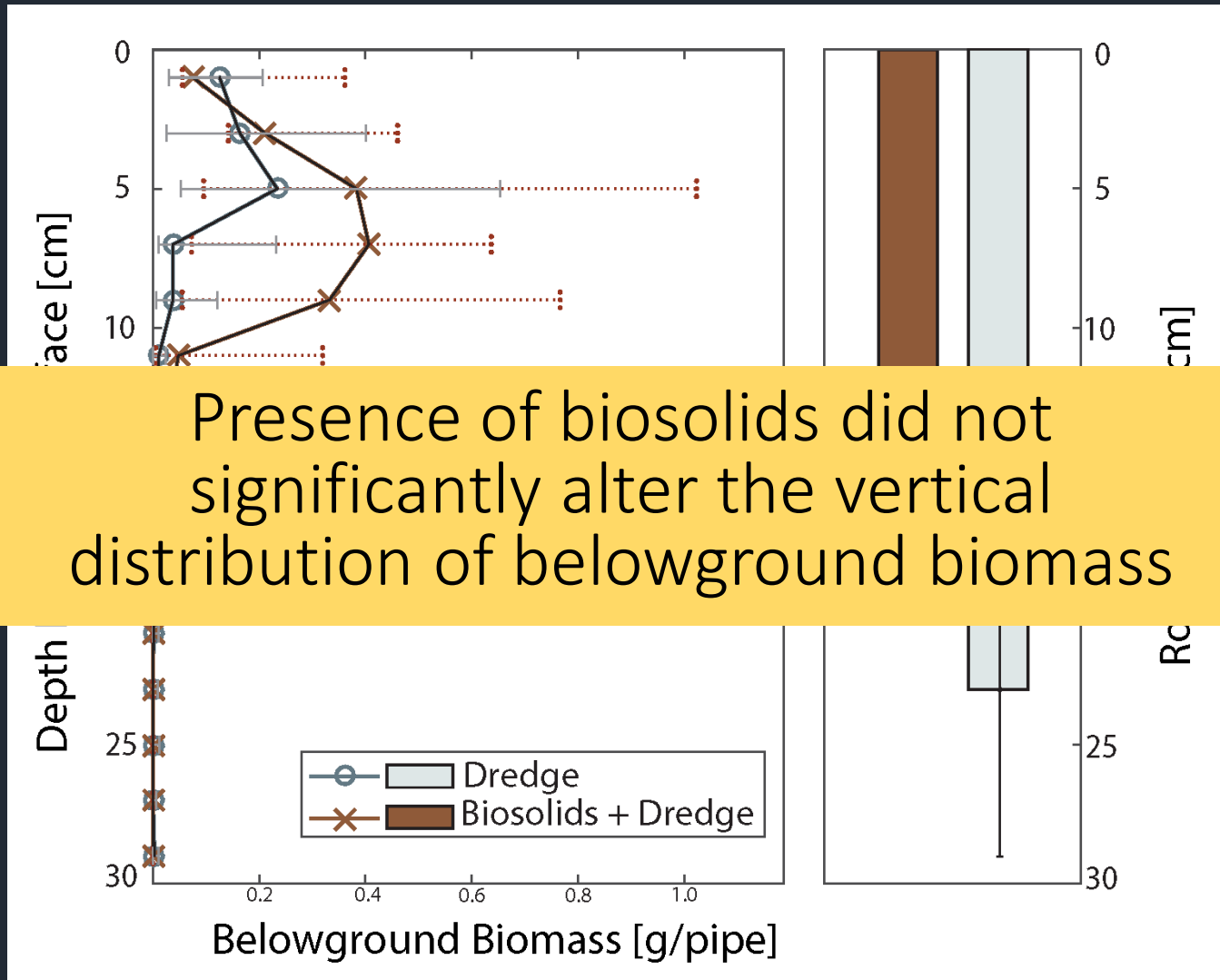
Foster-Martinez and Variano (2018)



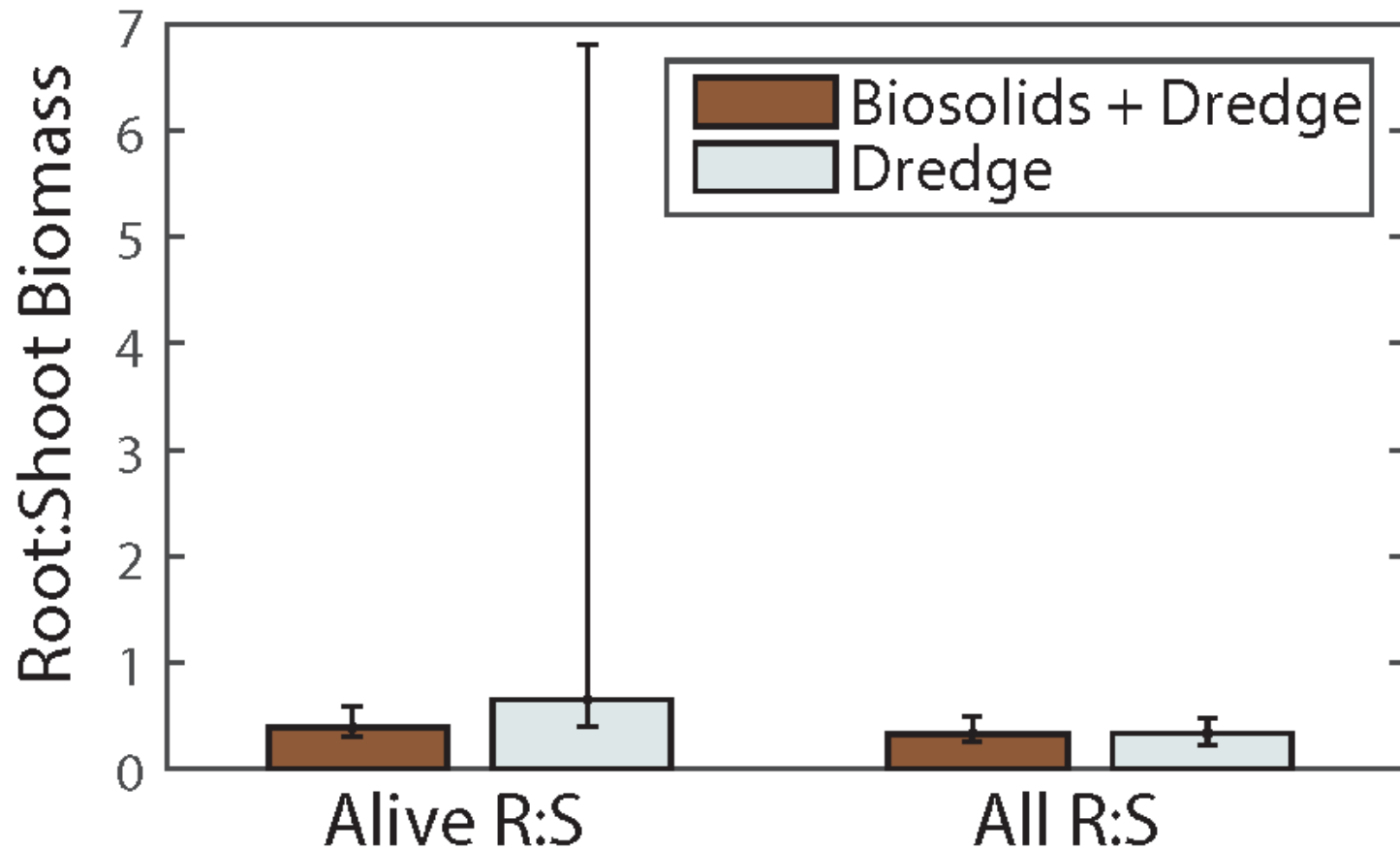
Belowground Biomass



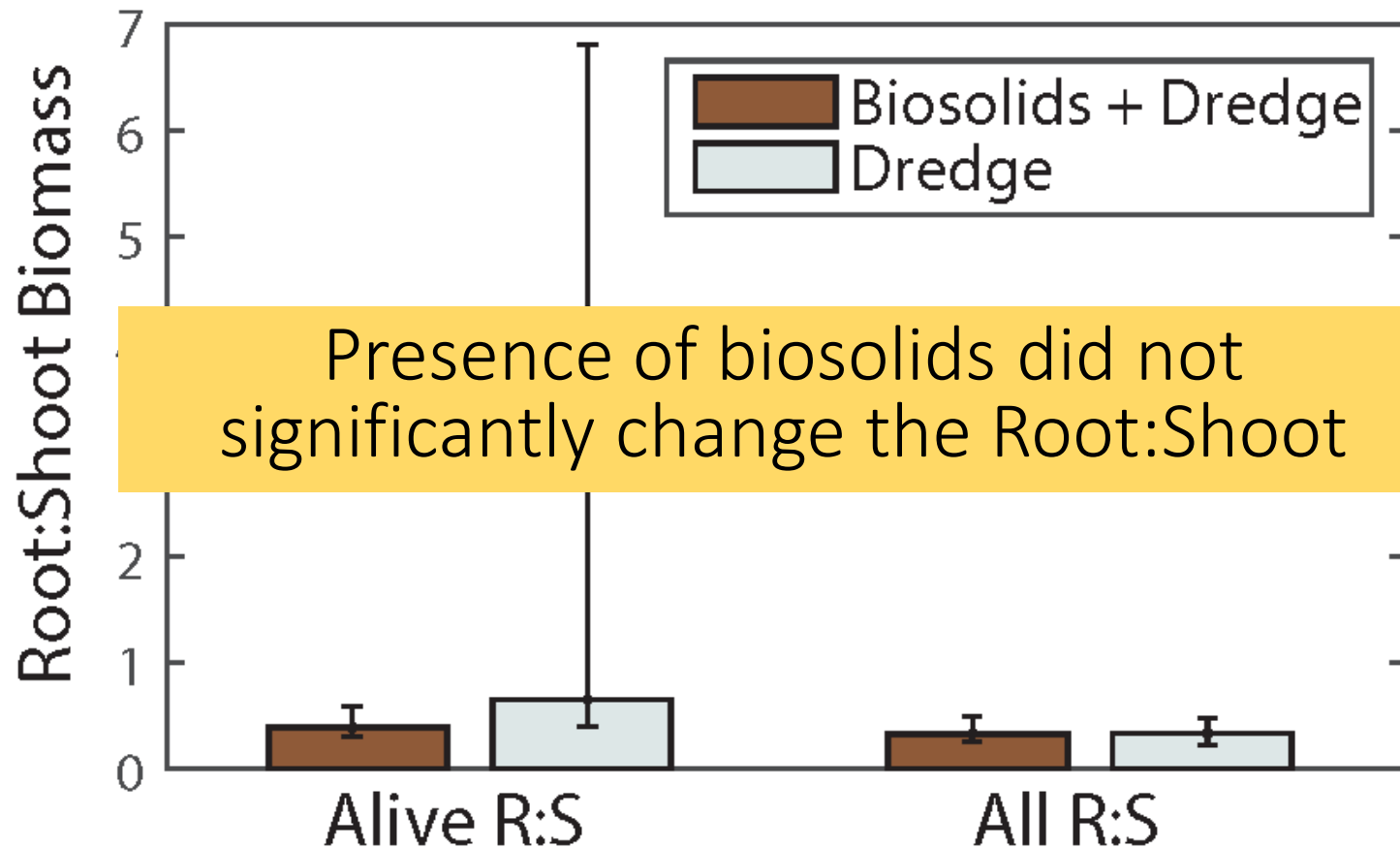
Belowground Biomass



Root:Shoot Ratio




Root:Shoot Ratio





The results are from
one possible design




The results are from
one possible design

- Width of layer set by:
 - nutrient concentrations in natural wetland soils in the area
 - stay below the maximum allowed mercury concentrations



The results are from
one possible design

Not a public-health focused



The results are from
one possible design

Not a public-health focused

Not all biosolids are
suitable for this application

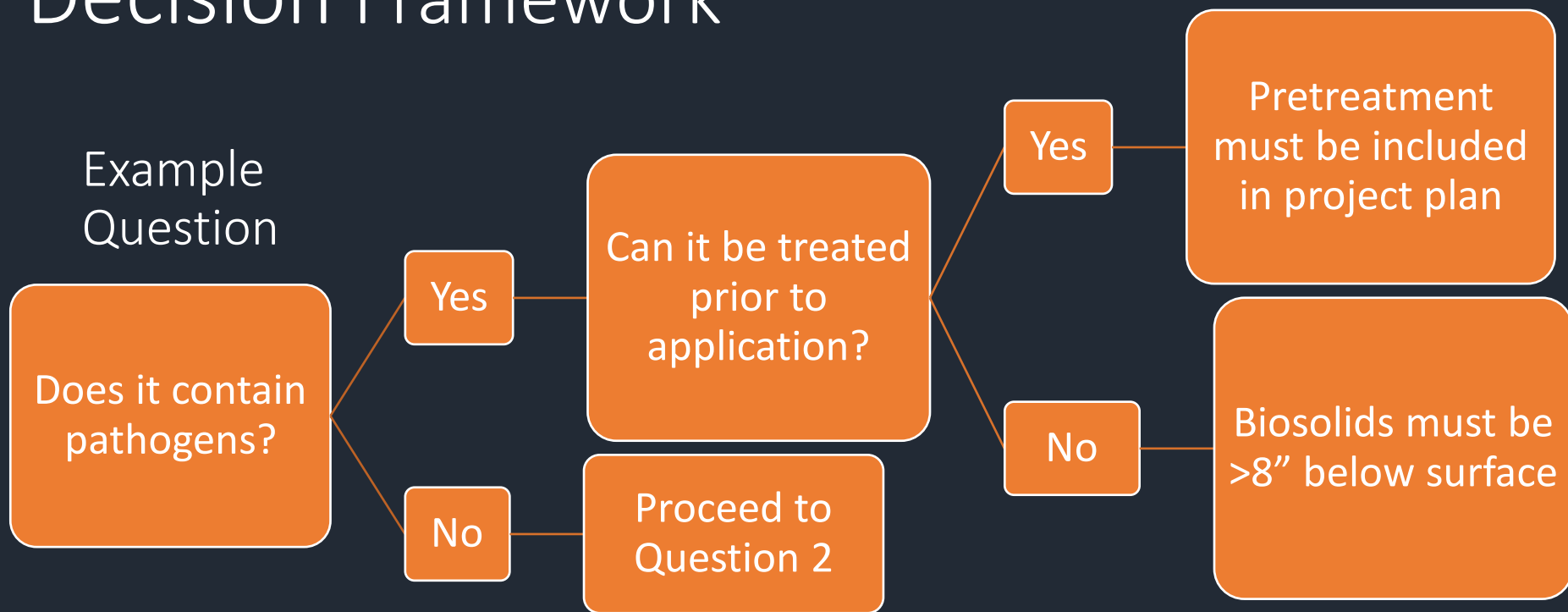


Not all biosolids are suitable
for this application

Decision Framework

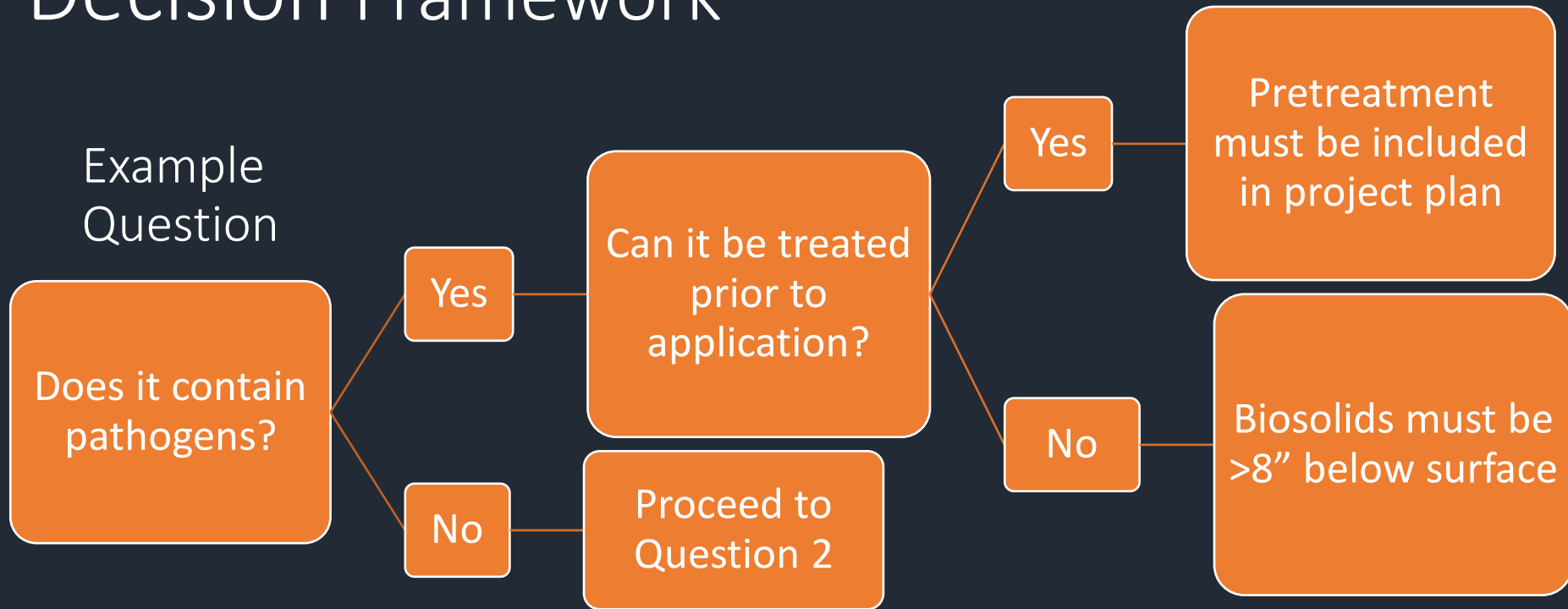
Not all biosolids are suitable for this application

Decision Framework



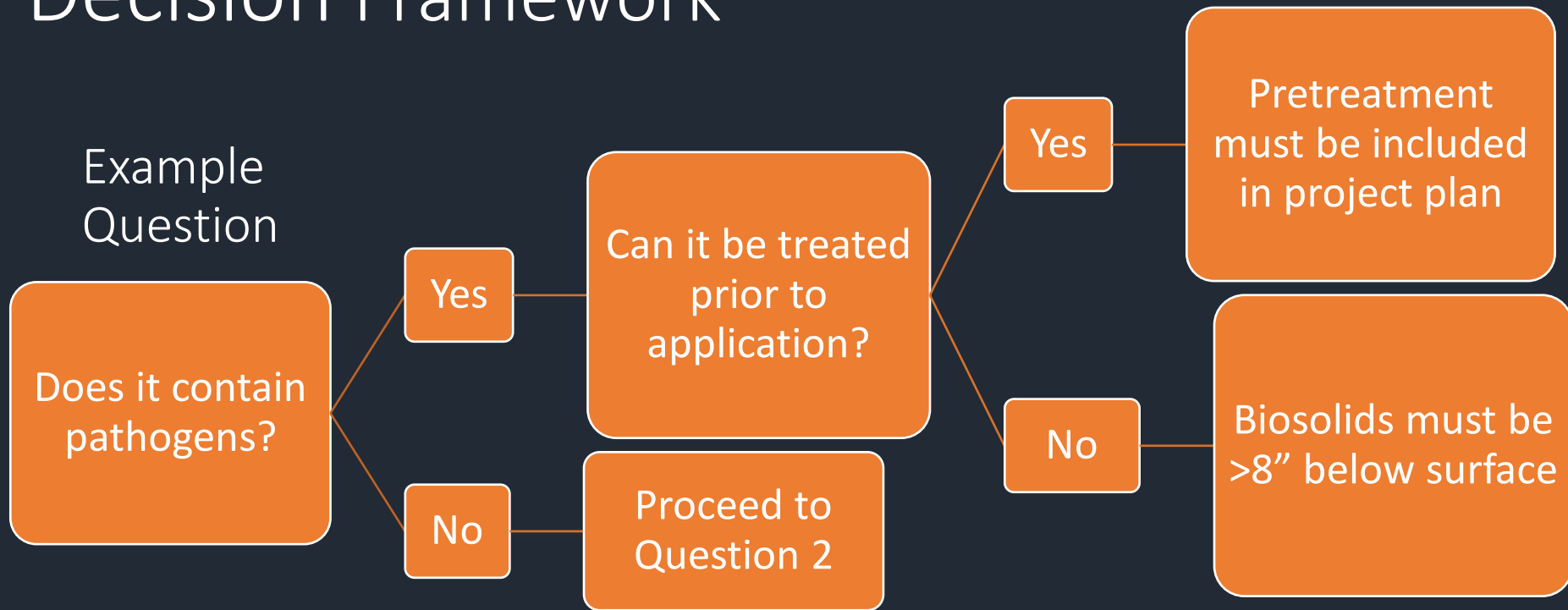
Can we flip this around?
Start with marsh needs?

Decision Framework



Can we flip this around?
Start with marsh needs?

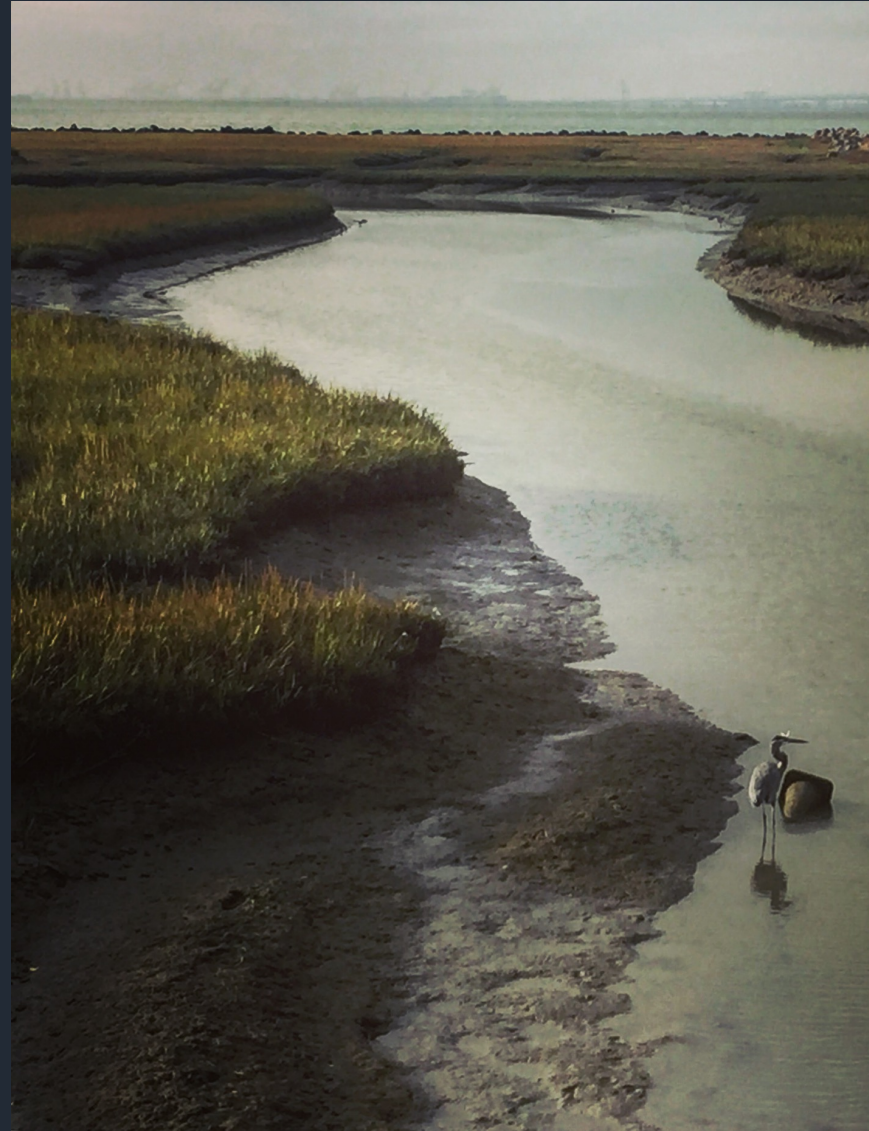
Decision Framework



Patent: Reimers et al 2015
(US9199885 B2)

Conclusions

- There is a need for sediment in marsh creation and restoration projects
- *Certain* biosolids may be suitable for *certain* projects
- Biosolids have the potential to expedite vegetation growth
- Concept worthy of further exploration



Thank you for your attention!



Foster-Martinez, M. R., & Variano, E. A. (2018). Biosolids as a marsh restoration amendment. *Ecological Engineering*, 117, 165–173. <https://doi.org/10.1016/j.ecoleng.2018.02.012>

Feagin, R. A., Lozada-Bernard, S. M., Ravens, T. M., Möller, I., Yeager, K. M., & Baird, A. H. (2009). Does vegetation prevent wave erosion of salt marsh edges? *Proceedings of the National Academy of Sciences*, 106(25), 10109–10113. <https://doi.org/10.1073/pnas.0901297106>