This is a “Nivel Tipo A” or an “A Frame Level” made from three sticks and a piece of string and bottle. It is a common simple tool used world wide to mark the contour of the land. You can use this tool for contour planting, terracing or calculating slope, like a 1% slope for building drainage ditches.

Using this tool was my first introduction to bioengineering, though we didn’t call what we were doing back then, 30 years ago, bioengineering. We just called it soil conservation or contour slope stabilization.

▪Today, we define bioengineering as THE Best Management Practice for restoring natural shorelines.
▪These “softscape” engineering techniques stabilize slopes and shorelands with native plants, biodegradable products, and other natural materials.
▪Bioengineering methods protect property from waves and erosion, while filtering stormwater to the lake, and restoring wildlife habitat.

Along with the new name of “bioengineering” for familiar practices to many of us, we also have new products that allow us to work more efficiently using these environmentally friendly techniques.

This Power Point Presentation will cover a few of the common bioengineering techniques as we look at several case studies.
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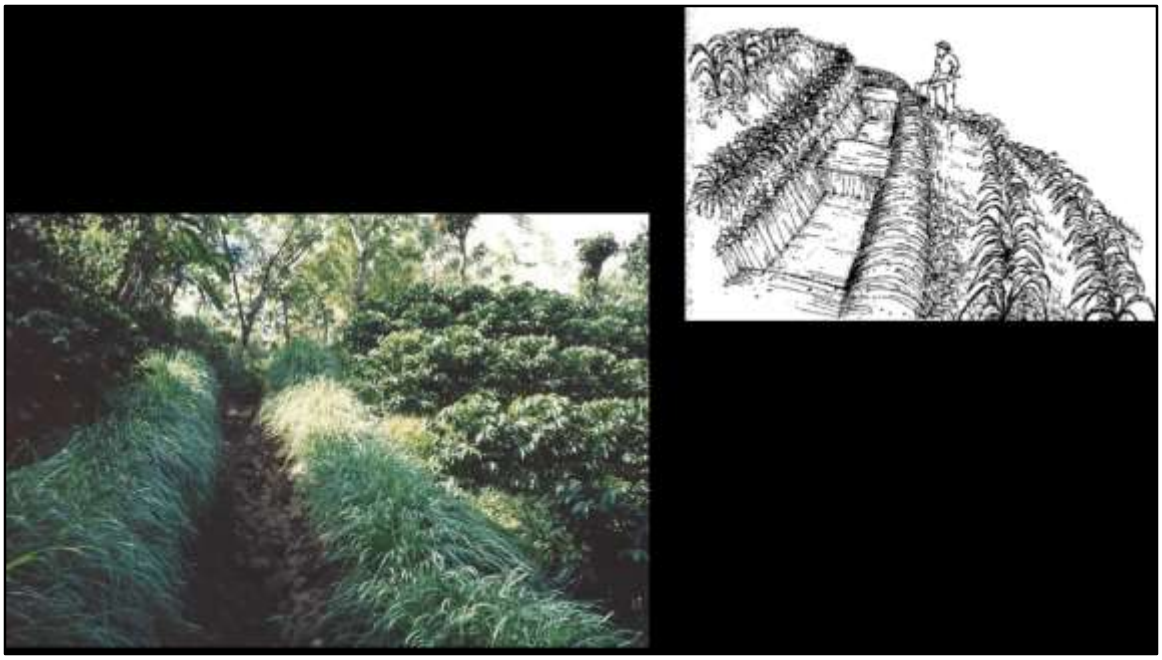
This was one of my first site visit when I was in the Peace Corps 30 years ago, just a year out as a graduate from the UVM Plant and Soil Science Department. I was working in soil conservation trying to keep the soil on the land for planting and out of our waterways, but when I went to help this farmer stabilize his slope, needless to say, I had no idea what to tell this guy, other than to stay away from the cliff and safely make his way back up the slope. We focused on the top of the bank and not the slope side of the bank for our revegetation project, planting a wide mix of vegetation on top buffering the edge.



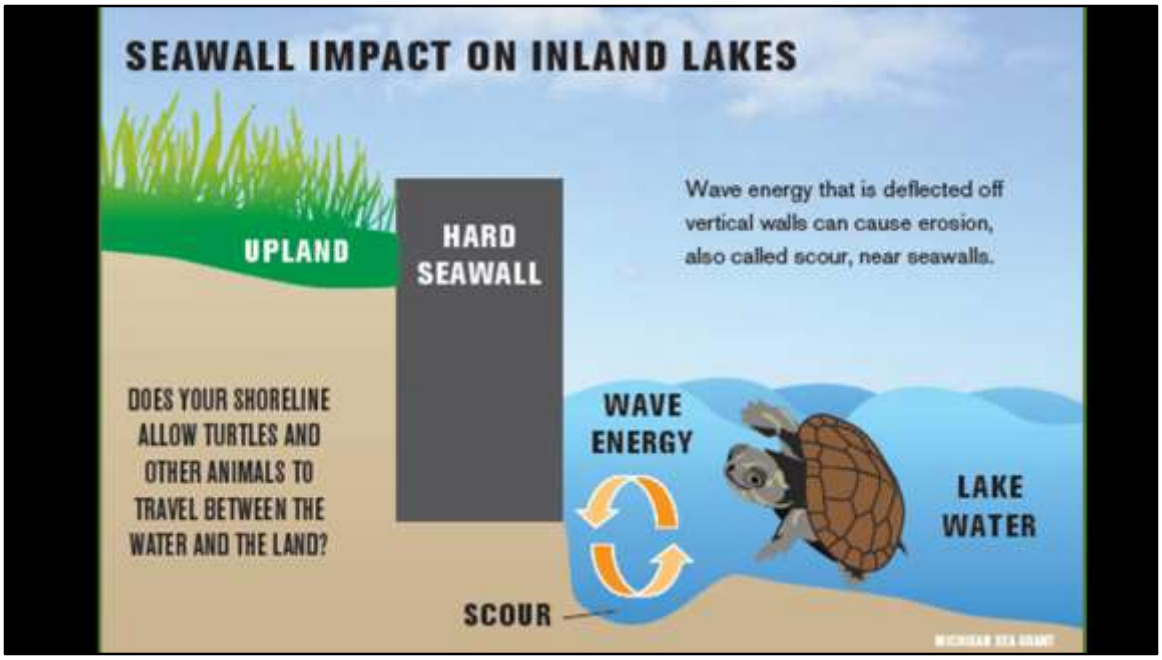
So again, the concepts of bioengineering are not new because for 1000s of years, people have built terraces and stabilized steep slopes with living and biodegradable materials.

Bioengineering techniques allow us to share the shore with wildlife while protecting our property. Shorelands are very sensitive areas and bioengineering provides a great solution
to eroding banks on these special sites.

Taking advantage of the strong system of plant roots will stabilize our shores better than any rebar or concrete possibly could.

Vegetated banks last longer and work harder than man-made seawalls. We saw this in 2011 on Lake Champlain with June high flood waters, but there's a lot of documented research on this topic from the Great Lakes.

This is a site on Lake Carmi where the trees are holding the shore together and where the rip rap has failed miserably.

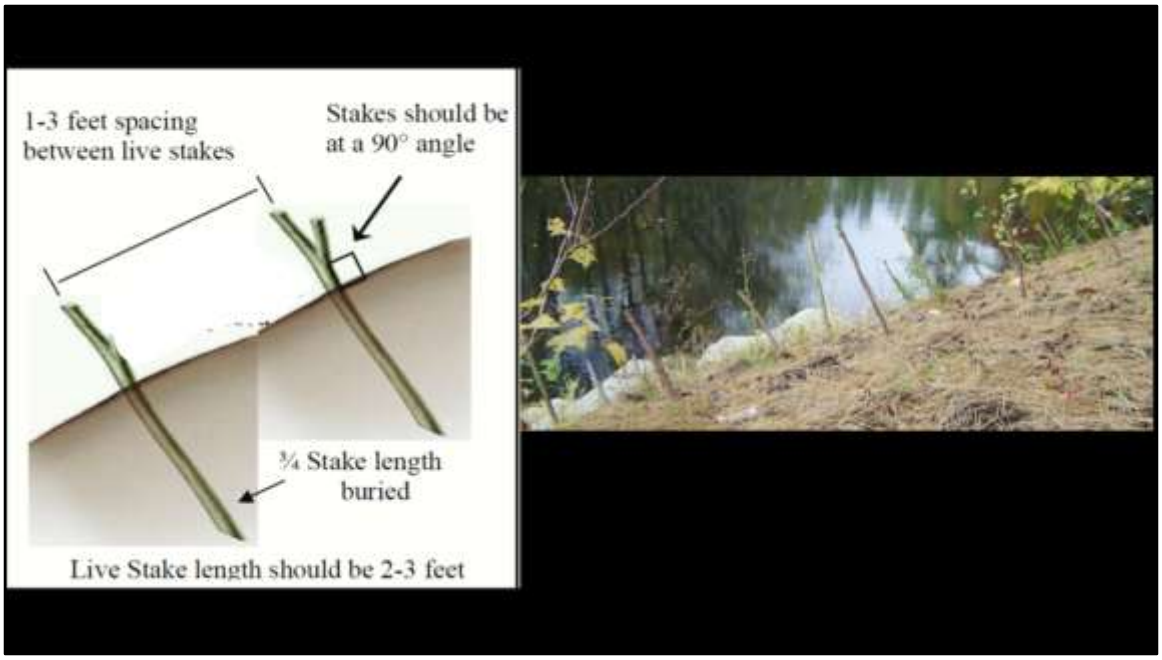


Vertical walls physically block access to and from the water for turtles, frogs and other animals that need contact with the land to feed, rest and nest. Yet, when shoreline erosion becomes a problem, property owners are drawn to seawalls because they are perceived to be more stable.

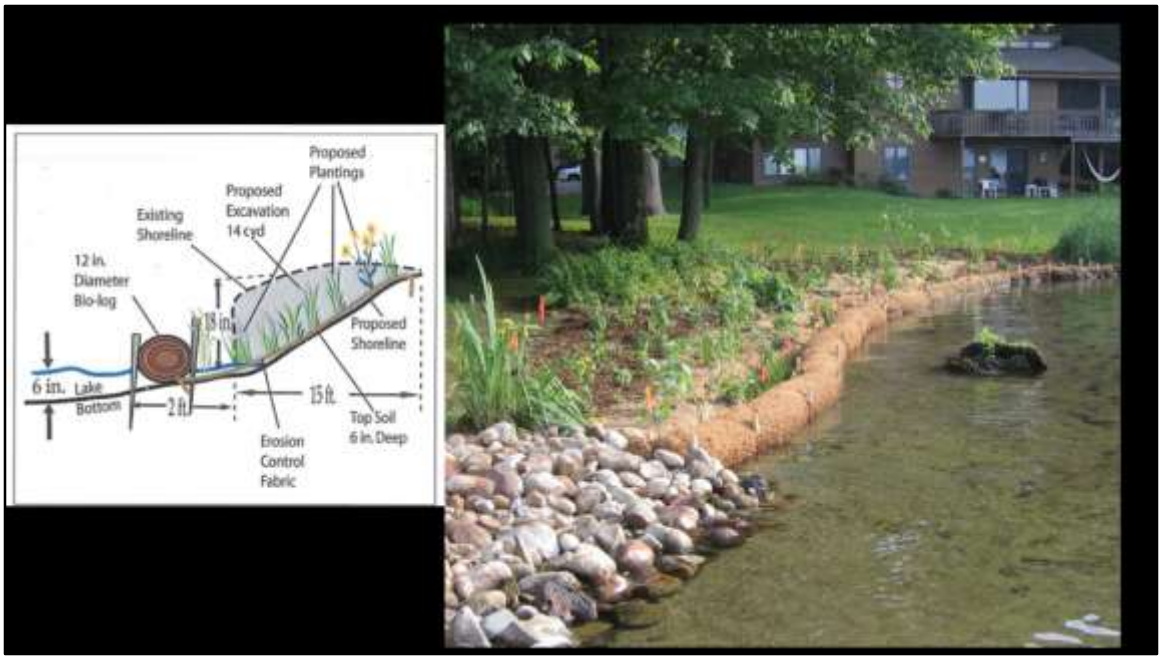
- A seawall is a hard scape of the shoreland, installed to block the waves from reaching the land.
- Seawalls are made out of many materials, including concrete, steel, and rock filled wood structures.
- Seawalls do not allow for absorption of the energy that waves bring in. Waves hit the seawall, and the energy is bounced back out to the water. This energy then scoops out the lake bottom and causes erosion at the base of the wall, which is called **scour**.

The two most destructive actions to the lake ecosystem are:
Native vegetation removal
Hardening of the shoreline

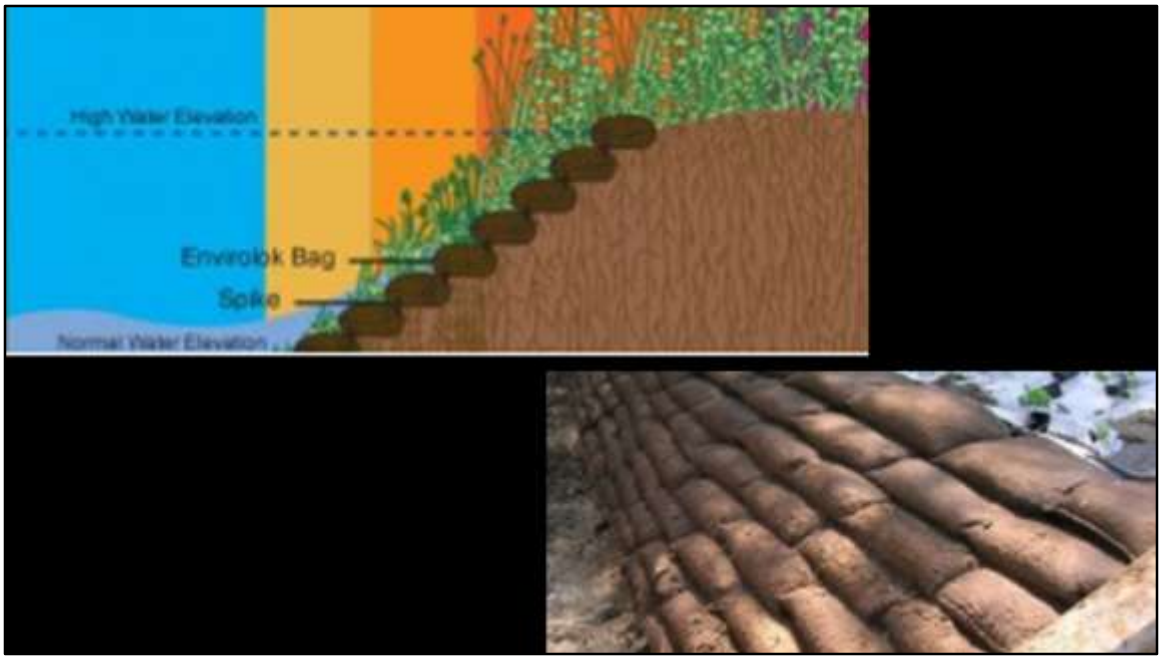
Wave flanking from this seawall is causing erosion on the neighboring property



So what are some of the bioengineering techniques?
Bio-engineering projects range from stabilizing slopes with live plants stakes, called live staking to…



Using fiber coir rolls to stabilize and revegetate the shore.



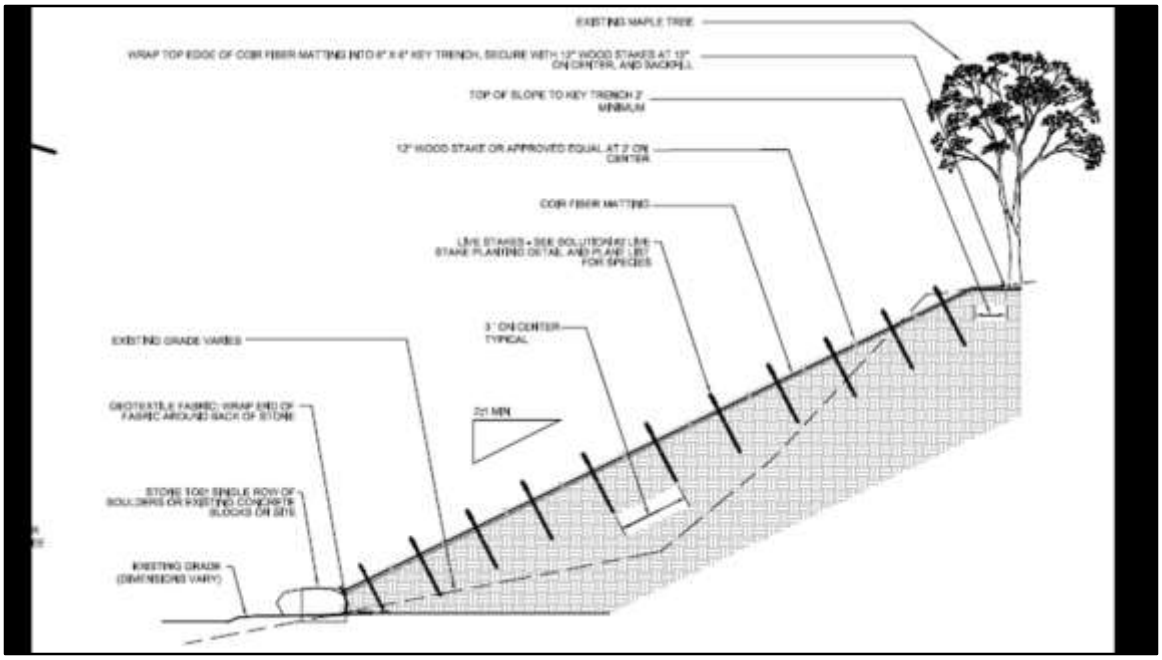
Or encapsulated lifts for steeper slopes and maybe higher energy sites.

All these methods involve native plants to help re-naturalize the shore.

So for these next few slides, we'll take a look at examples of these three types of bioengineering:
Live staking
Fiber coir rolls
Encapsulated Lifts

In this slide, the eroding bank on the left was stabilized with live staking. This was a project from 2012 in South Hero, where the shore took a hit from the high flood waters.
The image on the right is one season later with the live stakes taking hold.

Here’s another property on northern Lake Champlain that suffered from the high flood waters in 2011.



The engineered design to stabilize the shore called for live stakes with grading back to 2:1 slope.

The live stakes were added in the fall when the plants were dormant.

In this photo, dormant live stakes, that's how they are planted – harvested early spring or late fall when leaves are not on the shrub, are planted into a bundle of live brush rapped in the erosion control fiber. Both the live stake and brush is expected to root and grow, stabilizing this bank.

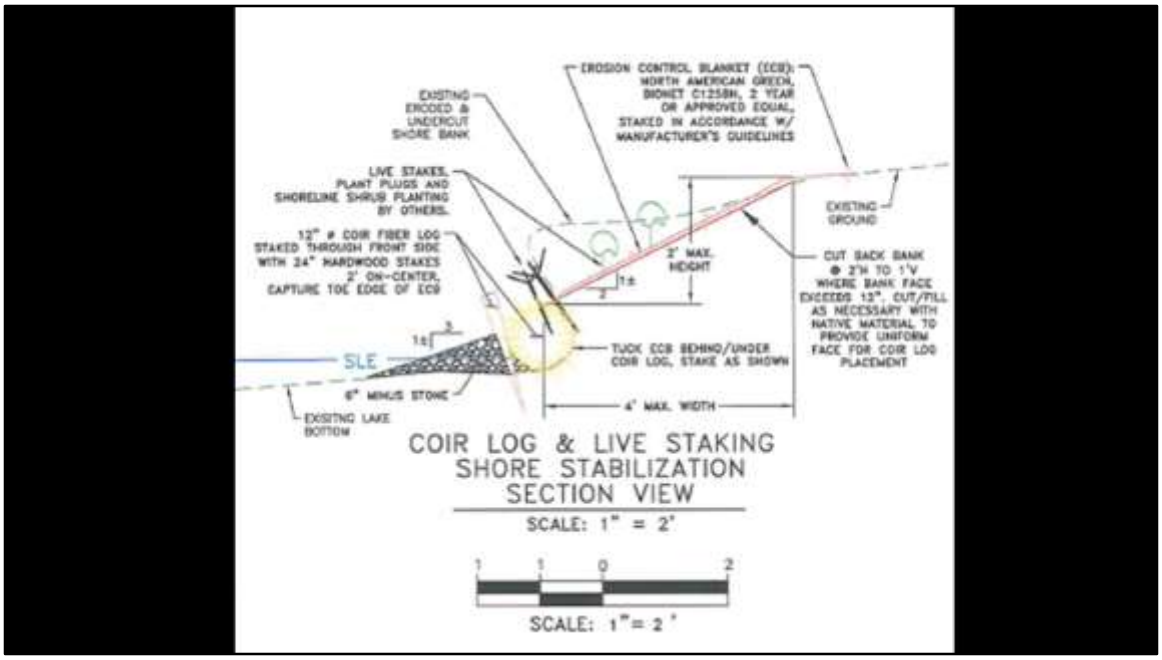
The next slides will show case some fiber coir roll stabilization projects.
Here is a Wisconsin eroding bank.

Here is a Wisconsin fiber coir roll re-naturlization project.
Fiber coir rolls or logs are made from varying diameters, densities and lengths of coconut husks and held together with natural nettings.

Native plants hold the slope. The fence was added to keep the geese out.

One year later.

Lake Iroquois Fish and Wildlife Access Area, Williston, Vermont. We had a little help on this one as it was an ANR training day event. Brian Majka from GEI Consulting in Michigan flew in to guide our project. Brian, along with Jane Herbert from University of Michigan, have the most experience with bioengineering and the most case studies, expanding now over a decade. So we were super excited to have them join us to coach us along on this project.



Engineers from Vermont's ANR drew up the design.

Contractor Howard Stickney from Rutland helped us out. He graded the bank back to a 2:1 slope. A floating sediment curtain is installed in the water to keep the turbitity contained.

Brian Majka from GEI Consultants of Michigan explains the steps to installing the fiber coir rolls.

Fastening these fiber coir logs is critical to making sure they are anchored well.

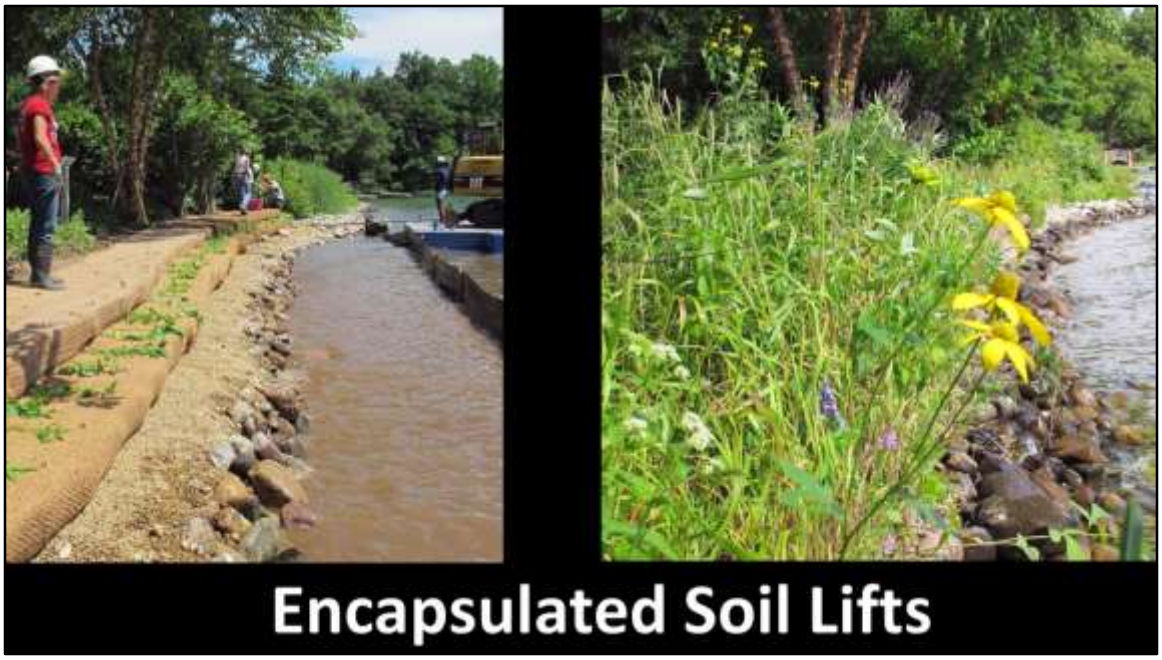
The erosion control cloth is laid and soil is back filled into it. It's then flipped over like a burrito.

The erosion control cloth or blanket is then tacked in place with biodegradable “bio-stakes.”

Planting comes next.

Securing the area from dogs is important so the plants can get established.

One year later, Aug. 2016



Encapsulated Lifts. What are they?
I'm going to let Jane and Brian, our friends from Michigan explain by clicking on this video from their work.
http://www.shoreline.msu.edu/shorelinemgt/natural-shoreline-constructing-encapsulated-soil-lifts/

Encapsulated soil lifts can also be built with bags. Wisconsin project using encapsulated envirolok bags. The bags are made from synthetic fibers and are not bio-degradable. But what makes them semi-eco friendly is that they allow plants to root into them. They are not a weed barrier, yet can hold soils in place.

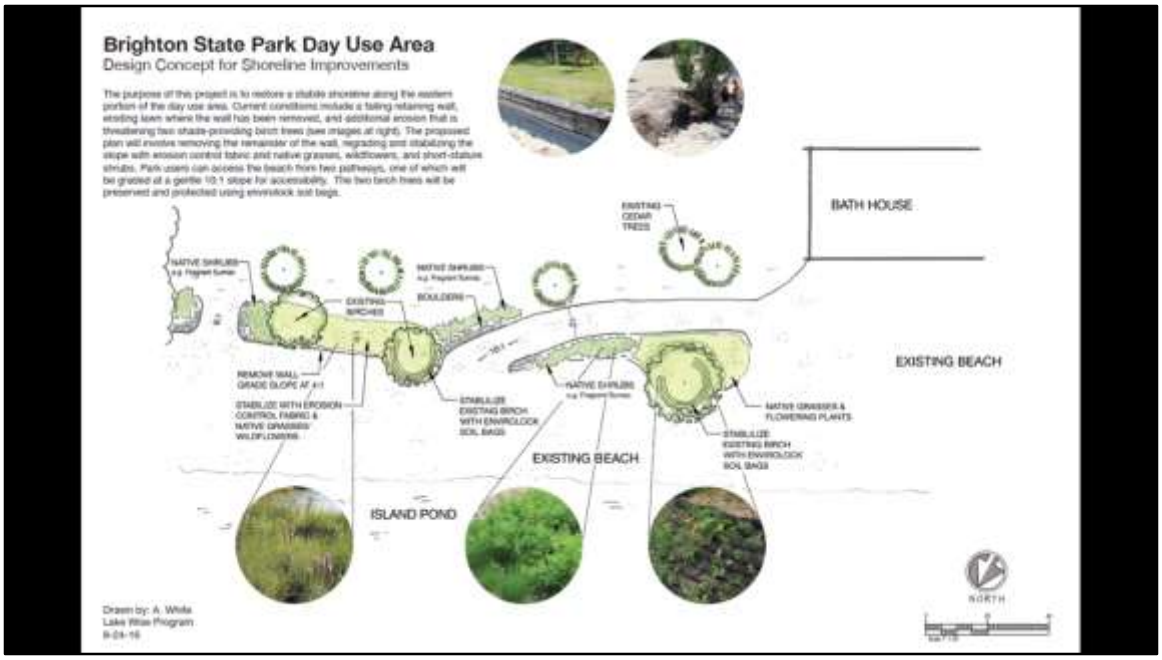
Envirolok bags.

Other examples of encapsulated soil lift was used for this riparian (river bank) erosion.

Minnesota Fish and Wildlife Public Access – Envirolock Project

Encapsulated Lifts

Possible project in 2017 at Brighton State Park that will use encapsulated soil lifts for bank stabilization

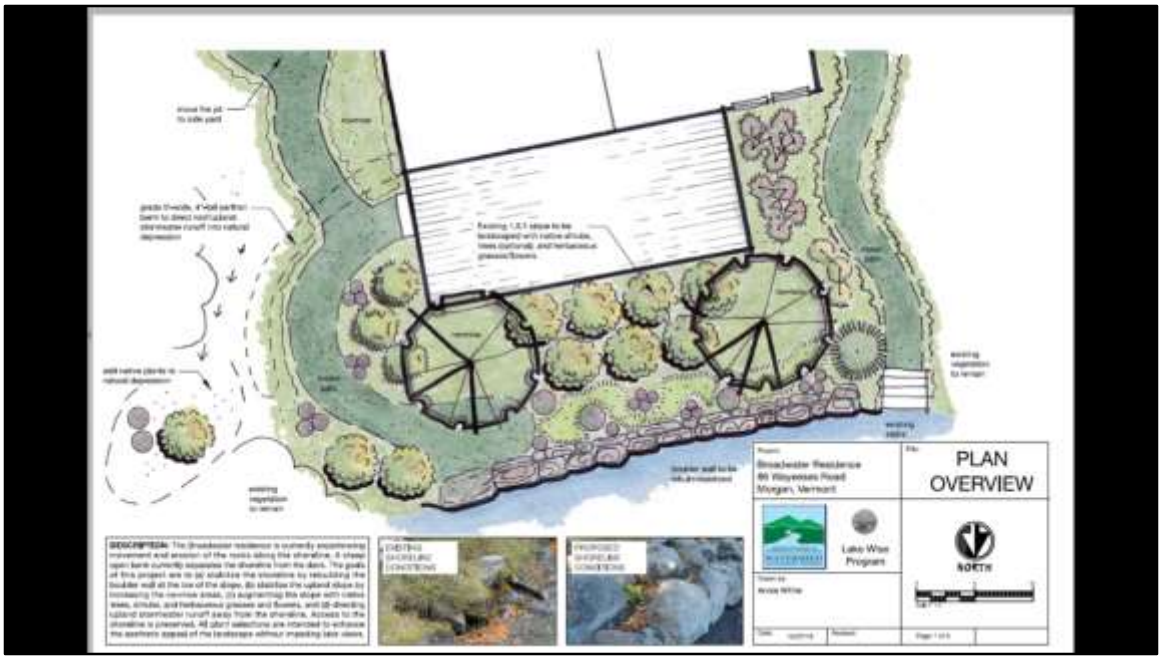


Proposed Draft Plan

Other sites that could benefit from encapsulated soil lifts – Shelburne on Lake Champlain

Fort Ticonderoga on the NY side of Lake Champlain. The challenge is to replace the gabions with a bioengineering solution.

Slope stabilization Project at Seymour Lake in Morgan, VT



The bioengineered plan. NOTE, this plan calls for a berm upland of slope to prevent upland runoff flowing down lawn right at bank.

The work with upland berm.

Nice completed project.

VTANS Study on the White River with three different slope stabilization techniques used. The bioengineered one worked best. (Note, today we would replace compost socks with fiber coir rolls.)

VTRANS three treatment sits. The Bioengineered one lasted the best.

ICE BERMs are Natural.
Only a problem when a built environment is in their way.

2016 winter ice push problems on VT lakes.
Tricky shoreland projects! What bioengineered project would work best?

Wildlife entanglement and death from plastic netting and other man-made plastic materials has been well documented in birds, mammals, fish and reptiles.
Erosion control products that are wildlife, plant and water quality friendly do exist.
Biodegradable netting made from natural fibers is what you want to look for when purchasing erosion control blankets.
Products that require UV light to degrade or also called photodegradable do not degrade when shaded with vegetation, so don't use those.

Biodegradable fiber products. Erosion control blankets made from:
Coconut
Aspen
Straw

Always use native plants. Native plants are ESSENTIAL for insects as they have co-evolved together for 1000s of years. Insects feed song birds and fish.
Native plants – Insects – birds and fish = healthy lake ecosystem.