

# Bioengineering case study:

Planting Approaches  
for Bank Regrade &  
Erosion Control



**GREENLEAF DESIGN, LLC**  
ECOLOGICAL LANDSCAPE DESIGN  
ILLUSTRATION & GRAPHIC DESIGN

**Holly Greenleaf**  
**January 8<sup>th</sup> & 10<sup>th</sup>, 2025**  
**NSECC Training**

# 4 PLANTING APPROACHES TO RESTORE & STABILIZE THE BANK



**Seed Mix + Live Stakes**  
North Hero, Lake Champlain  
Installed: 2020, Photo: 2024



**Seed Mix + Tree & Shrub Containers + ECB**  
North Hero, Lake Champlain  
Installed: 2020, Photo: 2024

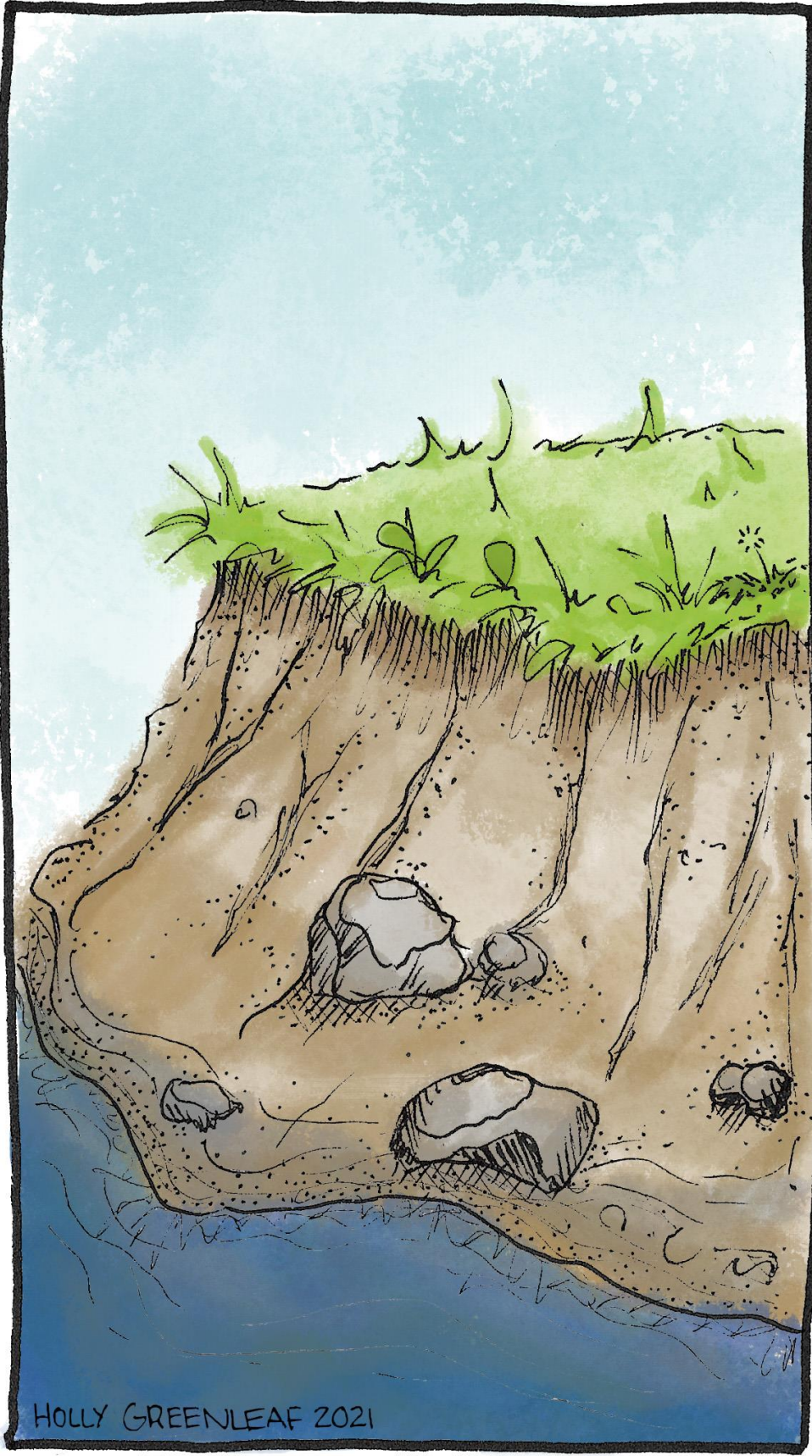


**Shrub Containers + Mulch + Clover Seed**  
Danville, Joe's Pond  
Installed: 2024, Photo: 2024

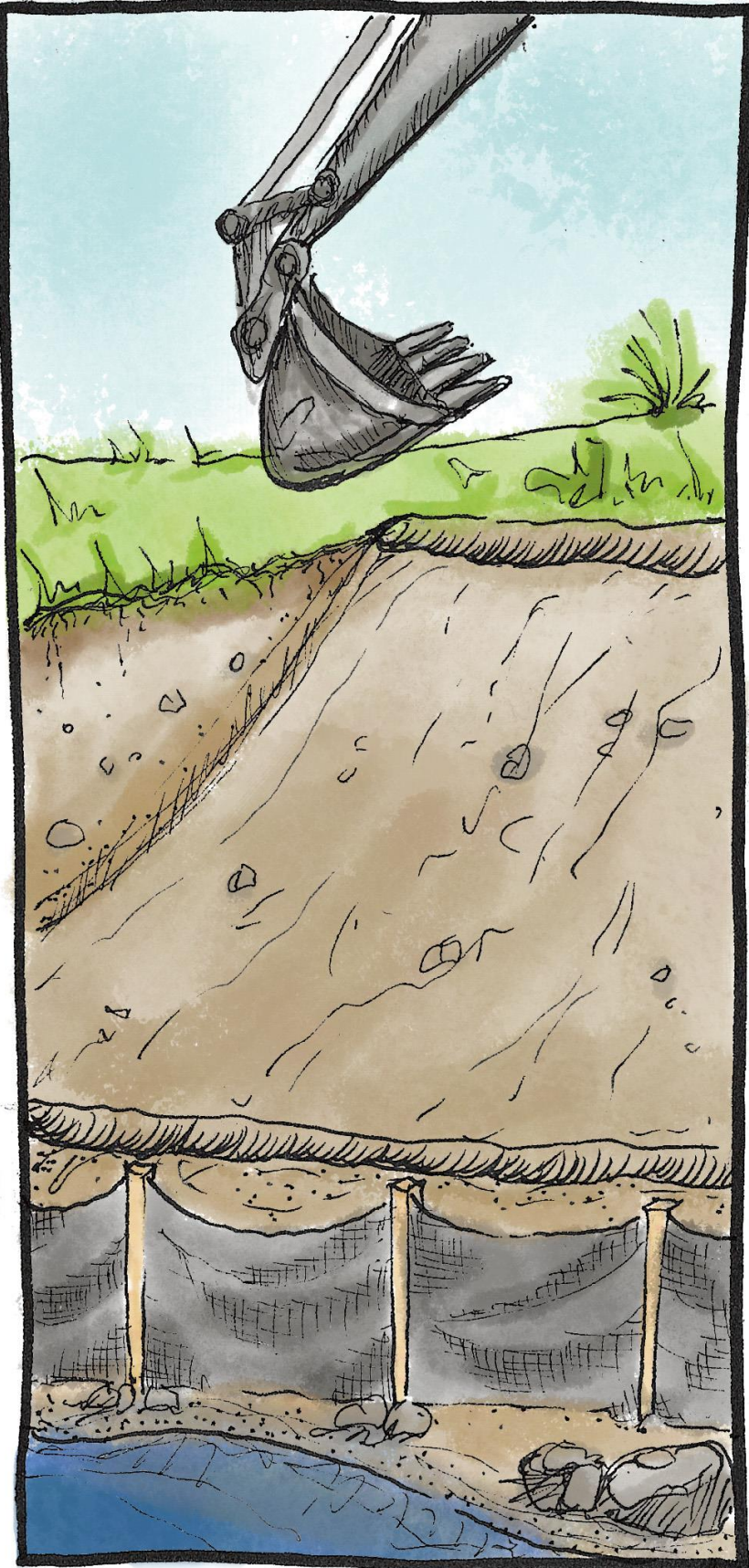


**B&b Trees + Shrub & Perennial Containers + ECB + Mulch**  
Salisbury, Lake Dunmore  
Installed: 2023, Photo: 2023

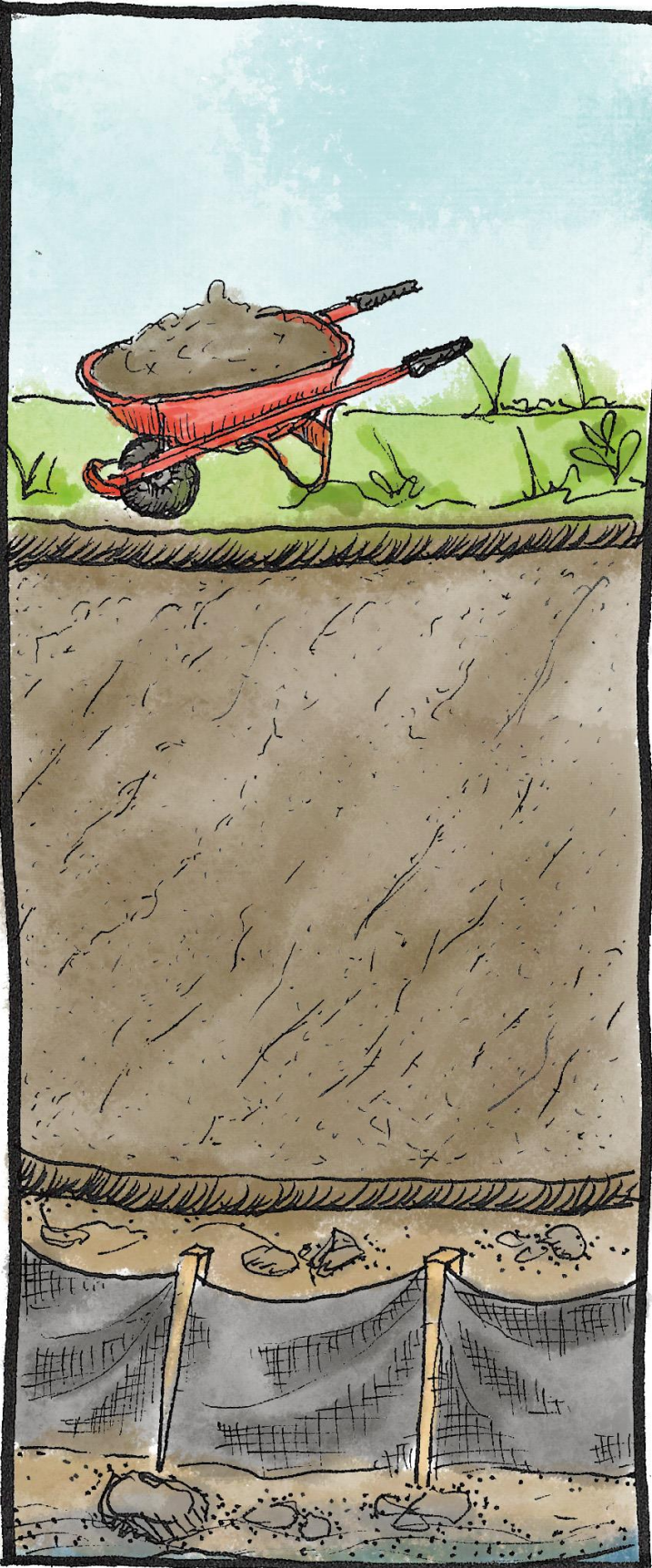
# Regrade the slope



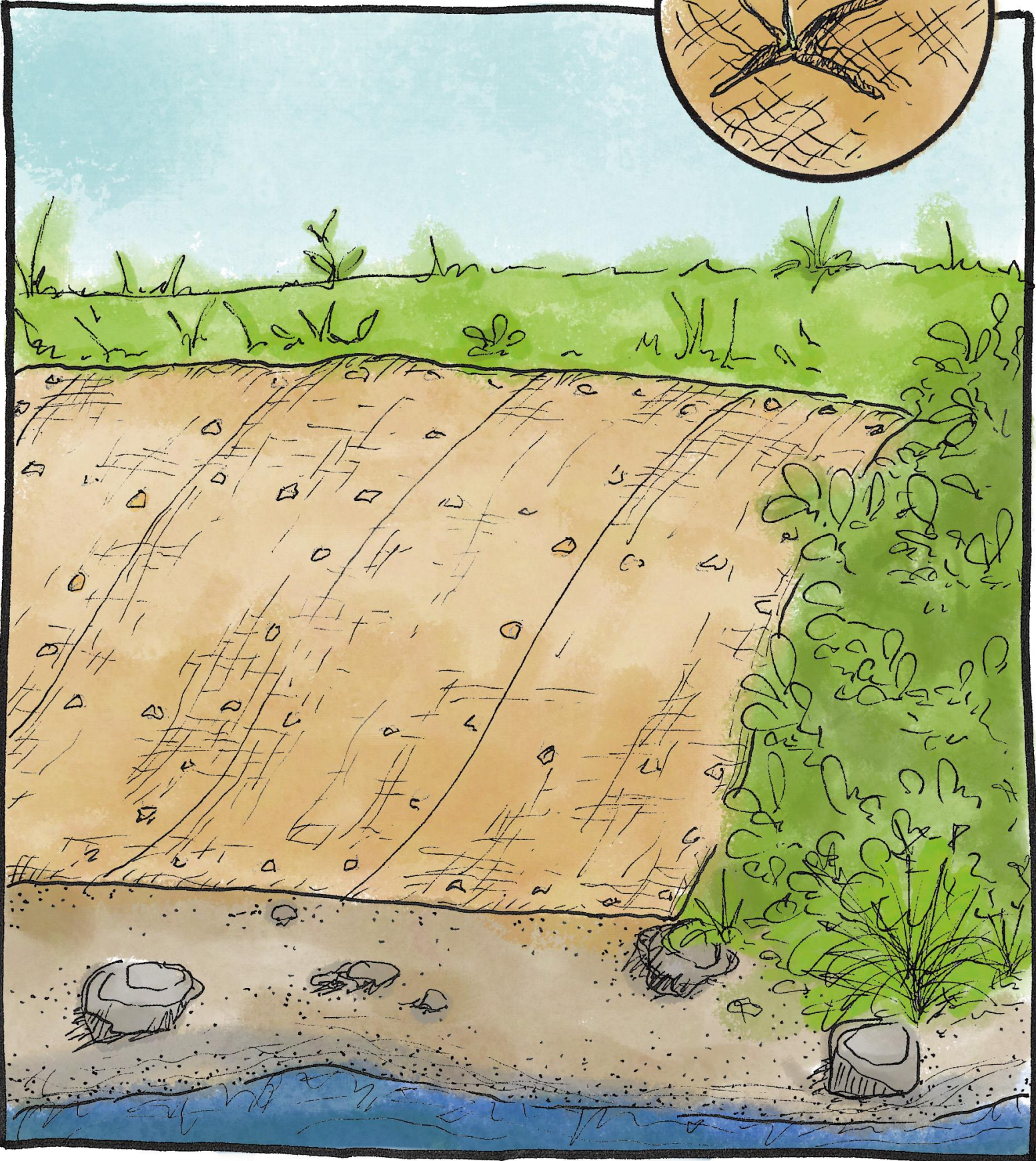
**BEFORE**  
Install a silt fence or turbidity curtain depending on water depth



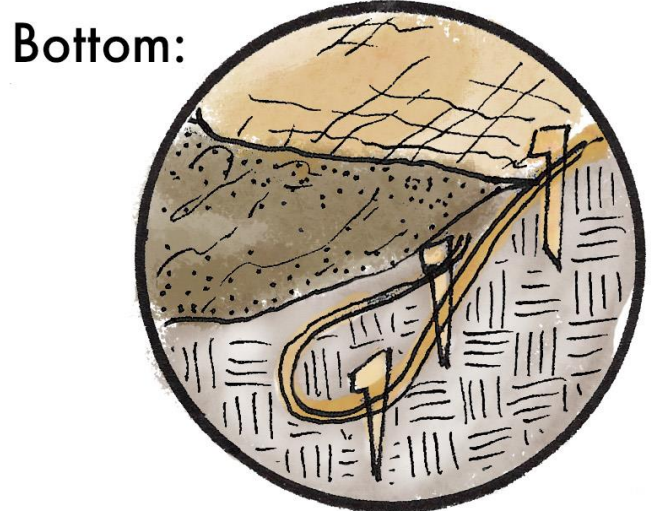
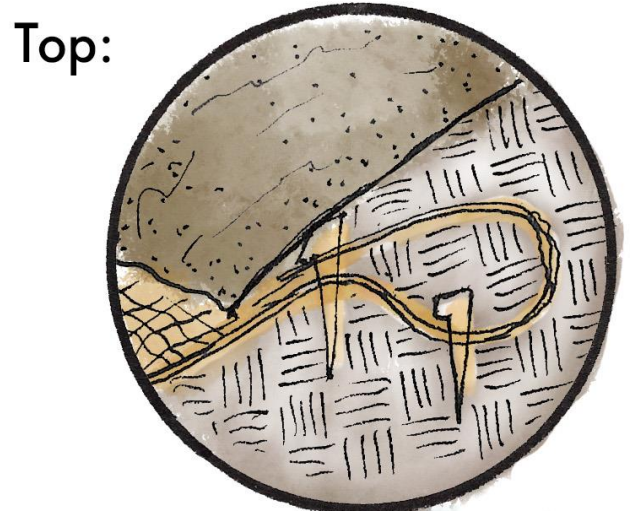
**REGRADE**  
Till/scarify subsoil across slope 4" deep  
  
Dig trenches 6" deep and wide at the top and bottom of the slope to anchor the ECB



**ADD TOPSOIL & SEED**  
Select screened, weed-free topsoil  
  
Seed with native species



**PLACE & SECURE EROSION CONTROL BLANKETS (ECB)**  
Anchor top & bottom in trenches, use biodegradable pins

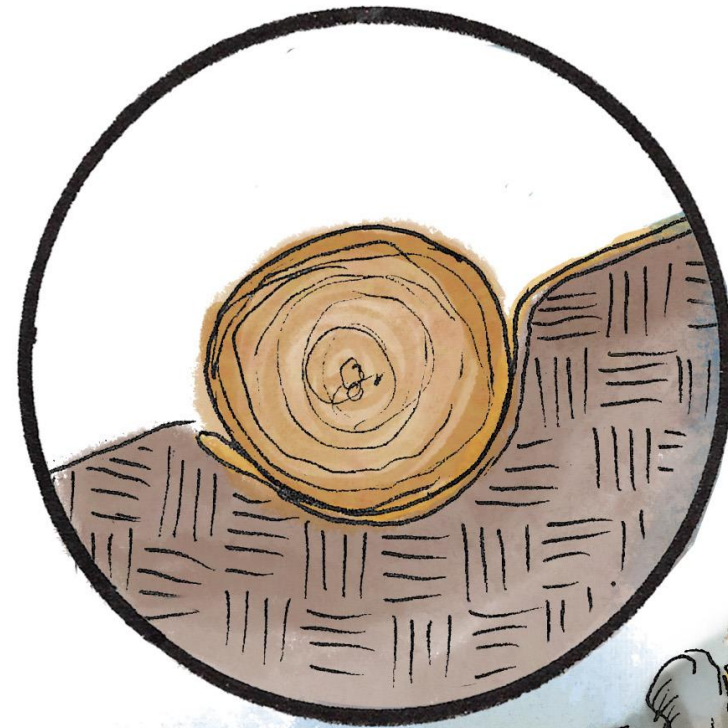


Cut "X" or burn hole in ECB to plant

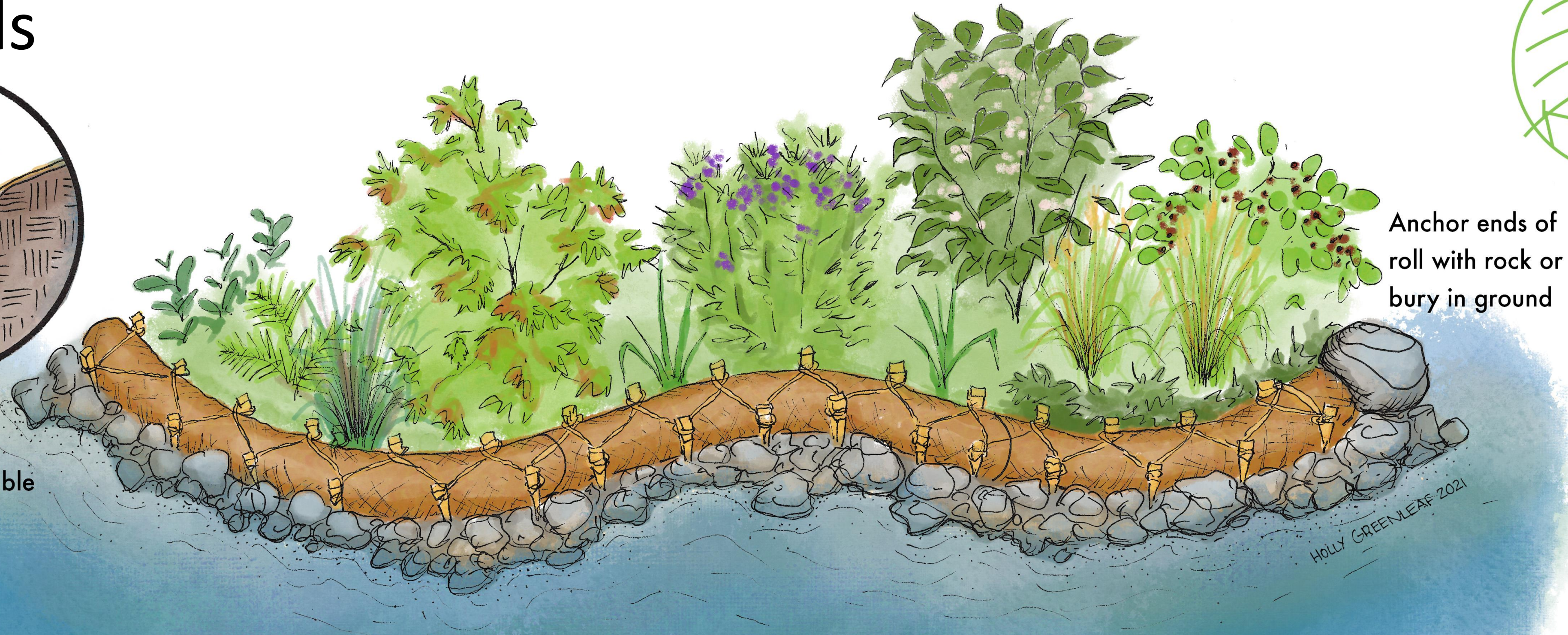


\*ECB can be placed horizontally along more gradual slopes

# Fiber coir rolls



Lay roll in 6" deep trench, lay ECB in trench first if applicable



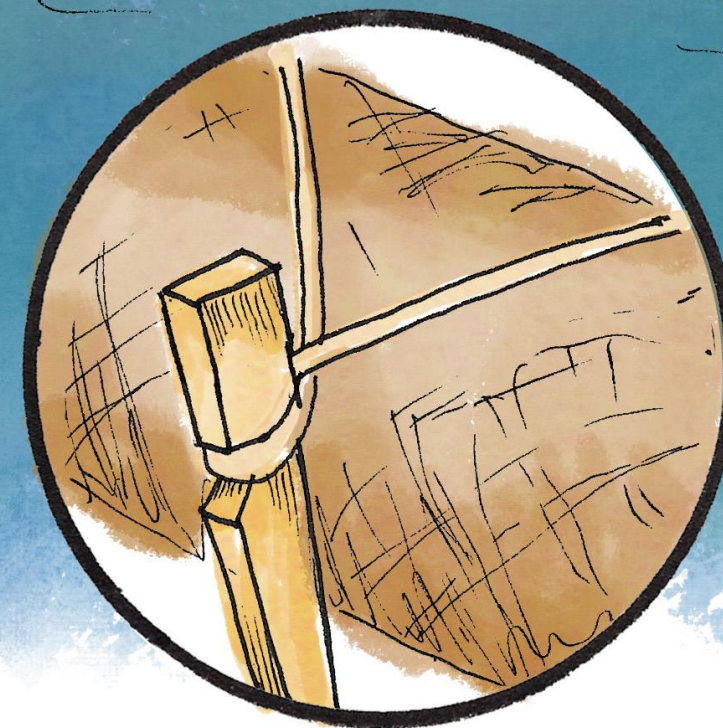
Anchor ends of roll with rock or bury in ground



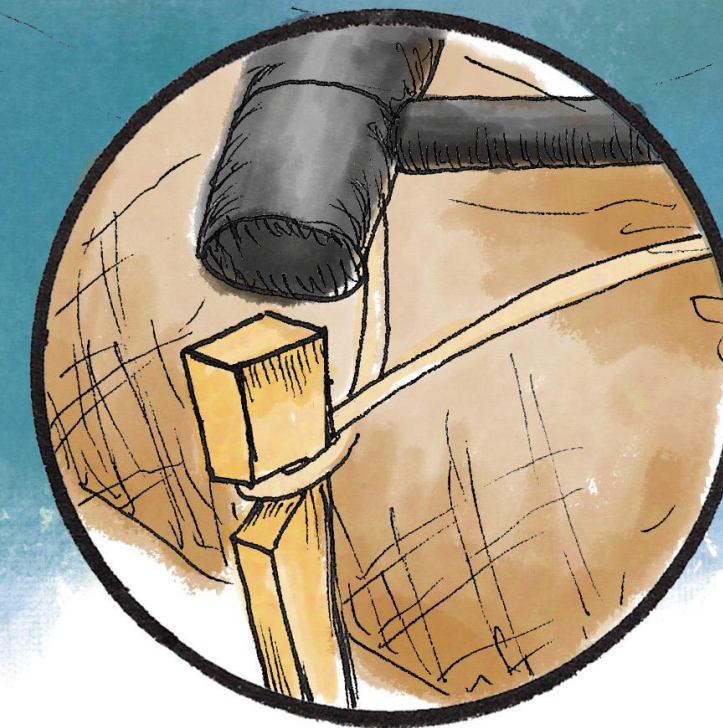
Pound stakes on either side of roll perpendicular to ground level every couple feet



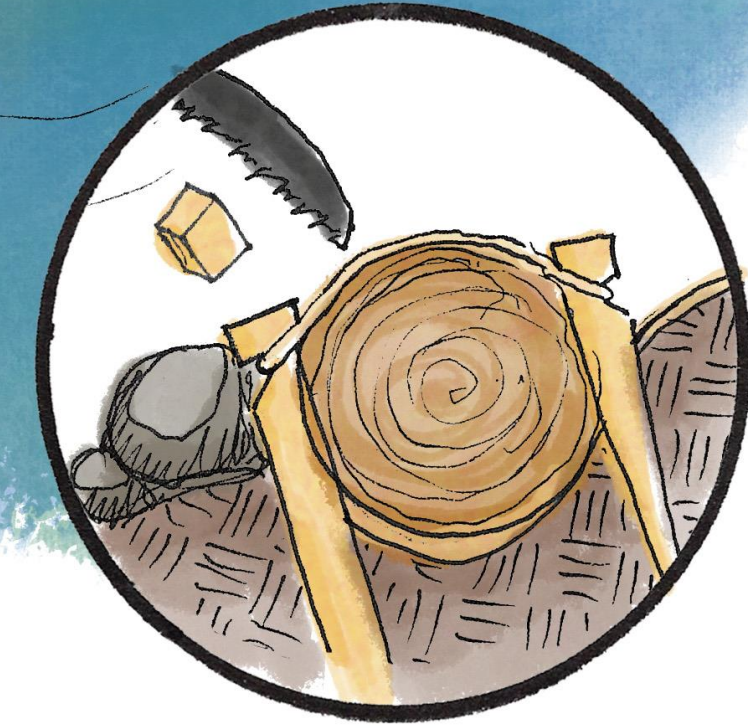
Notch outer side of stake with reciprocating saw at the level where the stake and roll meet



Tie fiber rope in tight zig-zag pattern (jute, coir, manila, sisal fiber)

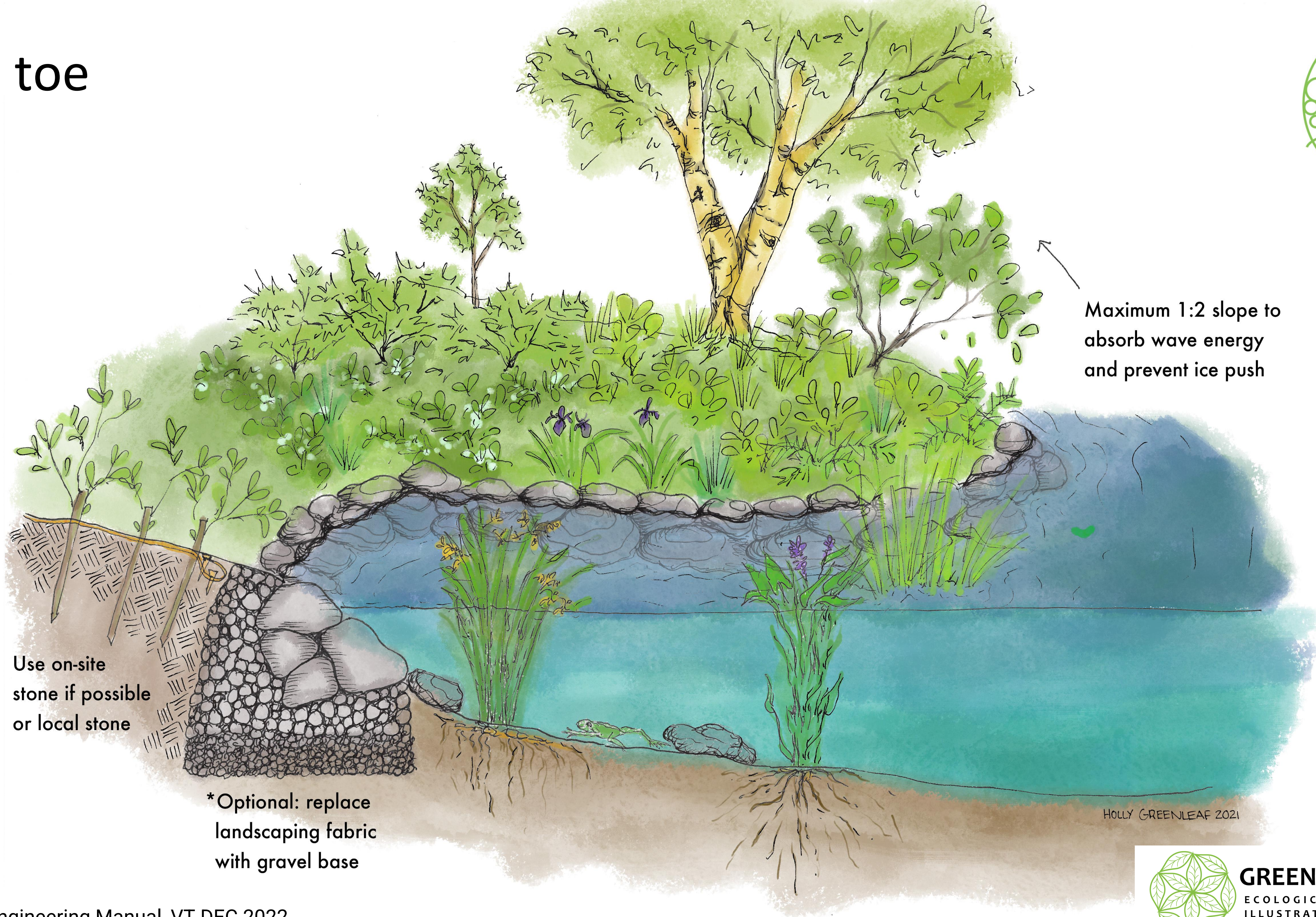


Pound again to tighten rope



Cut off excess stake to be level with the top of the roll and prevent ice push

# Stone toe



Maximum 1:2 slope to absorb wave energy and prevent ice push

Use on-site stone if possible or local stone

\*Optional: replace landscaping fabric with gravel base



# 1. Case study: lake champlain, NORTH HERO



Before

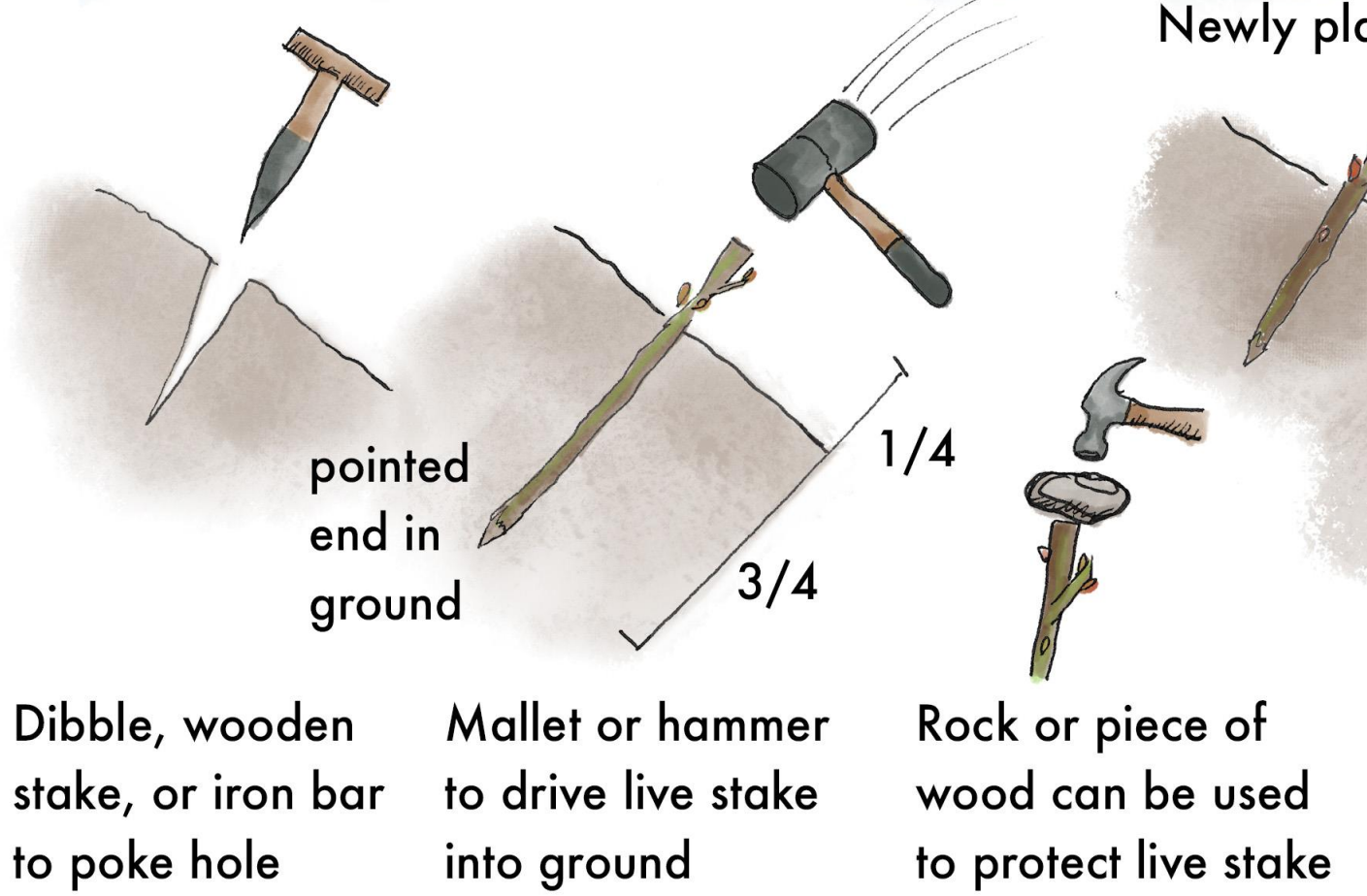
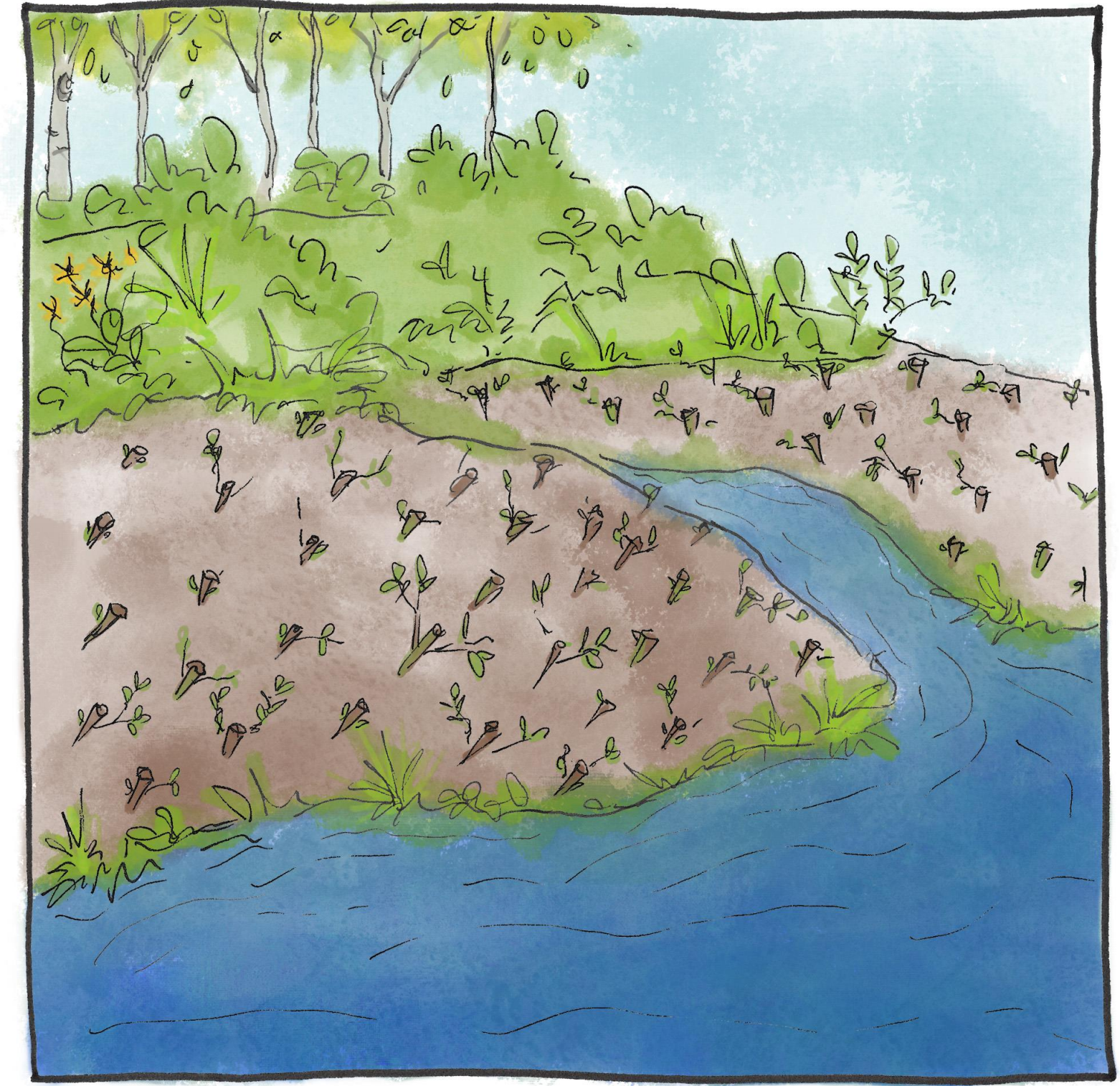


After

# Live stakes & fascines

- ▶ **Red Osier,**  
**Silky, Gray**  
**Dogwood,**  
*Cornus/Swida*  
*sericea,*  
*amomum,*  
*racemosa*
- ▶ **Shrub Willows,**  
*Salix spp.*
- ▶ **Pussy Willow,**  
*Salix discolor*
- ▶ **Black Willow,**  
*Salix nigra*

## LIVE STAKING

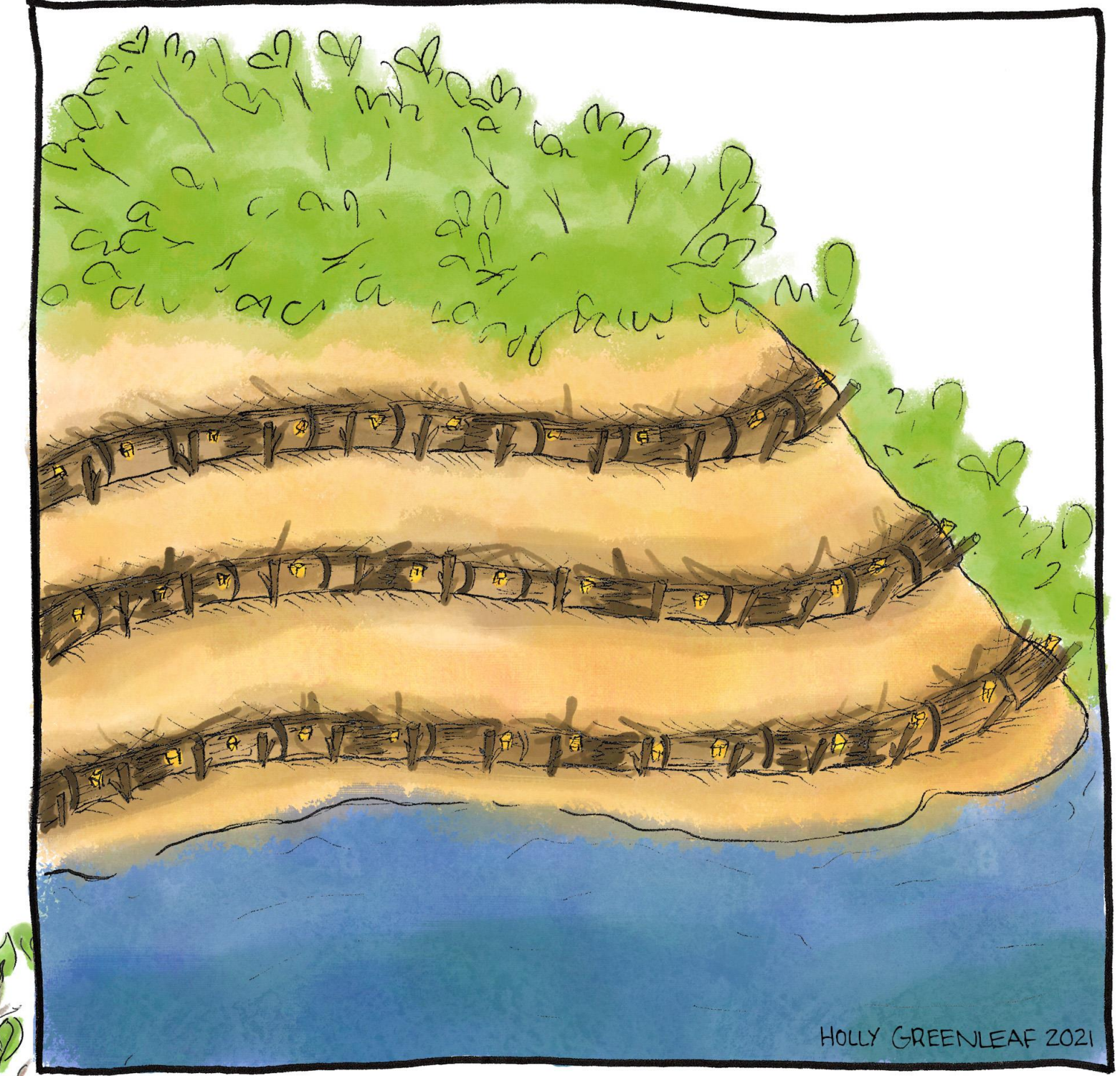


Newly planted

1 year

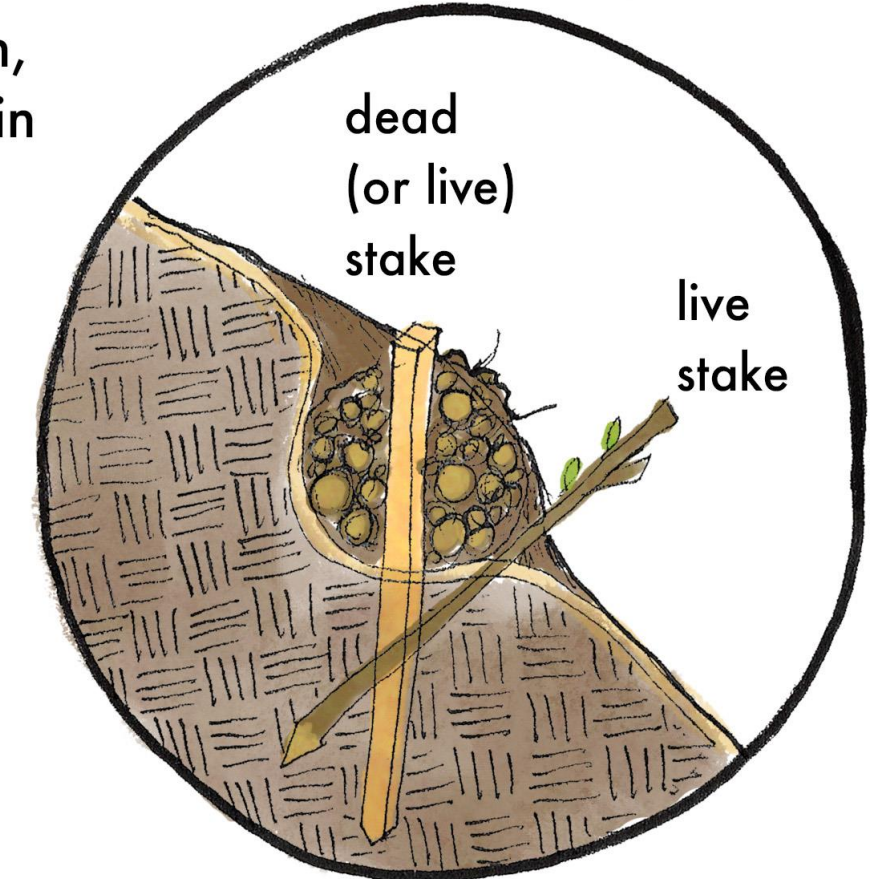
3 years  
"It will be great,  
just wait!"

## WATTLES & LIVE FASCINES



HOLLY GREENLEAF 2021

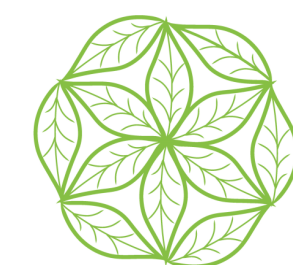
Dig 6" on-contour trench, place wattles and stake in every couple feet with a dead stake through the middle and live stake at the base. Partially cover with soil.



# UNDERCUT, Eroding lakeshore



Lake Champlain





# Minimal disturbance solution: Erosion Control Materials + LIVE STAKES



Erosion Control Matting/Blankets (ECB), Coconut coir rolls, Live stakes, plugs/tree pots of woody trees and shrubs, seed with native flower and grass mix



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1 year



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5 years

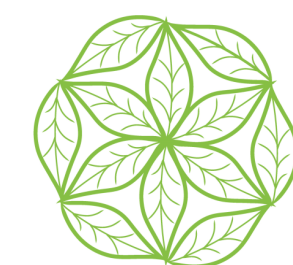


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# Common Problem: Eroding lakeshore



Lake Champlain



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# Solution: Stabilize & Live Stakes



Understory stabilization

# Solution: Stabilize & Live Stakes



Willow & Dogwood Bank, stone toe, ~ 75% survival - replacement

# 2. Case study: lake Champlain, North hero



Before



After

**Project Collaborators:** Friends of Northern Lake Champlain , VT DEC Lake Wise Program, Gracie Masonry, LLC

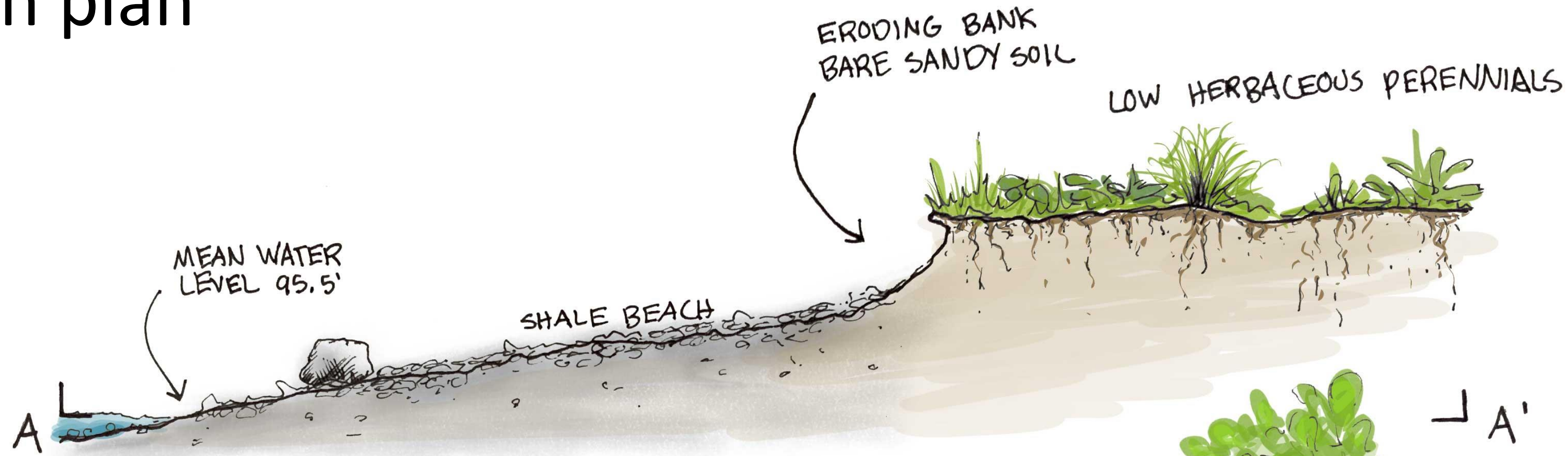


# Eroding, undercut bank from 2011 floods

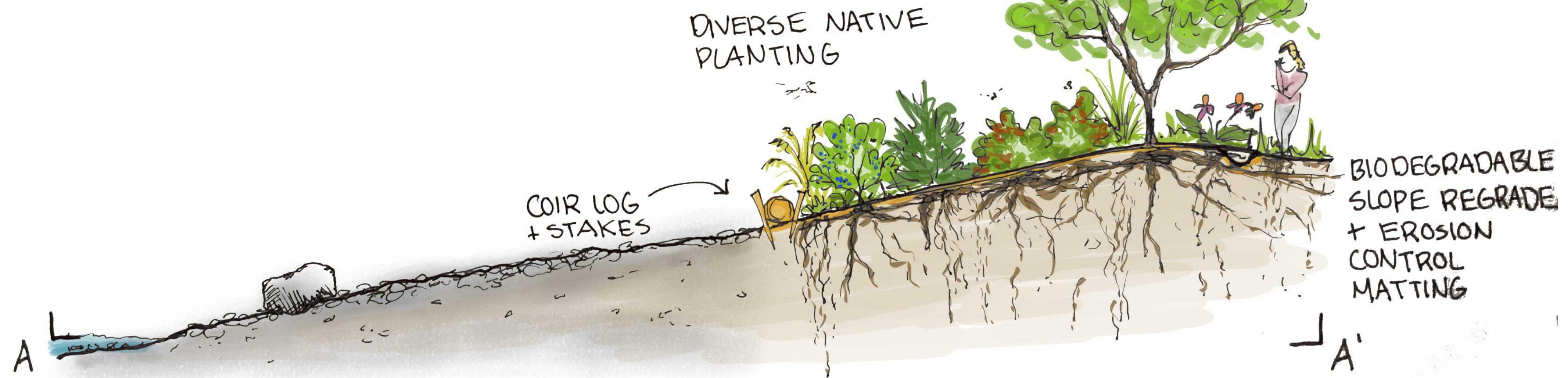




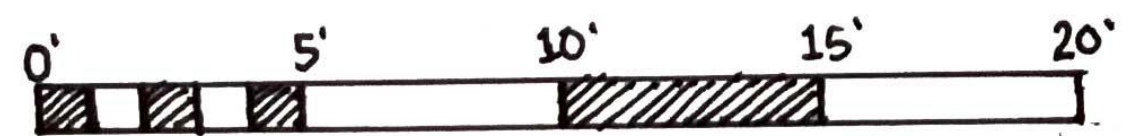
# Section plan



SECTION A-A' : EXISTING CONDITIONS



SECTION A-A' : PROPOSED BANK REGRADING & VEGETATION

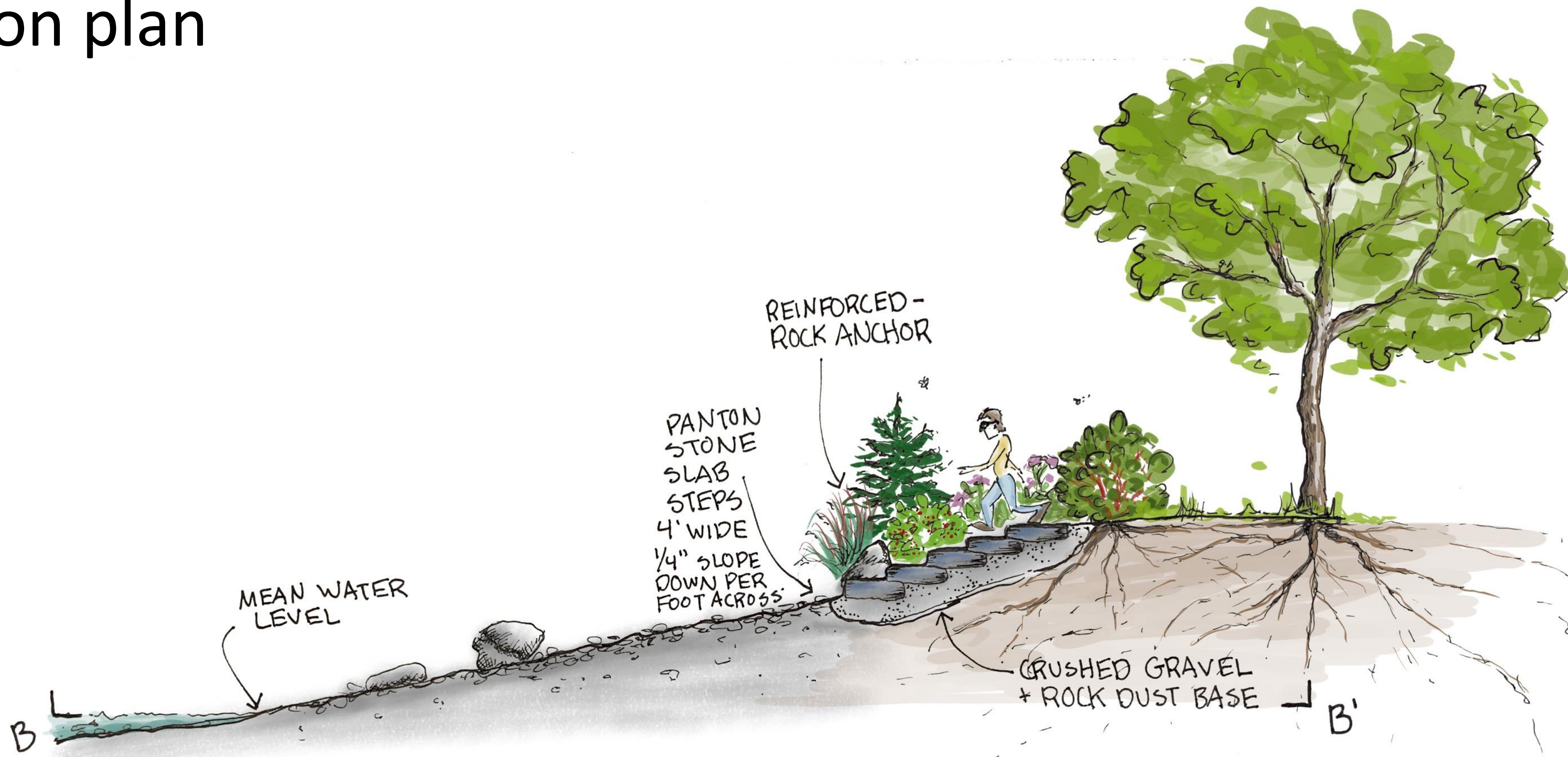


SCALE: 1" = 5'

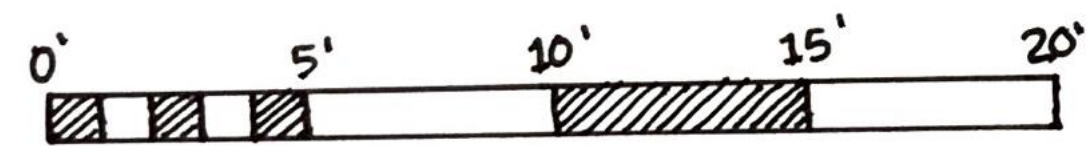


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# Section plan



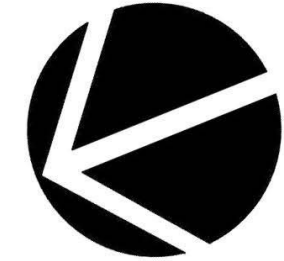
SECTION B-B' : PROPOSED STONE SLAB STAIRWAY



SCALE: 1" = 5'

# LAKESHORE RESTORATION // PLANTING PLAN

NORTH HERO, VT

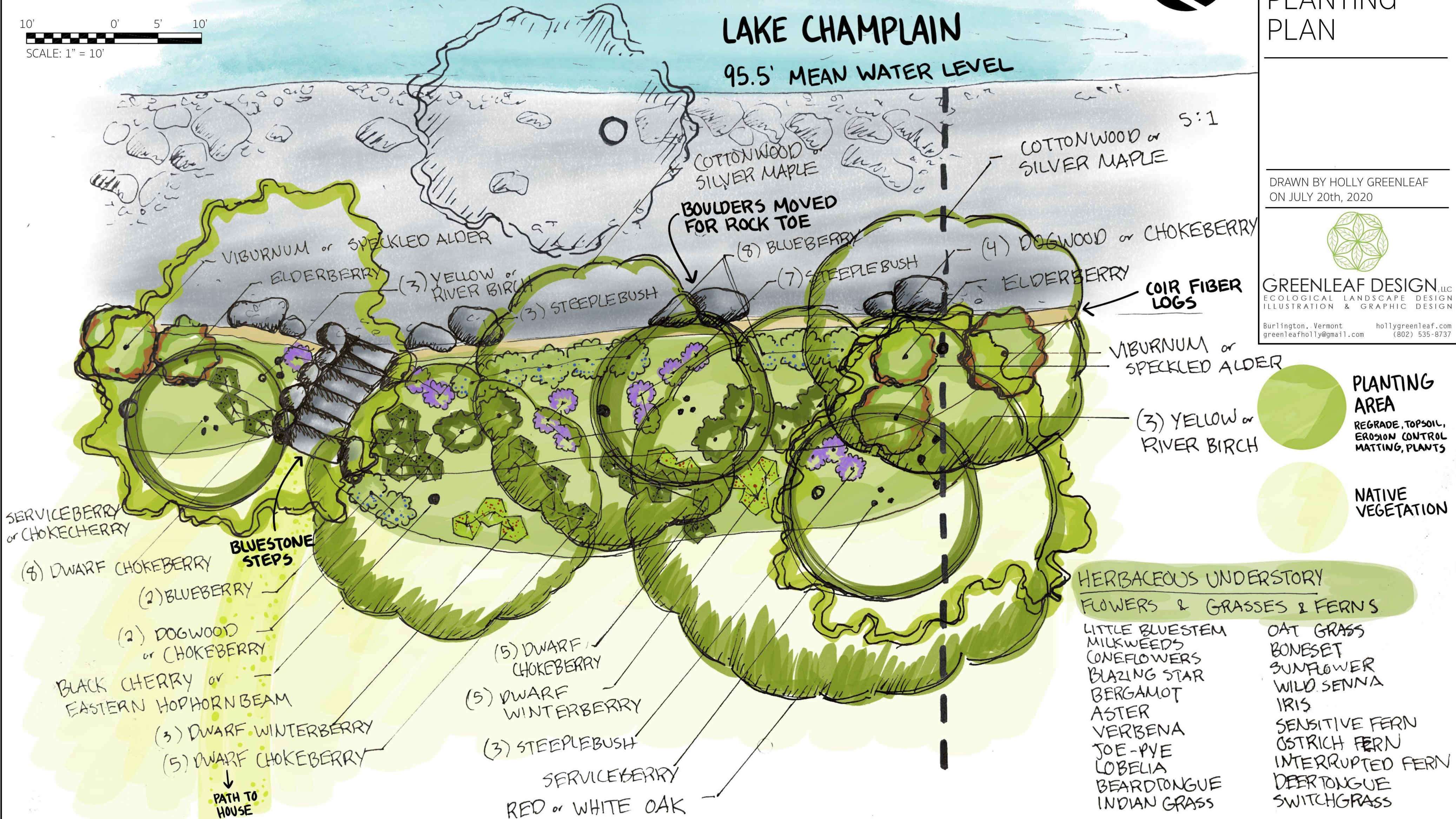


# LAKESHORE RESTORATION PLANTING PLAN

10' 0' 5' 10'  
SCALE: 1" = 10'

## LAKE CHAMPLAIN

95.5' MEAN WATER LEVEL



DRAWN BY HOLLY GREENLEAF  
ON JULY 20th, 2020



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greenleafholly@gmail.com (802) 535-8737



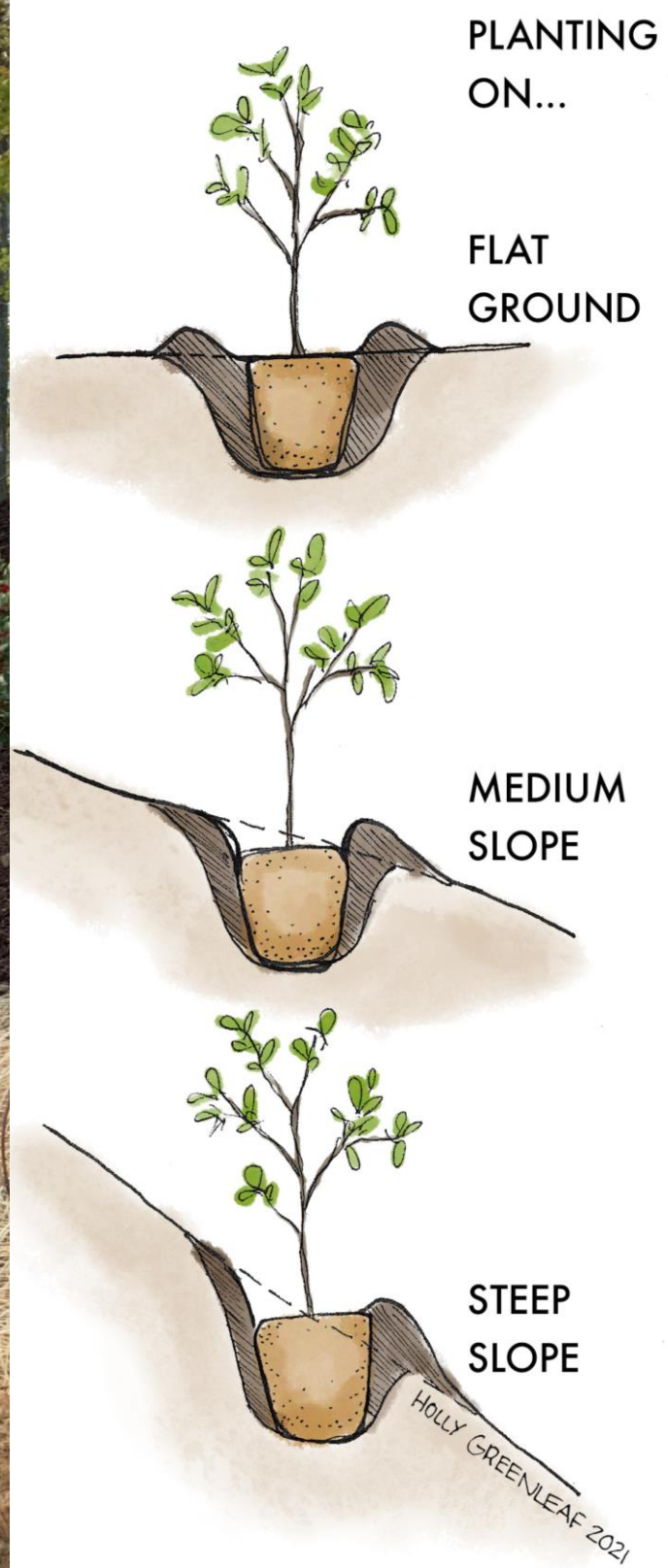
planting plan

# Regrade, EROSION CONTROL, plant



Topsoil, Erosion Control Matting/Blankets (ECB) (SC 150BN), Coconut coir logs (12" diameter x 10' long)

# regrade, EROSION CONTROL, plant



Native Shrub & Tree Container Plantings, Spot Compost, Mulch Rings

# Successional meadow > woodland



Native Perennial Flower & Grass Mix, Native Trees & Shrubs



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# FALL: YEAR 1



# Year 5



# winter: Year 4





# Summer: Year 5



### 3. Case study: Joe's Pond, Danville



Before



After

**Project Collaborators:** Caledonia County NRCD, Northwoods Stewardship Center, Auger Heights Excavating, LLC

# Failing retaining wall, sink holes, erosion





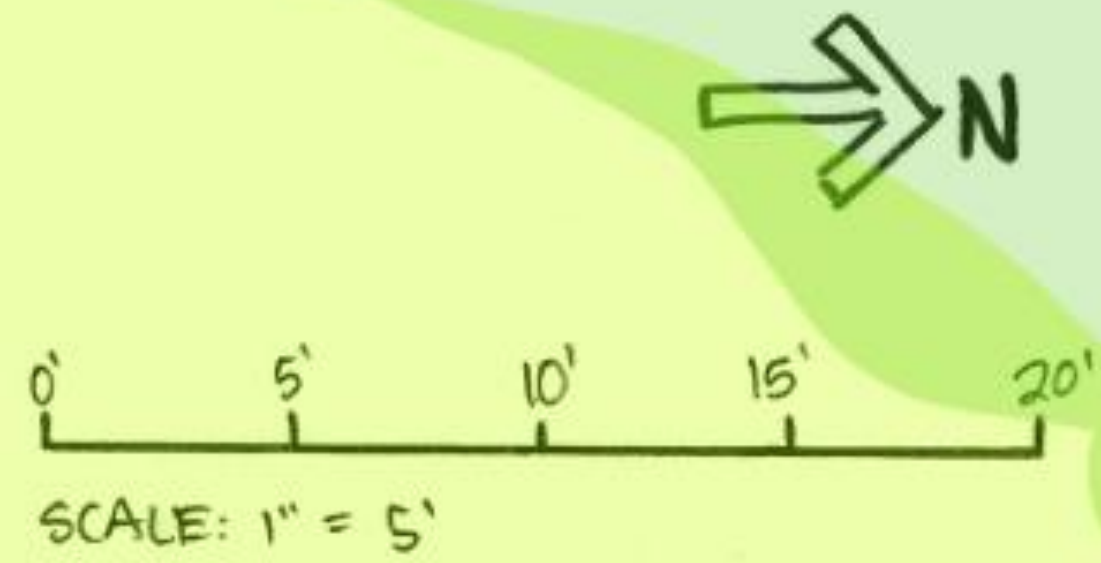
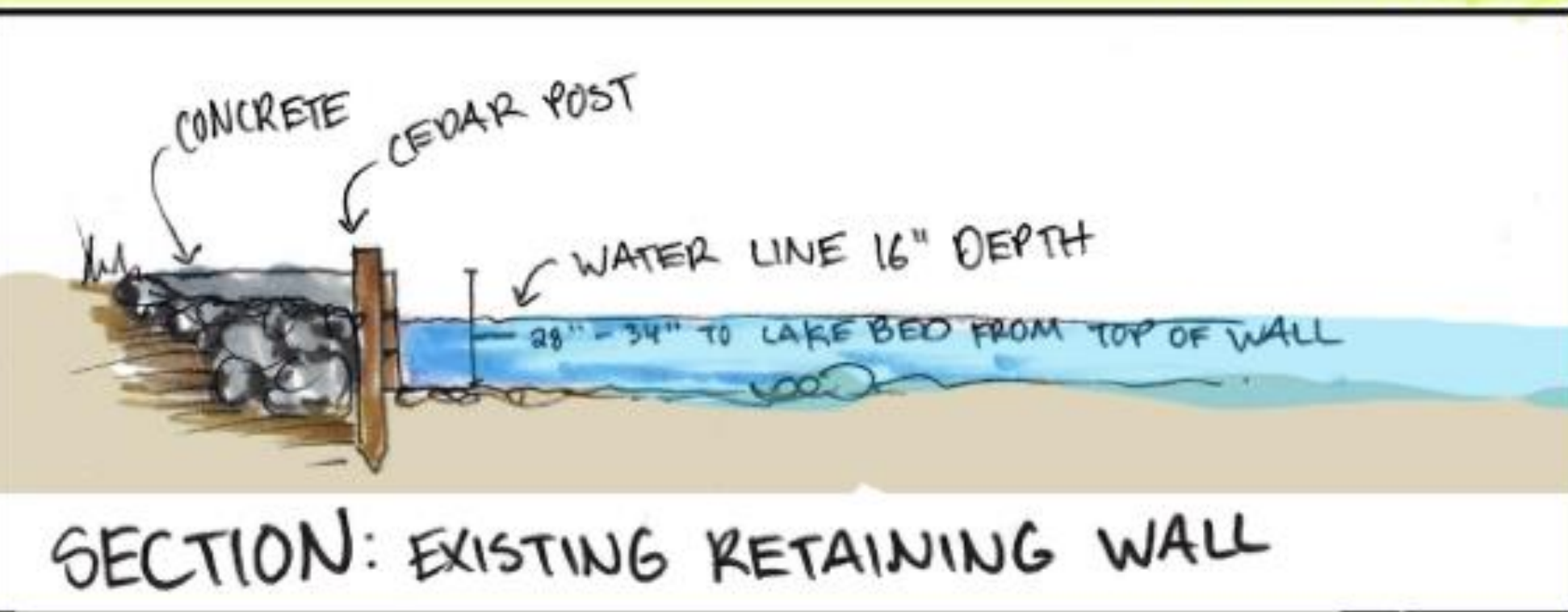
# EXISTING CONDITIONS BASEMAP: Old Wood & Concrete Retaining Wall



View of retaining wall from south side



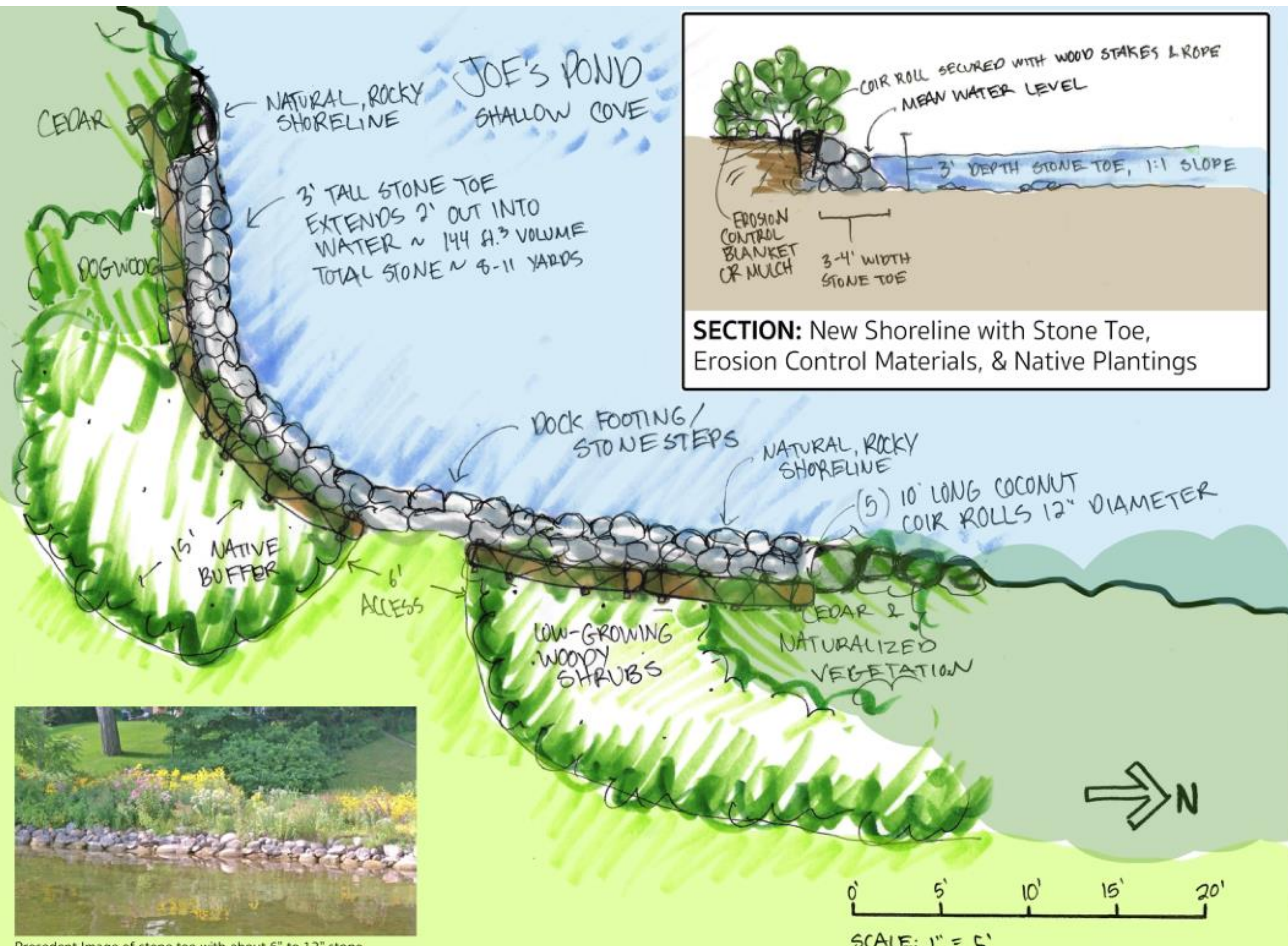
View of retaining wall from north side



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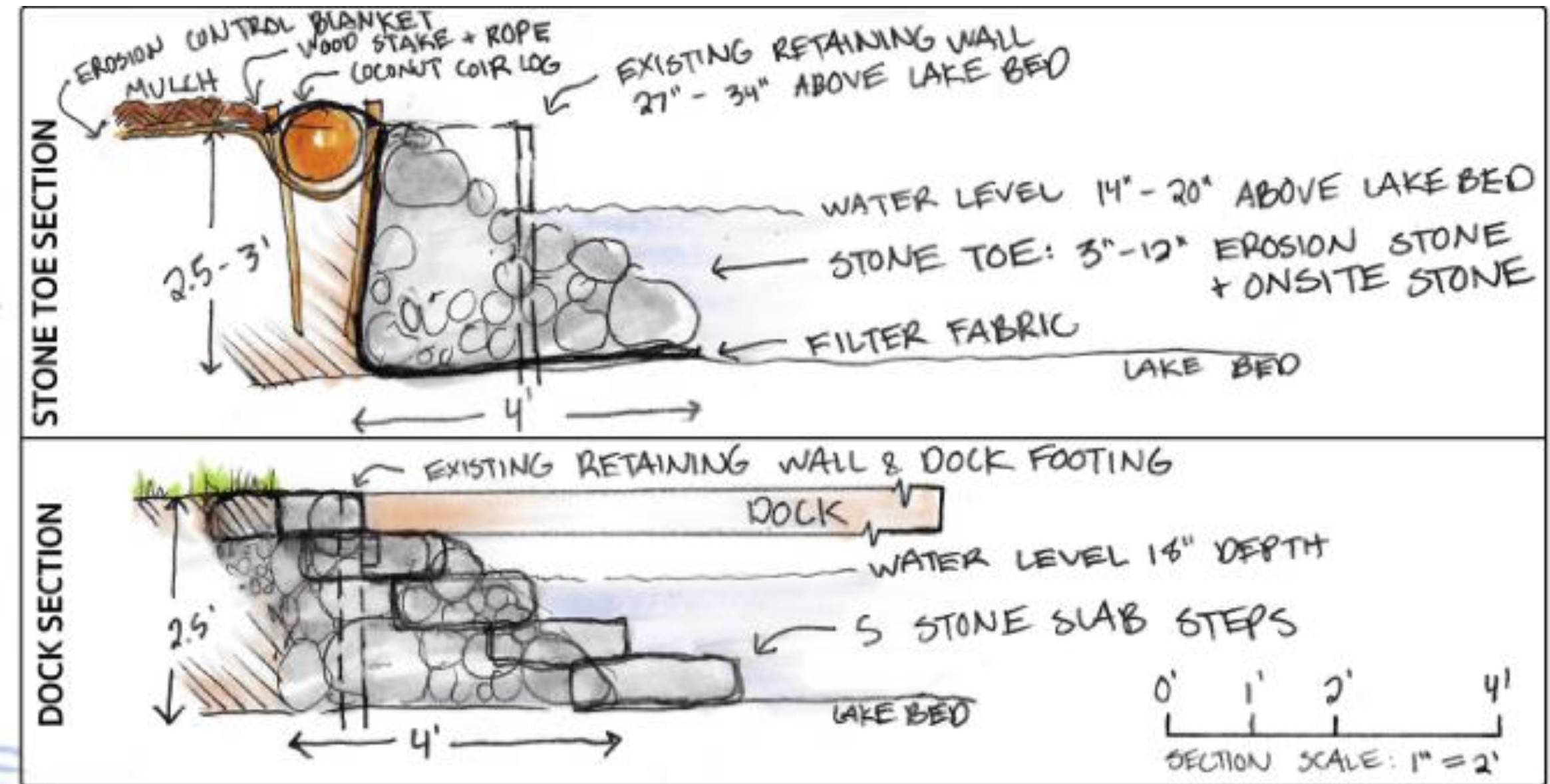
# SITE PLAN: Shoreline Restoration & Bio- engineering



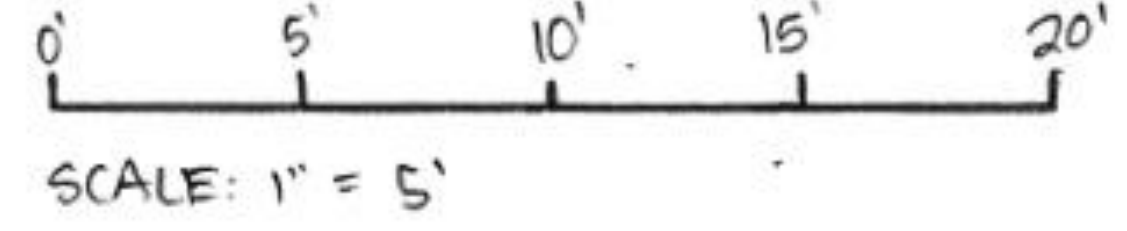
Precedent Image of stone toe with about 6" to 12" stone



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**SITE PLAN:**  
Retaining Wall Removal &  
Shoreland Restoration

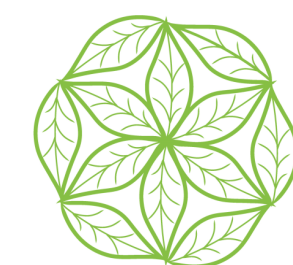


**PLANTED BUFFER AREA**  
TOPSOIL, EROSION CONTROL MATTING  
CONTAINER SHRUBS + SMALL AMOUNT COMPOST,  
MULCH, SEEDED WITH CLOVER.  
ALLOW TO NATURALIZE!

# Remove retaining wall, build stone toe



Nonwoven geotextile filter fabric



# stone toe, erosion control



Photo: Emily Finnegan



Washed 12" minus erosion stone + on-site rounded rock

Topsoil, Erosion Control Matting/Blankets (ECB) (SC 150BN),  
Coconut coir logs (12" diameter x 10' long)



# Plant!



Native Shrub Containers, Spot Compost, Mulch, Red Clover Seed



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# 4. Case study: Lake DuNmore, Salisbury



Before



After

**Project Collaborators:** LaPete Excavation Contractor, LLC,  
Restless Native, LLC



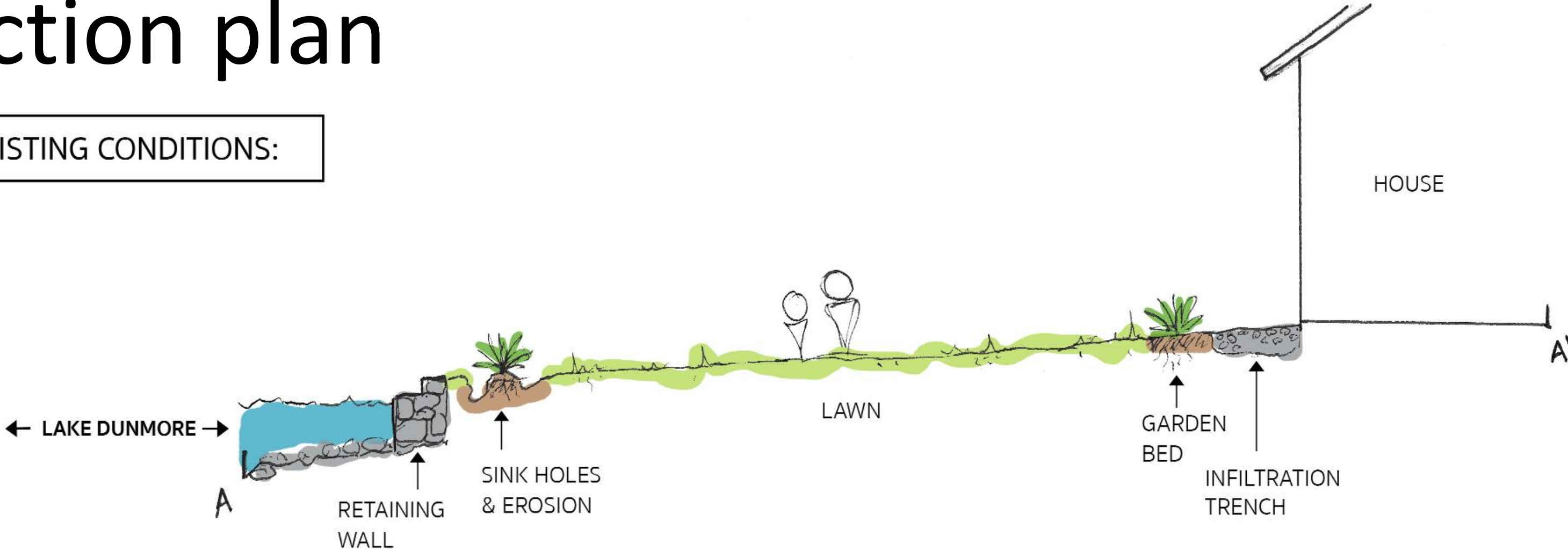
# Failing retaining wall, sink holes, erosion



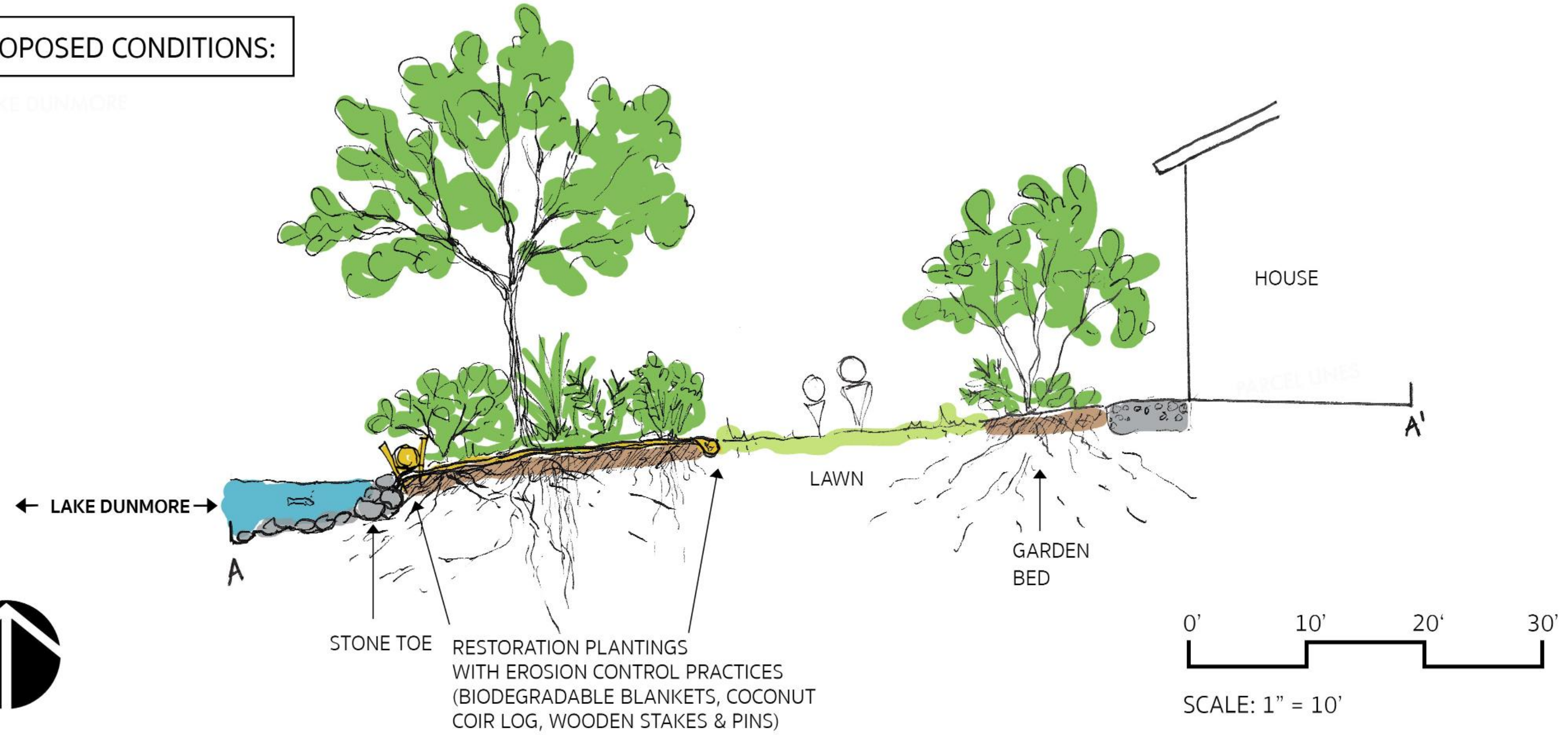
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# Section plan

EXISTING CONDITIONS:



PROPOSED CONDITIONS:



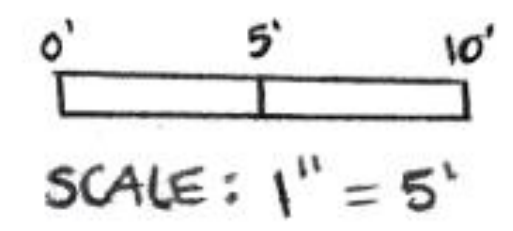
SECTION VIEW



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# PLANTING PLAN



# Remove retaining wall, Regrade, Stone Toe



On-site stone, Erosion Control Matting/Blankets (ECB) (SC150BN), Coconut coir logs (12" diameter x 10' long)

# Fall: Erosion control

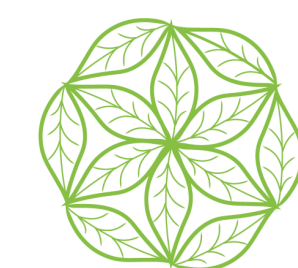




spring: Plant!



B&b Red Maples, Shrub & Perennial Containers, Low-P Compost, Mulch



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# Year 1



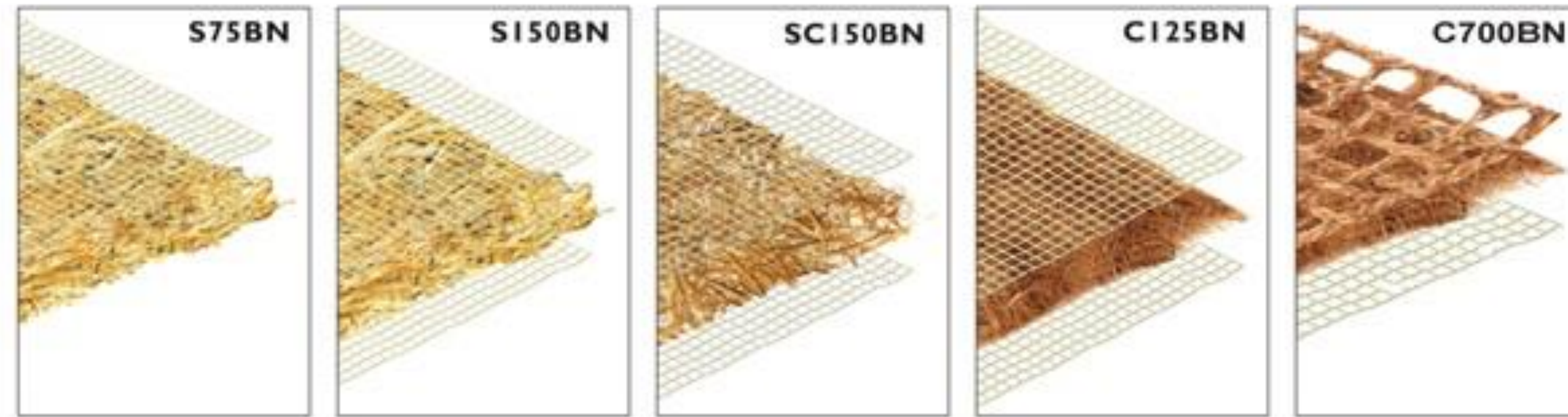
# Year 1



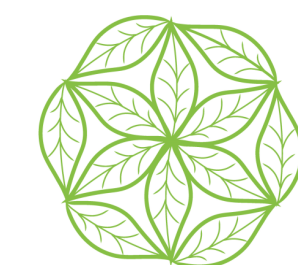
# Biodegradable Erosion COntrol Materials



## BioNet



- ▶ Natural fiber *only*
- ▶ **No** photo-degradable plastics - save the turtles!
- ▶ Coconut coir, straw, jute, manila, sisal, hemp



# Further resources

## Vermont Bioengineering Project Tour

Scroll down to explore a series of bioengineering practices installed across Vermont and to see before and after photos.

Last Updated April 1, 2022



VT DEC Lake Wise  
Watershed Consulting Associates, LLC



Vegetated Buffers



Slope Regrading



Fiber Coir Rolls



Stone Toe



Live Stakes



Encapsulated Soil Lifts



Live Crib Wall

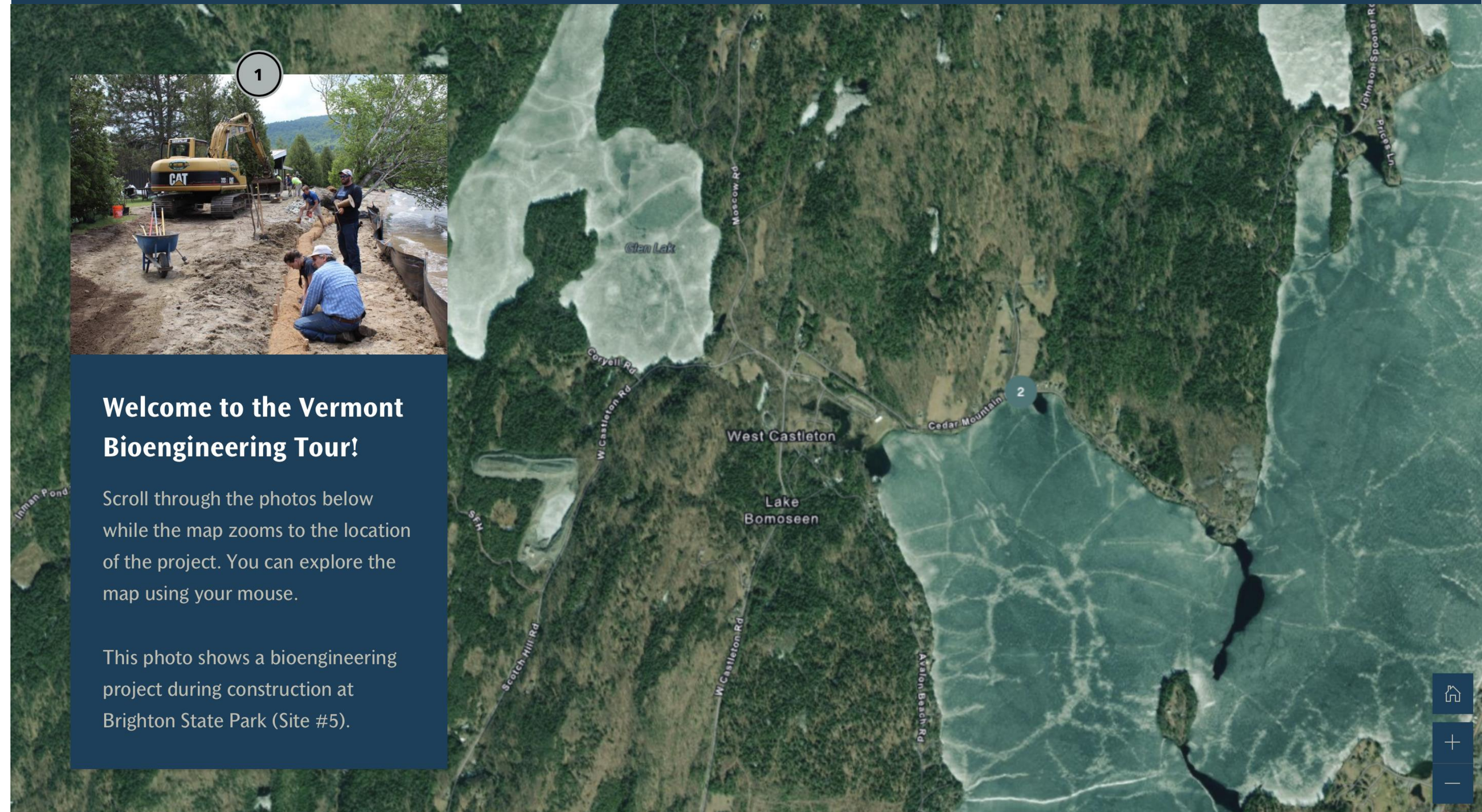
Examples of Bioengineering practices



### Welcome to the Vermont Bioengineering Tour!

Scroll through the photos below while the map zooms to the location of the project. You can explore the map using your mouse.

This photo shows a bioengineering project during construction at Brighton State Park (Site #5).



# Further resources

## Vermont Bioengineering Manual

A Technical Manual for Lakeshore Contractors and Homeowners



Vermont Agency of Natural Resources - January 2022



### Lake Wise Info Sheet



#### Shoreland Best Management Practices for Lake-friendly Living.

##### Benefits

- Water Quality
- Wildlife Habitat
- Prevents Erosion
- Slow, Spread, Sink Stormwater
- Visual Appeal
- Low Cost
- Low Maintenance
- Small Spaces
- Protection & Resiliency

VT DEC recommended restoration practices

##### Related Info Sheets:

- Lakeshore Buffers
- Restore Natural Plant Communities
- Beaches & Recreation Areas



## BIOENGINEERING

Nature-based solutions for living shorelands



##### Description.

Bioengineering uses native plants, biodegradable products, and other natural materials to stabilize shorelands, prevent erosion, protect property, and support healthy lake ecosystems. It is often referred to as "soft-scape engineering," living shoreland restoration, or nature-based solutions. A suite of methods mimic naturally stable shorelines by creating vegetated lakeshore banks and a stabilized bank toe.

##### Applicability.

Bioengineering practices can be used in place of hardscaped lakeshore stabilization such as retaining walls and rip-rap. Hardscaping is typically much more expensive, requires more upkeep, and has harmful impacts to lake health and habitat. It creates a barrier for wildlife, causes scouring of the lake bed, and erosion along the shore.

Bioengineering can protect your property from waves, ice push, erosion, and provide the same stabilization benefits as hardscaping while also enhancing ecological benefits, such as wildlife habitat, stormwater filtration, lake resiliency, and aesthetics.

##### Cost comparison.

Cost	Stabilization method
\$	Fiber coir roll Live stakes & fascines
\$\$	Slope regrading Stone toe
\$\$\$	Encapsulated soil lifts Live crib wall
\$\$\$\$	Retaining walls & other hardscaping

The cost of bioengineering is site and project dependent, but typically much less than hardscaping in the short and long-term.

##### Bioengineering practices are solutions for the following shoreland conditions:

- Unstable or eroding shoreline
- Vegetation has been cleared
- Failing retaining wall or rip rap
- Areas of heavy use & soil compaction
- Upland erosion and runoff into lake

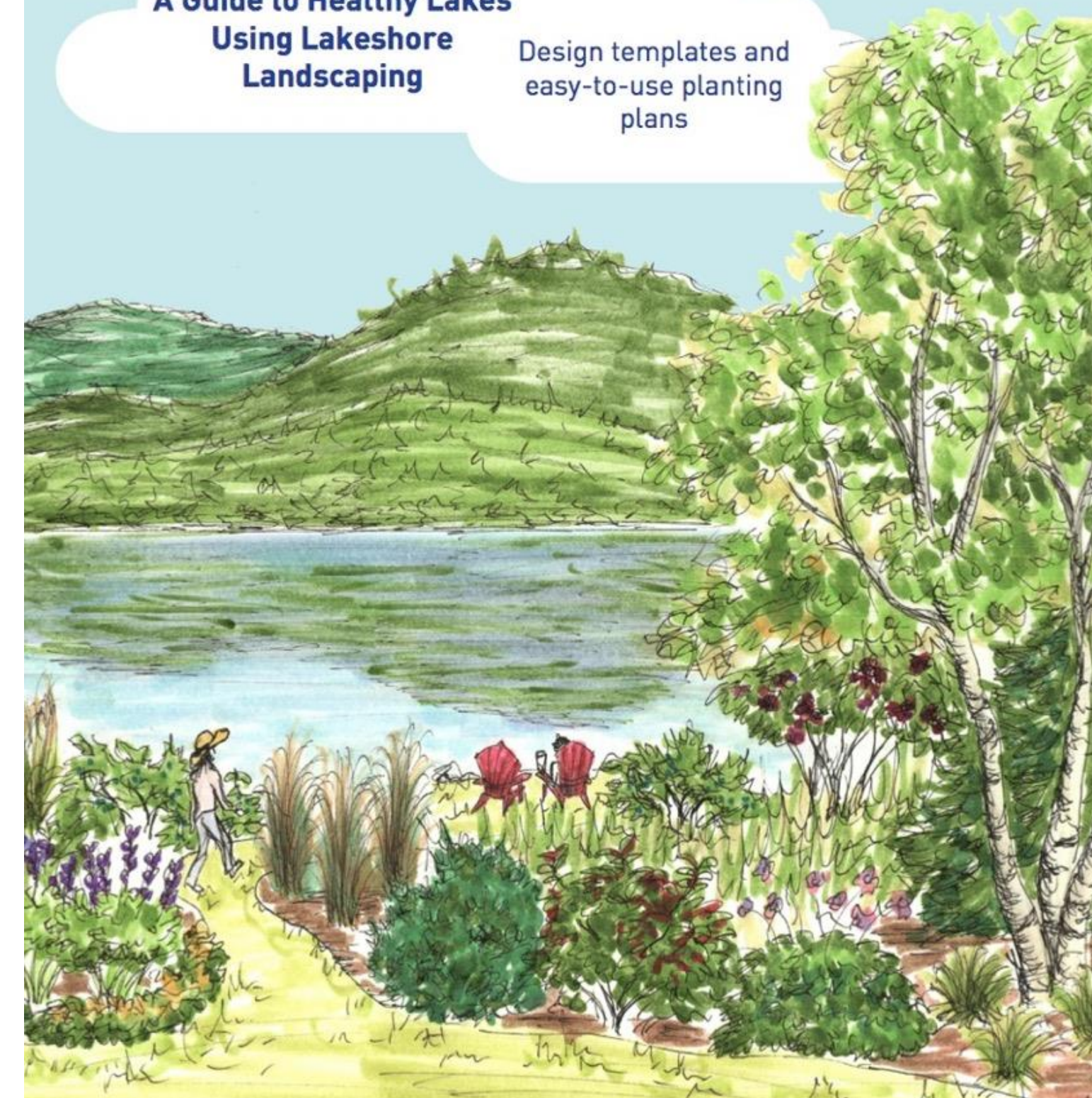
The practices range from very simple and inexpensive to complex and more costly. Many factors such as site conditions, space availability, location of structures, lake levels, lake shape, water depth, and erosive energy of waves need to be considered when selecting the proper practices.



Graphics by Greenleaf Design, LLC

## A Guide to Healthy Lakes Using Lakeshore Landscaping

Design templates and easy-to-use planting plans



### The Federation of Vermont Lakes and Ponds - FOVLAP

Research, design, graphics, and layout by Holly Greenleaf and Gavin Zeitz.  
Project Coordinator: Judy Davis. Landscape Design Coordinator: Stephanie Hurley.

Thank You!!!  
Questions?

Contact:  
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[hollygreenleaf.com](http://hollygreenleaf.com)



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