

**Nature-Based Solutions
for Streambank Armoring**

**Virginia Rail Trail Case
Study**

Adam Pierce, CPESC
Engineering Business Manager

September 16, 2025
STGEC 2025


1

Content

- 01 Nature-Based Solutions Advancement
- 02 USACE and FEMA
- 03 Engineered Earth Armoring System
- 04 Engineered Wrap-Face Vegetated System
- 05 VA Rail Trail Case Study

SOLMAX


2




**Nature-Based
Low Carbon
Solutions
Advancement**

3

Nature-Based Solutions Advancement
Water Resources Development Act 2020



- Dec. 2020 - Biennial water infrastructure bill passed
- Carried out by USACE
- Improves U.S. water resources infrastructure
- Builds resilient infrastructure
 - Reaffirms the commitment to greater use of natural and nature-based projects by ensuring natural alternatives are fully evaluated by the Corps and are provided the same cost-share as structural alternatives.
 - WRDA 2020 also clarifies that natural and nature-based projects are eligible under the Corps' continuing authorities programs.


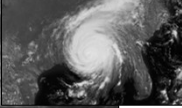


US Army Corps
of Engineers

SOLMAX

4

2005 Hurricane Katrina Levee Overtopping





Eroded Levee from Hurricanes Katrina and Rita

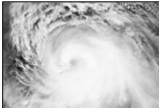
SOLMAX

5

LA DOTD Penn Levee - 2008
Reinforced Vegetation w/ HPTRMs & Engineered Earth Anchors



Installation - April 12, 2008
Loading south along Penn Levee




Hurricane Ike
Storm Surge Begins - Sept. 13, 2008 - 3:17 PM
First signs of overtopping the levee

- Largest Atlantic hurricane ever recorded with higher destructive potential than Katrina
- 70% larger than average hurricane
- 3rd costliest storm in US history - \$31.5 billion in damage
- Hits The Penn Levee within approximately 5 weeks of initial vegetation


SOLMAX

6


LA DOTD Penn Levee
2008 Hurricane Ike Overtopping



The Assessment - October 14, 2008
HPTRM tensile strength holds up to debris loading
Erosion resisted from hydraulic forces



Tensile Strength
Important Debris Loading



The Recovery - June 22, 2009
Revegetation along the Penn Levee

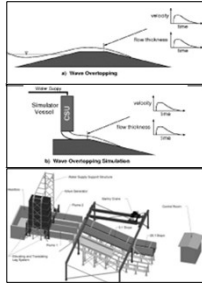

SOLMAX

7

Design Criteria
Hydraulic Testing - USACE

USACE commissioned Colorado State University (CSU) to erect a full-scale wave overtopping simulator



- Apparatus applied Dutch mobile wave overtopping simulator design to a full-scale levee section
- Designed to test erosion resistance of alternative armoring materials for 500-yr Hurricane and Storm Damage Risk Reduction System (HSDRRS) overtopping conditions

SOLMAX

8

USACE Hydraulic Stress Testing
Colorado State University - Wave Overtopping - 2014

SOLMAX

9

USACE New Orleans & Omaha Districts Levee Armoring

New Orleans District Levee Armoring - 2020
HPTBM + Engineered Earth Anchors for Wave Overlapping

Omaha District Missouri River Levee Armoring - 2022
HPTBM + Engineered Earth Anchors for Riverside Protection

SOLMAX

10

Nature-Based Solutions Advancement FEMA BRIC FY2021

- BRIC Technical Criterion 3 awards additional points for the incorporation of **Nature-Based Solutions (10 points)**
 - Support for new technology for hazard mitigation
 - Incentivize projects with innovative and/or green solutions
 - Incentivize use of materials made within the U.S.

Building Resilient Infrastructure & Communities (BRIC)

Community Lifelines

FEMA

SOLMAX

11

Nature-Based Solutions Advancement + Carbon Reduction FEMA BRIC FY2022

FEMA Fact Sheet:

Notice of Funding Opportunity for Fiscal Year 2022 Building Resilient Infrastructure and Communities Program

FEMA provides federal funds for the Building Resilient Infrastructure and Communities (BRIC) grant program to state, local, tribal and territorial governments for hazard mitigation activities, including capacity and capability activity types and hazard mitigation projects. For Fiscal Year (FY) 2022, FEMA will distribute up to \$2.295 billion for the BRIC program.

The FY2022 BRIC program's activities are to:

- Incentivize natural hazard risk reduction activities that mitigate risk to public infrastructure and disadvantaged communities, as referenced in [Executive Order 14176](#) - Tackling the Climate Crisis at Home and Abroad
- Accelerate nature-based solutions, including but not limited to coastal resiliency
- Enhance climate resilience and adaptation
- Increase funding for the adoption and enforcement of the latest published editions of building codes
- Encourage hazard mitigation projects that meet multiple program priorities

FEMA

SOLMAX

12

Nature-Based Solutions Advancement FEMA BRIC

- Mitigation Action Portfolio (MAP) 2023
- Nature-Based Projects Included
 - Oyster Lake Outfall, FL
 - Atlanta Airport Slope, GA
 - Lower Montoya Arroyo, NM
 - USACE Engineer Research Development Center Vicksburg, MS
 - Murielita Creek Flood Control, CA

Hazard Mitigation Assistance
Mitigation Action Portfolio
FEMA
October 2023

SOLMAX

13

FEMA BRIC Mitigation Action Portfolio Oyster Lake Outfall, FL

HPTBM and Earth Anchors

Soil Fill + Vegetation

Pool Construction - January 2020

SOLMAX

14

Materials and Application

SOLMAX

15

Reinforces Vegetation

Road Reinforcement Stem Reinforcement

EDGEWOOD MIDDLE SCHOOL, Mount Airy, NC - 2019

YERBA BUENA ISLAND SLOPE STABILIZATION, San Francisco, CA - 2021

MANDARINA FLOOD CONTROL CHANNEL, Marietta, AZ - 2022

DES MOINES RIVER, Palo Alto, CA, 18 - 2020

USACE NEW ORLEANS LEVEE SYSTEM, New Orleans, LA - 2022

SOLMAX

16

High Performance Turf Reinforcement Mat Second Generation TRM

- Material Construction
 - Homogeneous Woven Polypropylene
- Tensile Strength
 - 4,000 - 3,000 lb/ft
- High UV Stabilization
 - Up to 75-year life if exposed
- Appropriate Applications
 - High Flow Channels
 - Slope Slopes
 - Severe Non-Hydraulic Stresses
 - FHWA & USACE Recommended for Heavy Mowing

SOLMAX

17

Design Criteria Non-Hydraulic Stresses

- Heavy Mowing Activity
- Maintenance Loading
- Debris Loading
- Animal Loading
- Wildlife Burrowing

SOLMAX

18

Design Criteria

Durability UV Resistance

- Ultraviolet (UV) Resistance
- Additives incorporated to increase stability of UV degradation
- ASTM D-4365 Xenon Arc testing
 - Accelerated exposure
 - Changes in temperature and moisture
 - up to and over 10,000 hours (417 days)
 - Measure retained tensile strength
- Correlate lab test results to actual field performance

USA Max Avg. Annual Solar Radiation
2,200 kWh/m² = 21.20 MJ/m²-day

Average annual sun, period 1989-2013
© 2014 SOLMAX

19

Engineered Earth Anchor System

HPTRM + Engineered Earth Anchors

Comprised of Three Components:

1. High Performance Turf Reinforcement Mat (HPTRM)
2. Securing Pins
3. Engineered Earth Anchors (EEA) or Percussion Driver Anchor (PDA)

© SOLMAX

20

Engineered Earth Anchor System

Engineered Earth Anchor (EEA) or Percussion Driver Anchor (PDA)

For Erosion Control

For Surficial Slope Stability

Type B1 Anchor:

- 3-5 ft length
- 200-300 lb. pullout resistance

Type B2 Anchor:

- 6-9 ft length
- 800-1,500 lb. pullout resistance

Type B3 Anchor:

- 6-9 ft length
- 1,000-2,000 lb. pullout resistance

© SOLMAX

21

Engineered Earth Anchor System

How the System Works

- Engineered Earth Anchors are designed to provide resistance to shear and lateral forces, and embedded beyond the predicted plane of failure
- HPTRM distributes loads amongst anchors while providing a continuous compressive cover
- HPTRM is also permeable for pore pressure relief and promotes vegetative establishment

© SOLMAX

22

Engineered Wrap-Face Vegetated System

Typical Section

For Constructing Reinforced-Earth Walls and Steepened Slopes

© SOLMAX

23

Engineered Wrap-Face Vegetated System

System Components

© SOLMAX

24

Engineered Wrap-Face Vegetated System

Engineering Design Benefits

- Vegetated BMP
 - Improved water quality
 - Permeable vegetated wall face improves vegetation establishment
- Height/Access
 - 14-24" (max.)
 - 7-ft height no primary geogrid reinforcement needed
 - For higher walls/slopes use primary geogrid reinforcement
- Interlocked bracing:
 - Braces pre-installed at the manufacturing plant
 - Eliminates the need for temporary metal bracing or forms
 - Environmentally inert and not susceptible to corrosion
- Flexibility of system allows for:
 - Curves to be incorporated
 - On-site wall to be used for utility
- System is easily transported
- Available in Green or Tan

© SOLMAX

25

Jackson River Trail Case Study

© SOLMAX

26

Jackson River Trail

Streambank Stabilization - Hot Springs, VA

Application: Streambank Stabilization
Location: Hot Springs, VA
Owner: Virginia DOT
Engineer: Hurt & Proffitt
Contractor: Combs Land Solutions
Roanoke, Virginia

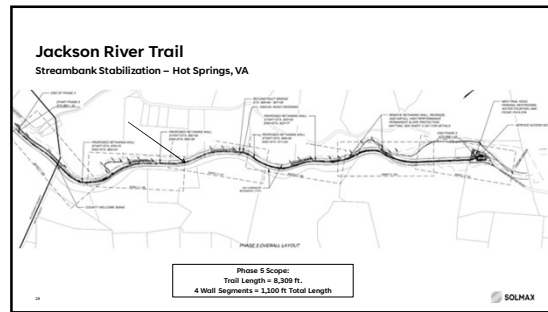
Installed: 2024

Materials:

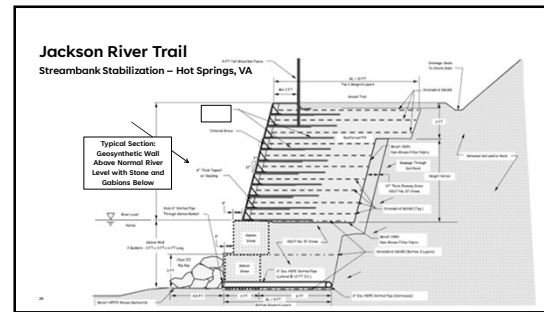
1. Engineered Earth Anchor System
2. Engineered Wrap-Face Vegetated Solution
 - 14-24" Batter
 - 10 Feet High
 - Native Vegetation

© SOLMAX

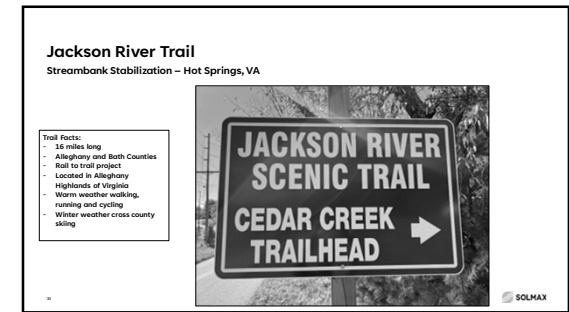
27



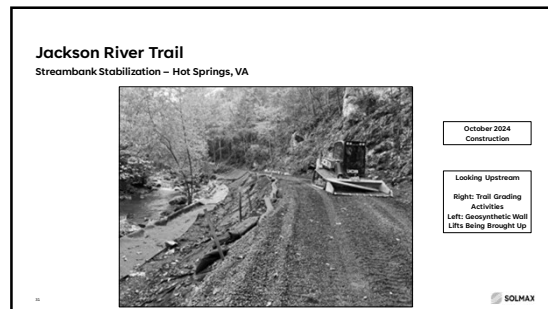
28



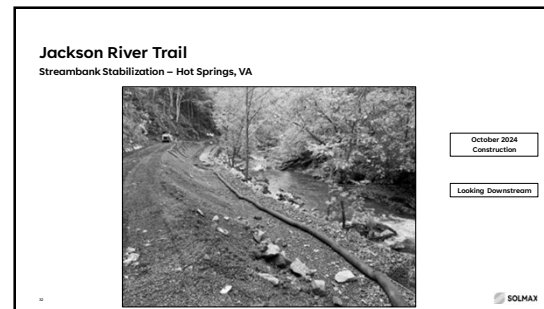
29



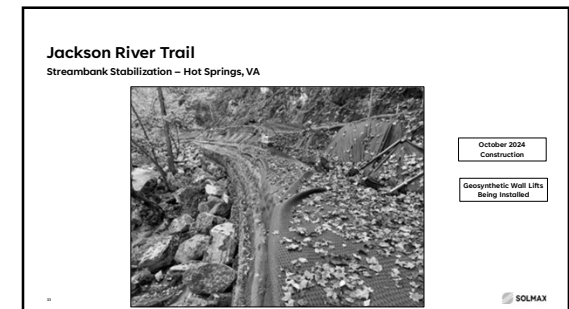
30



31



32



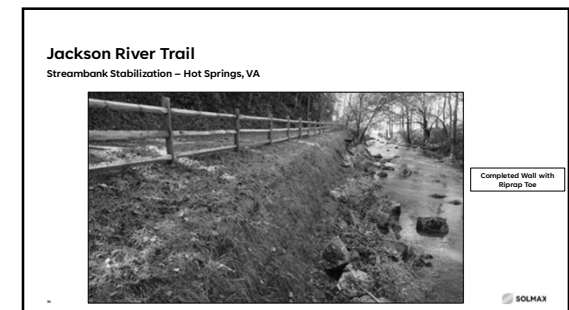
33



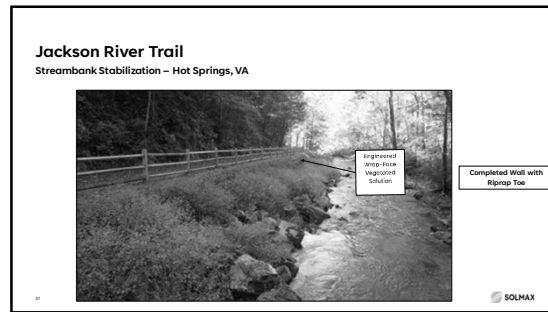
34



35



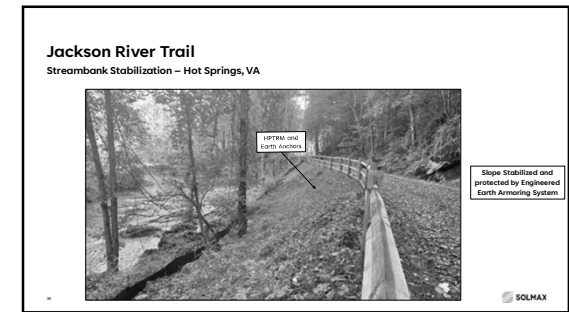
36



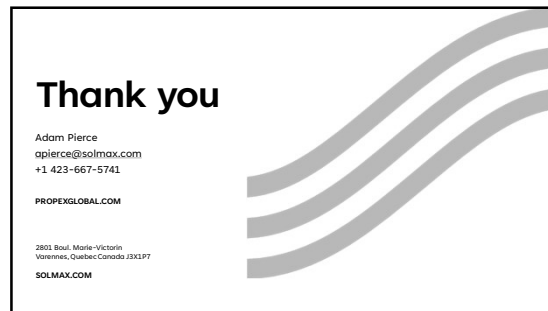
37



38



39



40