DEMONSTRATION PROJECTS

DEMONSTRATION PROJECTS

Project Number	Project Proposals
DEMO-01	Artificial Seagrass Bed Shoreline Protection & Sediment Trapping
DEMO-02	Use of Bioengineering Techniques to Strengthen Previously Stabilized Shorelines & Banks
DEMO-03	Stabilized Red Mud (SRM) Diversion Berms
DEMO-04	Stabilized Soil Shorelines

DEMO-01

Artificial Seagrass Bed Shoreline Protection & Sediment Trapping

DEMO-02

Use of Bioengineering Techniques to Strengthen Previously Stabilized Shorelines & Banks

PPL23 DEMONSTRATION PROJECT NOMINEE FACT SHEET
February 5, 2013

Demonstration Project Name:
Use of Bioengineering Techniques to Strengthen Previously Stabilized Shorelines and Banks

Coast 2050 Strategy(ies):

- Protect shorelines,
- Maintain land bridges,
- Maintain shoreline integrity.

Potential Demonstration Project Location(s):
Coastwide

Problem:
What problem will the demonstration project try to solve?
The demonstration project would use natural materials to enhance the ability of protected and natural shoreline to absorb wave energy and attempt to protect existing shoreline features, using the abilities of nature to heal itself. The demonstration project would help reduce shoreline retreat along bay and lake areas that have experienced excessive amounts of erosion and would also have the intent to offset increased rates of land loss to wetlands that become exposed due the loss of protective shorelines features.

What evidence is there for the nature and scope of the problem in the project area?
Historically Louisiana's coastal shoreline, bays, and lake rims have experience high levels of retreat and land loss. The approach to repairing these areas have utilized heavy, hard engineering methods that eventually settle into the substrate, which has not achieved the goal and even presented additional hazards. Repair of these areas using sturdy but lighter, living materials and non-living natural materials will encourage self-repair with the goal of enhancing the native plant community. With no specific area identified it is difficult to quantify the exact amount of that loss or retreat the project would attempt to offset. Shoreline erosion rates have been measured in excess of 30 feet per year in areas across the Louisiana coast. The need for stabilization in critical areas was noted in all four Coast 2050 regions.

Goals:
What does the demonstration project hope to accomplish?
The proposed demonstration project would stabilize existing shoreline features and attenuate shoreline retreat and potentially enhance interior marshes and also provide a natural substrate for plant propagation and an accretion platform. The methodology would re-establish/jump start the plant community whose root systems forms the webbing that strengthens rock stabilized banks and shorelines as well as natural sediments and peat at and around the shorelines. Surface portions of the plants absorb wave and precipitation energy that would otherwise impact surface soils. Finally, identifying just the right woody plants that are most efficient at performing these services is an essential goal, so that parishes and others who wish to inexpensively stabilize soils will have a palette of species with which to work.

Proposed Solution:
Describe demonstration project features in as much detail as possible.
Use of Bioengineering Techniques (using mostly live cuttings of unrooted woody plants) to Strengthen Previously Stabilized Shorelines and Banks project is a multi-faceted shoreline protection and restoration demonstration effort to provide land bridge and marsh protection, restoration, and enhancement system that would absorb and deflect wave energy, protect and enhance vegetation, protect and create emergent marsh and woody shrub/forested wetlands, trap sediment and provide nursery, foraging and escape cover habitat for aquatic and terrestrial species.

1. The species and forms of woody plants used as stabilization and protection materials have a variety of application possibilities that can be adjusted to best suit the problem area to restore and enhance the strength of shorelines, land bridges and marshes in different types of coastal environments.
2. We may use coir material to wrap unvegetated soils/slopes but the intent is to plant slopes that are already stabilized by rock OR not stabilized to observe the performance of established woody growth. We will establish slopes with a few identified fast-growing species and then within 2 years live stake areas of the bank with other species where the first attempt was not successful, or where there is an opportunity to introduce diversity in the plant community. After a slope is covered by fast growing woody vegetation, like *Salix nigra* (black willow) we will go back to re-vegetate with a more slow growing species, like *Taxodium* or *Cephalanthus* or another appropriate species with characteristics that would favor strong and extensive rooting ability in that particular hydrologic setting. When used as a method of shoreline enhancement; it is cheaper than rock and could be considered a compromise between "hard" and "soft" shoreline protection methods.
3. A staggered terrace-like orientation can break up wave action, reducing turbidity and allow sediment time to settle, potentially accreting and creating emergent marsh.
4. The use of native woody materials obtained from naturally growing vegetation close to the restoration site allows the use of native plants and provides a relatively inexpensive source of plant materials.
5. We do not anticipate the need for building a rock-protected slope or shoreline. We anticipate using rock protected shorelines/banks and unprotected shorelines and banks to plant with woody plant cuttings (stakes, whips, poles, mattressing) and compare these to rock protected and unprotected banks that have not been planted.

The demonstration would include the selection of 4 diverse application sites (rock with plantings, rock without plantings, natural soils with plantings, natural soils without plantings) for treatment. Each treatment would include 3 replicate 1000-foot sections for a total project installation of 12,000 linear feet. Project effectiveness would be monitored and evaluated after construction according to the CWPPRA workgroups' recommendation for this product in Phase 0. The conceptual treatment is shown in the attached PowerPoint presentation.

Project Benefits:
Describe demonstration project benefits in as much detail as possible.
The proposed project would:

1. Absorb and deflect wave energy;
2. Strengthen rock protected slopes and shorelines;
3. Protect and enhance existing or planted shoreline vegetation;
4. Allow ingress and egress of aquatic species;
5. Collect sediment by reducing wave energy;
6. Protect and stabilize land bridges;
7. Reduce interior marsh loss.

Project Costs:
The estimated construction cost including 25% contingency is $1,685,109.

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PPL 23 Demonstration Project Nominee Fact Sheet
January 30, 31 2013

Demo Project Name: Use of Bioengineering Techniques to Strengthen Previously Stabilized Shorelines and Banks

Revision of PPL 22 Bioengineering of Banks and Shorelines Demo

- Presented in 2011, 2012
- Supported by USEPA
- Revisions after discussions with NRCS, and Researchers at University of Louisiana

Stated Requirements for Demo Projects

- **Innovative**-Not routine in LA but not experimental
- **Applicability or Transferability** – Freshwater and intermediate, and possibly estuarine locations
- **Potential Cost-Effectiveness** – Used as a means to improve the longevity of rock protected shorelines, but ability to exibit cost effectiveness in Louisiana needs demonstration
- **Potential Environmental Benefits** – Above and Beyond
- **Recognized Need for the Information to be Acquired:** Bioengineering techniques have not been widely applied in the Southeast
- **Potential for Technological Advancement** –if proven successful, these techniques could improve current practices.

Definitions

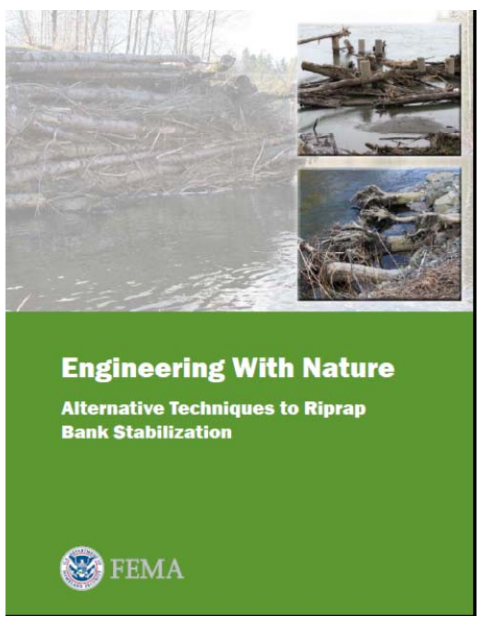
Soil Bioengineering: A system of living plant materials used as structural components. Live hardwood material (usually dormant) of woody shrub and tree species used to repair slope failures and to increase slope stability. The live hardwood materials serve as primary structural components, drain and barriers to earth movement.(NRCS)

Rickson & Morgan (1990) **Bioengineering** refers to the use of any form of vegetation, whether a single plant or a collection of plants as an engineering material, providing a quantifiable characteristic and behavior.

Biotechnical Engineering refers to techniques where vegetation is combined with inert structures such as crib walls (or riprap slopes), so combining the structural benefits of both the vegetative and non-vegetative components of the scheme

Questions

- Can vegetation be used to alleviate landscape instability?
- Is it possible that a more holistic approach could be the answer to a multidisciplinary question?
- Can successful application of biotechnical methods elsewhere in the world be adapted to Louisiana & it's dire circumstances?
- Can broadly applicable questions be answered through this demo project?



Riprap, or hard armoring, is the traditional response to controlling and minimizing erosion along shorelines or riverbanks. As demonstrated by past multiple disasters in Washington State, the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) has provided funding assistance for the repair to these riprap facilities.*[1] The very nature of having to repair these facilities counters the popular engineering belief that riprap is the best solution for mitigating stream bank erosion.

FEMA

US Army Corps of Engineers
Waterways Experiment Station

Technical Report EL-97-8
April 1997

Environmental Impact Research Program

Bioengineering for Streambank Erosion Control

Report 1
Guidelines

by Hollis H. Allen, James R. Leech

WES

Approved For Public Release; Distribution Is Unlimited.

eirp

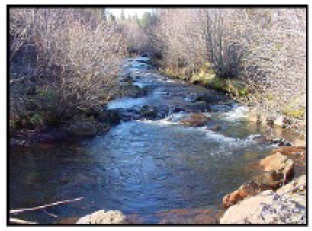
Prepared for Headquarters, U.S. Army Corps of Engineers

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

Part 654
National Engineering Handbook

Stream Restoration Design



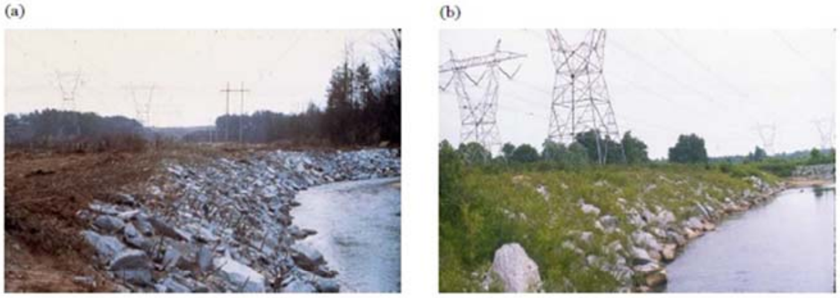
Technical
Supplement 14I

Streambank Soil Bioengineering

Figure TS14I–23 Installation of dormant posts with stinger

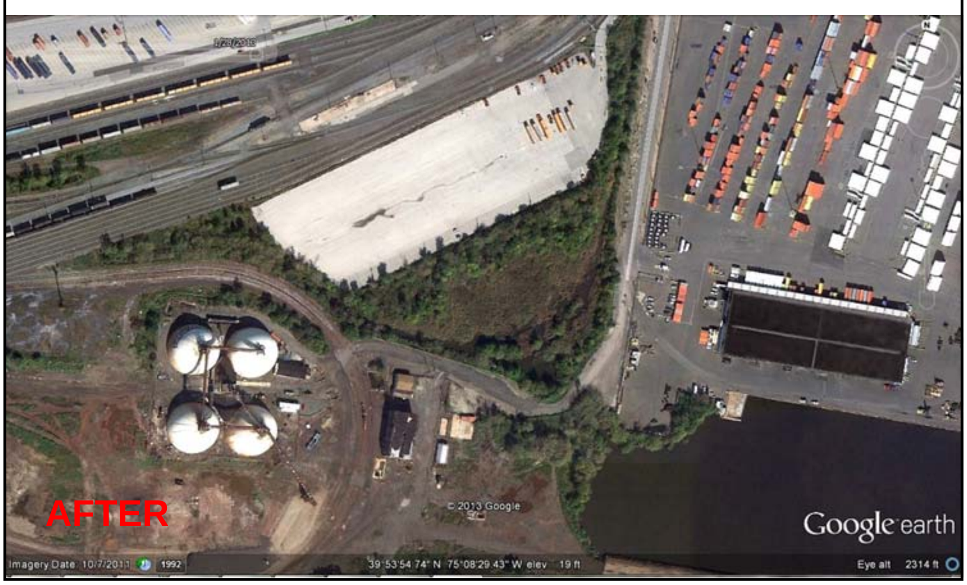
Figure TS14I–25 (a) Completed installation of joint planting; (b) Early in first growing season (*Photo courtesy of Robbin B. Sotir & Associates, Inc.*)

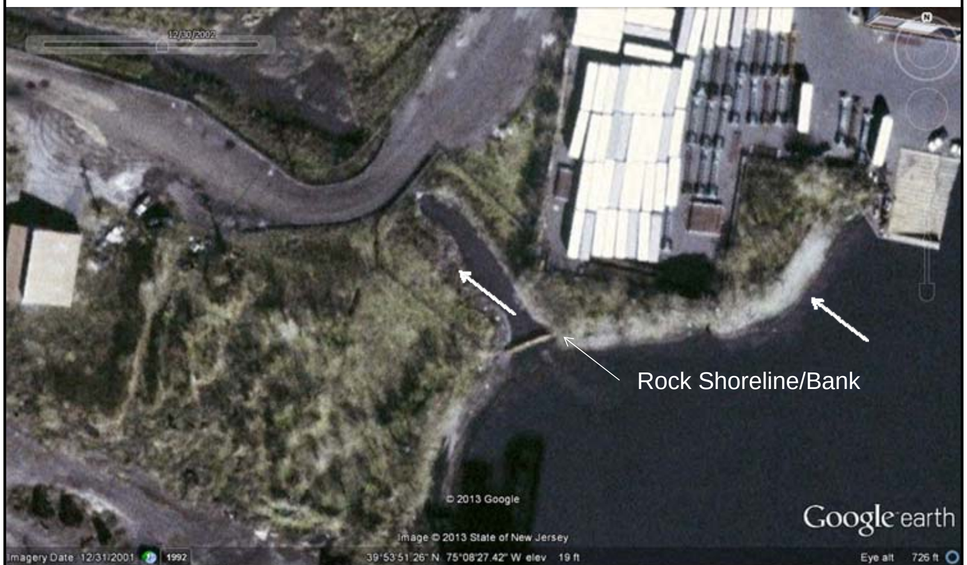
(a) (b)

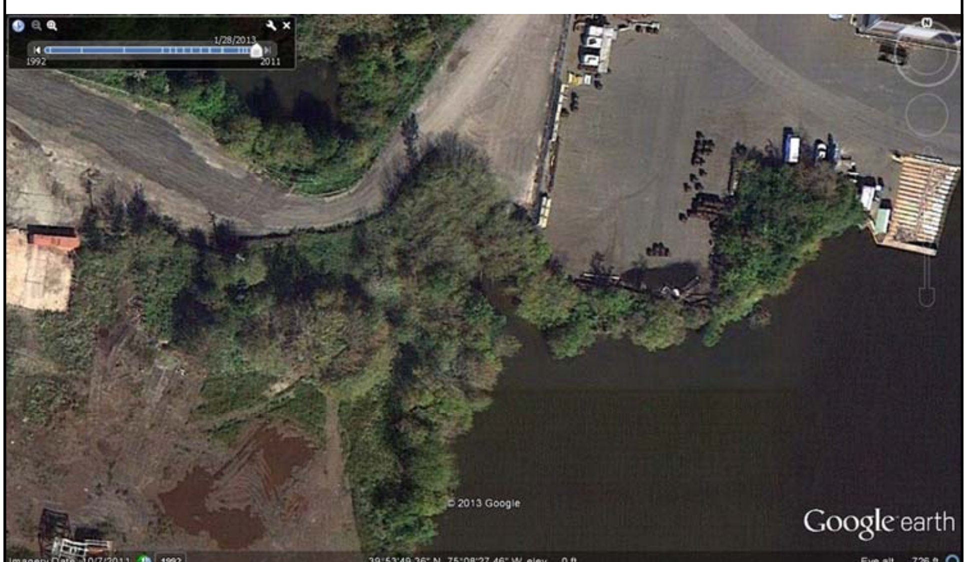


RESTORE TIDAL RIVER FLOW TO FILLED WETLAND – PRE-CONSTRUCTION for MITIGATION FOR THE CSX Intermodal Facility in the Port of Philadelphia

Live stake and rock riprap joint planting used extensively in this successful mitigation wetland creation site.




Rock Shoreline/Bank
© 2013 Google
Image © 2013 State of New Jersey
Google earth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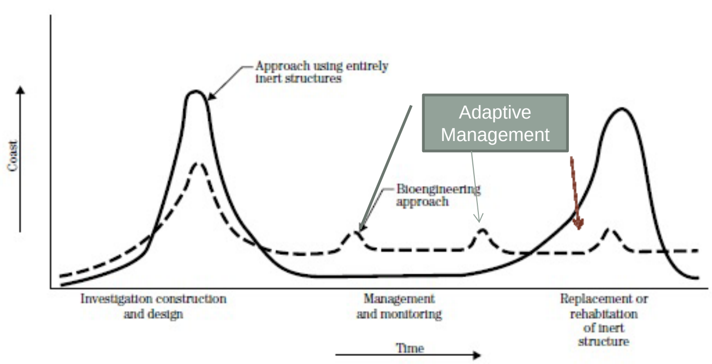
Current Benefit to Achieve: Detail

- Vegetation is self regenerating, dynamic, adaptable and therefore more sustainable over time
- Woody vegetation biomass absorbs wave and precipitation energy better than herbaceous plants
- Woody vegetation root network increases the tensile strength of the rock and soils
- Native woody vegetation provides habitat and allochthanous materials for invertebrates
- Native woody vegetation develops methods to adapt to their surroundings, developing methods to stay at optimal elevations—buttressing, surface roots

Figure TS14I–49 Illustration of expenditure profiles for soil bioengineering and inert structures



(210–VI–NEH, August 2007) TS14I–75

NRCS Document
Graph Edited

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Materials Program

Plant Materials Technical Note - No. 1
January 2007

Plant Species with Rooting Ability from Live Hardwood Materials for use in Soil Bioengineering Techniques

Introduction
Choosing the best plant for soil bioengineering techniques can be extremely important. The correct plant will insure the required performance in any slope stabilization project. This Technical Note supports NRCS documents: Engineering Field Manual-Chapters 16 and 18, The Stream Corridor Restoration Handbook, and the National Employee Development Centers Soil Bioengineering course.

How to Use this Technical Note
The list of species is prepared to assist with selecting plants for use in the application of soil bioengineering techniques. The list may also function as a tool to indicate the performance of a species in a specific soil bioengineering technique in a specific region of the country. The Species List is organized alphabetically according to rooting ability of the species.
Table 1: *Species with very good to excellent rooting ability from live hardwood materials*
Table 2: *Species with fair to good rooting ability from live hardwood materials*
Table 3: *Species useful for the Caribbean Area and Hawaii*
Table 4: *Region of Adaptation Codes for Tables 1-3*

Tables 1-3 contain the following information:
- Scientific Name
- Common Name
- Cultivar or Ecotype
- Region of Adaptation
- Rooting Ability
- Soil Bioengineering Technique

Species Lists are not intended as recommendations of plants for specific projects. Consult with your NRCS state specialists for specifications for specific project recommendations.

Table 1: Species with very good to excellent rooting ability from live hardwood materials

Scientific Name	Common Name	Cultivar or Ecotype	Region of Adaptation	Rooting Ability	Soil Bioengineering Technique
Oemleria cerasiformis	Indian plum	local collections	9	very good	fascines, live stakes, brush mattress, brush layering, live cuttings
Populus balsamifera	balsam poplar	local collections	1, 2, 3, 4, 5, 8, 9, O, A	very good	live stakes, poles, live cuttings
Populus balsamifera ssp trichocarpa	black cottonwood	local collections	4, 8, 9, 0, A	very good	live stakes, poles, live cuttings
Populus deltoides	eastern cottonwood	local collections	1, 2, 3, 4, 5, 6, 7	very good	live stakes, poles, live cuttings
Salix alaxensis	feltleaf willow	local collections	A	very good	live stakes, poles, live cuttings
Salix amygdaloides	peachleaf willow	local collections	1, 2, 3, 4, 5, 6, 7, 8, 9	very good	live stakes, poles, posts, live cuttings
Salix barclayi	Barclay's willow	local collections	A	very good	live stakes, poles, posts, live cuttings
Salix boothii	booth willow	local collections	7, 8, 9, 0	excellent	fascines, live stakes, poles, brush mattress, brush layering, live cuttings
Salix brachycarpa	barren ground willow	local collections	A	very good	live stakes, poles, posts, live cuttings
Salix cottetii	dwarf willow	Bankers	Introduced 1, 2, 3	very good	fascines, live stakes, brush mattress, brush layering, live cuttings
Salix discolor	pussy willow	local collections	1, 2, 3, 4, 9	very good	fascines, live stakes, poles, brush layering, live cuttings
Salix drummondiana	Drummond's willow	local collections	7, 8, 9, 0	very good	fascines, live stakes, poles, brush mattress, brush layering, live cuttings
Salix eriocephala	Missouri River willow	local collections	7, 8, 9, 0	very good	fascines, live stakes, poles, brush layering, live cuttings
Salix eriocephala spp. ligulifolia	erect willow	Placer	9, 0*	excellent	fascines, live stakes, poles, brush mattress, brush layering, live cuttings
Salix sessilifolia Nutt.	northwest sandbar willow	Multnomah	9*	excellent	fascines, live stakes, poles, brush mattress, brush layering, live cuttings
Salix sessilifolia Nutt.	northwest sandbar willow	local collections	9	very good	fascines, live stakes, poles, brush mattress, brush layering, live cuttings
Salix geyeriana	Geyer's willow	local collections	7, 8, 9, 0	very good	fascines, live stakes, poles, brush mattress, brush layering, live cuttings
Salix gooddingii	Goodding's willow	local collections	6, 7, 8, 0	very good	live stakes, poles, posts, live cuttings
Salix hookeriana	hooker willow	Clatsop	9, 0*	excellent	fascines, live stakes, poles, brush mattress, brush layering, live cuttings

Current Problem to Address: Big Picture

- Lack of habitat value of current methods of stabilizing shorelines and banks
- Need to stabilize rock and heavy structures from moving/subsiding on organic and unconsolidated soils
- Need to restore habitat value and encourage native plant succession along the shoreline
- Need to strengthen inner “honeycomb” portions of the inner marsh complex for greater resilience against storms forming an inner core “line of defense”
- Improve understanding of the value of bioengineering techniques in Louisiana within habitat types that could potentially greatly benefit with its successful application

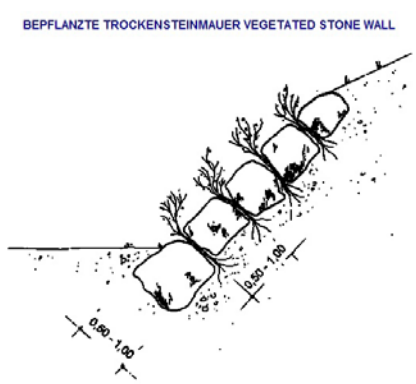
Demo Project Goals

- Increase longevity of rock stabilized shorelines and banks
  - Improve tensile strength of the soil/rock matrix with the deeper root systems of some woody plants
  - Improve cohesiveness of soils with plants that produce broad surface root systems
- Develop list of native tree and shrub species that can be used in future applications
  - Native
  - Forms adventitious roots
  - Roots from cuttings
  - Provides nursery conditions for other native species
  - Estuarine to Freshwater habitats; organic or silty soils

Possible Location

- No location currently selected
- Any location with newly placed or previously placed rock that is currently or potentially experiencing subsidence.
- Shoreline areas recently stabilized with rock in and near Jean LaFitte/Lake Salvador could be used
- Other locations including intermediate habitats, with possible estuarine habitat
- Current or newly completed projects of any type, including toe of levee banks.

Project Features: Rock Joint Planting, Existing Locations



Project Features: Proposed Scenarios

- Use *Salix nigra, Myrica cerifera, Cephalanthus* and later propagules of *Avicennia germinans* and *Taxodium, etc.*
- Utilize NRCS list of plants to select additional plants in the agricultural zone (9)
- Utilize appropriate species currently growing in and near the locations (native/adapted)
- Joint plant existing rock protected shorelines and banks in fresh and intermediate areas
- Plant unprotected peat and soil banks to provide comparisons
- Work closely with research community (U of Louisiana) to monitor success

Monitoring and Comparison for Evaluation of Success

- Number/Types of Locations: Two 1000-foot long previously stabilized areas with history of subsidence, freshwater, intermediate tidal, non-tidal; significant wave action, no wave action; two 100-foot, existing bank or shoreline with no rock stabilization
- Planting methods: Live-stake using the following possible species:

SPECIES	COMMON	Hydrologic Zone
Salix nigra	Black willow	-1 to +2 ft MW
Myrica cerifera	Wax myrtle	0 to +2 MW
Cephalanthus occidentalus	Buttonbush	-1 to +2ftMW

Monitoring and Comparison for Evaluation of Success

- Measure success in various hydrologic zones using the following comparison:
  - Mortality
  - Size
  - % Cover
  - Volunteering Species
  - Sediment depth
  - Root biomass/extent (where possible)

Proposed by: Jane O. Rowan
Normandeau Associates, Inc.
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- Consider the potential benefits to parishes
- Consider the transferability of successful applications already completed in other locations
- Provide for the opportunity to test a technique that has gone untested in the Southeast US
- Adaptive Management is KEY
- Revegetate to strengthen plant community and resilience of the wetland system to stress and disturbance

DEMO-03

Stabilized Red Mud (SRM) Diversion Berms

PPL23 DEMONSTRATION PROJECT
January 31, 2013

Demonstration Project Name: Stabilized Red Mud (SRM) Diversion Berms

Coast 2050 Strategy(ies):
Diversions and Riverine Discharge; Management of Diversion Outfall for Wetland Benefits

Potential Demonstration Project Location(s):
Region 1

Problem:
Salt water intrusion of marshes and/or swamps is exposing thousands of acres of interior pristine Wetlands to severe ecological change. In many occurrences, there are signs indicating loss of the freshwater ecosystem.

There is clear cut evidence that there are many dying swamps and Wetlands prevalent in Southern Louisiana. Two main such wetlands include the Maurepas Swamp and LaBranche Wetlands located within the Pontchartrain Basin. Both are affected by high tide and storm surges.

Goals:
Diversion outfalls should be managed to optimize freshwater, sediment and nutrient input into marshes and/or swamps, while minimizing the impact to wetlands. This strategy would utilize fresh water from rivers to benefit wetland habitats by channeling the fresh water between bermed diversions comprised of stabilized material. Riverine discharges would be introduced directly into wetlands in this manner to re-establish marshes and/or swamps, while improving water quality.

Proposed Solution:
Noranda Alumina, formerly Kaiser Aluminum in Gramercy, Louisiana, is the site of approximately 800-acres of red mud lakes. Current regulations allow Noranda to beneficially use dried red mud for mud lake levees. However, the unit weight of red mud due to the presence of iron oxides, requires a rather large levee footprint to distribute the weight. Red mud stabilized with blended reagents forms a chemical reaction that bonds red mud particles together, consumes up to 32 moles of water in the process, and increases the compressive strength of the material to greater than 20-pounds per square inch.

Noranda is in the process of applying for a Beneficial Use Determination (BUD) with respect to utilizing SRM for applications like bermed diversions. Chemical and geotechnical data have been archived from two demonstration pilot projects, and the data is being submitted to the Louisiana Department of Environmental Quality (LDEQ) along with in-depth assessment of risks.

Once a BUD has been issued (expected by July 2013), SRM can be used in lieu of clay for diversion berms. Although SRM weighs as much as clay soil, SRM gains strength through continual curing, thus allowing for steeper slopes to be constructed to minimize impact to wetlands. SRM has non-dispersive qualities, is low in erodibility, low in permeability, and remains stable even in submersed conditions that are typical of wetlands such as swamps and marsh. SRM is an ideal substitute for imported clay or clay mined from the proposed footprint of a diversion channel. Organic soil stripped in a proposed footprint of a diversion channel can be reused as topsoil cover over SRM to establish vegetative growth, while not having an extremely low flow-line that would require excessive pumping of fresh water into wetlands. The concept of using SRM bermed channels at or just below grade is very similar to how rice farmers irrigate and flood their fields.

SRM is installed much like clay, except that it is generally placed in thicker lifts without use of vibratory compactive effort. Static compaction is the recommended approach to consolidating the SRM.

Project Benefits:
Benefits related to using SRM are:

1. Meets EPA green initiatives;
2. Beneficial use of a by-product;
3. Superior material compared to clay;
4. Lower resistance to erosion;
5. Decreased permeability;
6. Increased strengths (3 to 5 times higher than clay);
7. Can withstand a hurricane storm surge;
8. Its economic value; and
9. Its long-lasing, enhanced structural integrity.

Project Costs:
The estimated construction cost for a segment of SRM diversion berms is less than $2,000,000.

Preparer(s) of documents:
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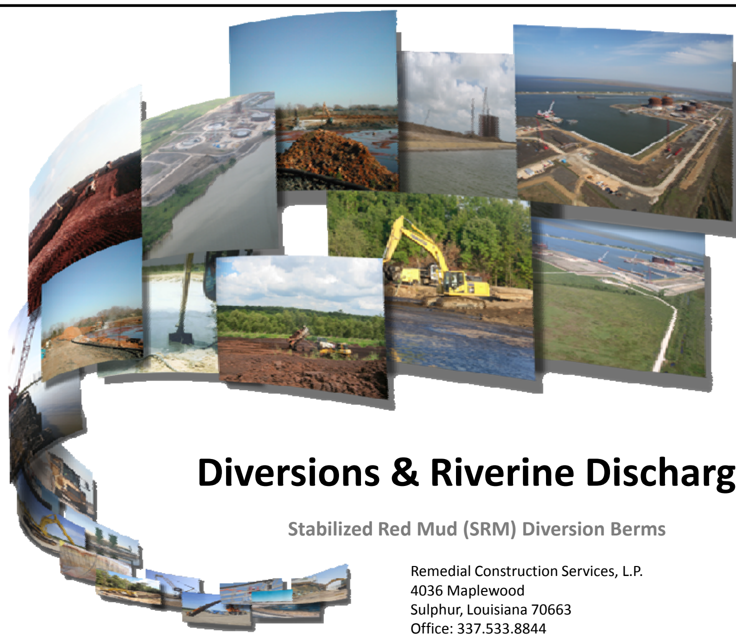


Diversions & Riverine Discharge

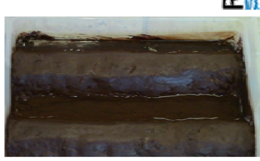
Stabilized Red Mud (SRM) Diversion Berms

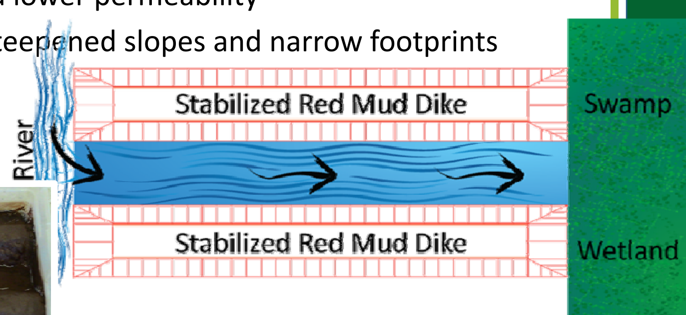
Remedial Construction Services, L.P.
4036 Maplewood
Sulphur, Louisiana 70663
Office: 337.533.8844
Fax: 337.533.8846

RECON noranda

Solutions

- Beneficial use of SRM as diversion berms
- Beneficial use of green reagents to stabilize red mud
- SRM has higher compressive strengths, lower erodibility potential, and lower permeability
- SRM allows steepened slopes and narrow footprints





RECON noranda

Solutions

- How it works:
  - Stabilization process forms a calcium aluminum sulfate hydroxide hydrate mineral
  - Mineral formed by a chemical reaction is strong and irreversible
  - Mineral growth binds red mud particles together in a matrix with no leachability issues
  - Exposed SRM is covered with a layer of soil to establish vegetative growth

RECON noranda

Benefits

- EPA Green Initiative
- Cost benefit over competing technologies
- Increased capacity to prevent erosion
- Minimize impact to wetlands due to smaller footprint
- Can maintain structural integrity even when submersed

RECON noranda

Experience

- 8MM cubic yards of stabilization
- Dike construction
- Sediment and erosion control
- Beneficial use of by-products
- Site restoration
- Cover systems

PPL23 DEMONSTRATION PROJECT
January 31, 2013

Demonstration Project Name: Stabilized Soil Shorelines

Coast 2050 Strategy(ies):
Maintain Gulf, Bay and Lake shorelines.

Potential Demonstration Project Location(s):
Region 2 (or Coastwide)

Problem:
Excessive erosion of Gulf, bay and lake shorelines expose thousands of acres of interior marshes to increased erosion rates and severe ecological change. In addition, the loss of wetlands resulting from the direct effects of wave action is magnified over open bodies of water where distances are great. Highly organic interior marshes have limited options for restoration because of poor soil conditions.

Shoreline erosion rates have been measured in excess of 30 feet per year in areas across the Louisiana coast. A large portion of coastline will not support rip-rap and require non-rock shoreline protection. The need for stabilization in critical areas was noted in all four Coast 2050 regions.

Goals:
The proposed demonstration project would greatly minimize or prevent continued erosion, enhance interior marsh shorelines and maintain exchange and interface with estuarine systems. Additionally, some accretion may likely occur and build emergent marsh.

Proposed Solution:
Stabilization may take place in-situ by blending in reagents that create mineral growth that is not susceptible to rehydration, or if the shoreline soils consist mainly of organic matter such as root matter and peat, importing lightweight, non-rock pre-stabilized materials, such as dredge spoils, would be distributed along eroding shorelines. The stabilized materials will not rehydrate and change back to an unstable, low-strength state. If wave action, similar to that along the Gulf, is causing stabilization along the shoreline to be counter-productive, or if sloughing is a deterrent due to a steep grade, then it may be more beneficial to excavate a trench along the shoreline and fill the trench with a lightweight stabilized material. In the latter case, shoreline between the stabilized material filled trench and open water will eventually erode away, exposing the trench-filled stabilized material that would serve to protect the remaining coastline.

Generally, placing stabilized dredge spoils along a bay or lake shoreline can take place from a deck barge with bin walls. First, a dredge spoil disposal area or excessively wet clay soil must be amended using a reagent blend that promotes structural mineral growth. Once the stabilized product has fully cured, it will be excavated similar to a borrow pit and loaded into dump trucks. The dump trucks would travel to the dock, back onto the barge via a ramp, and then dump the material on the back end of the barge to the front. It is highly recommended that stabilized material remain in the largest size possible without breaking the material up any more than the excavator did loading it. Stabilized material would likely vary in particle size from 2’, down to fines. The fines would serve useful in filling the voids of the larger stabilized particle sizes. A low-draft tug boat is recommended to push the barge to the shoreline requiring protection, and a long-reach excavator positioned on the barge would be used to off-load material. This method of shoreline protection is the least invasive to wetlands since most all of the protection is along the eroding face of the shoreline and weighs much less than rip-rap rock.

If deemed necessary due to extreme wave action or steep banks, trenches can be excavated on the bank of the shoreline adjacent and parallel to the open water using marsh excavators. Stabilized dredge spoils can be deposited in the trench and trench spoils can then be deposited back over the stabilized dredge spoils to fill any remaining voids and to allow re-establishment of vegetative growth. If shoreline soils are not too organic, rooted or peaty in nature, it is possible that reagents can be injected in-situ to structurally improve the native soils. In the event shorelines contain mainly organic, rooted matter caused by previous erosion, then a dry blend of reagents that consumes vast amounts of water can be injected in a saltwater-filled trench until the reagent forms a self-hardening solidified mass that is lightweight, yet reach compressive strengths of over 4.5 tons per square foot within a few days. This structural material would withstand the constant beating of wave action or periodic storm surge much like the stabilized dikes that surround and protect a multi-billion dollar LNG facility has proven so in Cameron Parish, Louisiana.

Various reagent blends that create sustainable mineral growth that are not susceptible to rehydration should be demonstrated in separate reaches in order to provide multiple solutions to shoreline protection.

Project Benefits:
The proposed project would:

1. Meet EPA Green Initiatives;
2. Have a cost benefit over other non-rock erosion control technologies;
3. Absorb and deflect wave energy;
4. Protect and enhance existing or planted shoreline vegetation;
5. Allow ingress and egress of aquatic species;
6. Trap sediment while reducing wave energy; and
7. Reduce interior marsh loss.

Project Costs:
The cost to perform at least four (4) options of shoreline protection using stabilized or pre-stabilized materials is $2,000,000; approximately $500,000 per reach.

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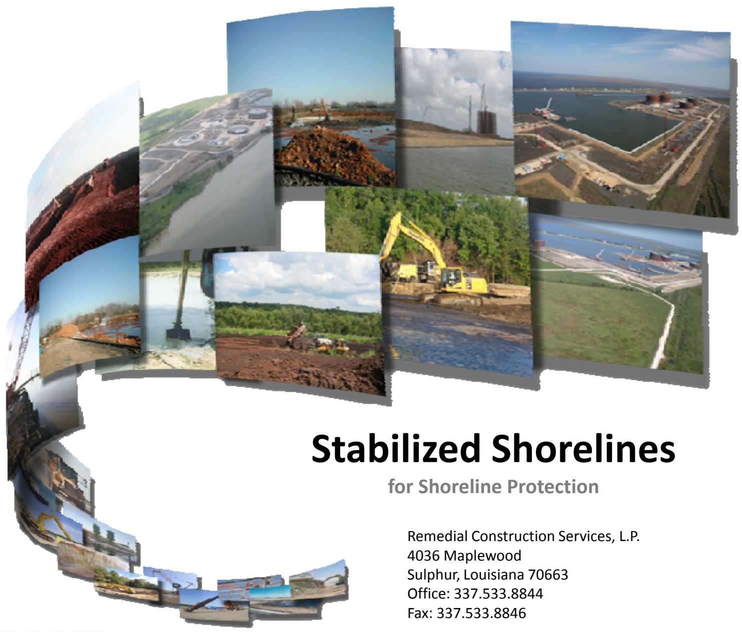
DEMO-04

Stabilized Soil Shorelines



Stabilized Shorelines

for Shoreline Protection

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Sulphur, Louisiana 70663
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RECON

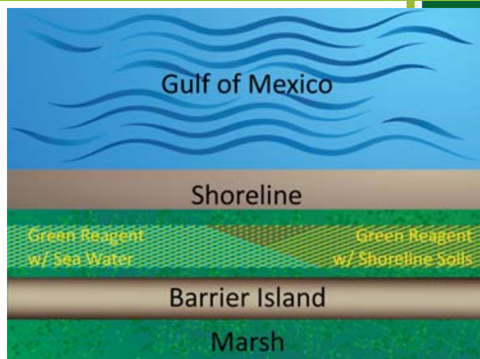
Solutions

- Protective solutions for both Gulf and lake/bay shorelines
- Beneficial use of stabilized dredge spoil to protect shoreline and allow natural sediment transfer

RECON

Solutions

- Beneficial use of green reagents to create:
  - Stabilized mass in saltwater-filled trench
  - Stabilization of existing shoreline using green reagents
- How it works:
  - Stabilization process forms calcium silicate hydrate minerals or derivative thereof
  - Minerals formed by a chemical reaction are strong, irreversible and long-lasting



Benefits

- EPA Green Initiative
- Cost benefit over competing technologies
- Absorb and deflect wave energy
- Protect and enhance existing or planted shoreline vegetation
- Allow ingress and egress of aquatic species
- Collect sediment by reducing wave energy
- Reduce interior marsh loss

Experience

- 8MM cubic yards of stabilization
- Shoreline restoration
- Dike construction
- Sediment and erosion control
- Beneficial use of dredge spoils
- Multi-billion dollar facility protected from hurricane Ike and Rita storm surge