Living Shoreline Professionals Advanced Training

August 24 & 31, 2017

Hosted by

Virginia Institute of Marine Science

College of William & Mary

VIMS | William & Mary

Virginia Institute of Marine Science

Center for Coastal Resources Management

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LIVING SHORELINE PROFESSIONALS
ADVANCED TRAINING
AUGUST 2017

Part 2

GENERAL SITE EVALUATIONS
&
DESIGN GUIDELINES
FOR NON-STRUCTURAL PRACTICES

GENERAL SITE EVALUATIONS

Parameters Typically Used in Living Shoreline Design

Source: Living Shorelines Engineering Guidelines 2016

System Parameters

Erosion History

Tidal Range

Sea Level Rise

Large scale - long term

Ecological Parameters

Native Plant Community

Water Quality

Soil Type

Sunlight Exposure

Local scale for natural elements

Hydrodynamic Parameters

Wind Waves

Boat Wakes

Currents

Ice

Storm Surge

Stormwater Runoff

Forces acting on the shoreline short-term

Terrestrial Parameters

Upland Slope

Shoreline Slope

Width

Nearshore Slope

Offshore Depth

Soil Bearing Capacity

Affect how shoreline responds to forces

Parameters Typically Used in Living Shoreline Design

Source: Living Shorelines Engineering Guidelines 2016

Additional Parameters

Permits/Regulatory

End Effects

Constructability

Native/Invasive Species

Shellfish Recruitment

Debris Impact

Project Monitoring

Property Owner Interest

Multiple parameters are not equally weighted

Some may be more critical than others

Just one alone might make a difference

Site Evaluation Process

Desktop - Map Parameters

- Existing information available from maps or Internet resources
- Not readily visible or measurable at ground level
- Data availability may be limited for some parameters

Site Visit Parameters

- Not easily captured by remote sensing or verifies desktop results
- Site-specific characteristics
- Local setting
- Local knowledge

More Information about Living Shoreline Design Parameters

- VIMS Living Shorelines Design Guidelines *2010*
  - 2017 updates in progress

- Stevens Institute Living Shorelines Engineering Guidelines *updated 2016*
  - Written for New Jersey, still a good reference for Virginia

First Living Shoreline Considerations

1. Define the problem

   Is erosion risk present ? Can it be tolerated and left alone?

   Is erosion or flooding risk significantly high?

   Can upland land use or stormwater adjustments solve problem?

   Avoid unnecessary shoreline alterations

2. Property owner factors

   Is the property owner willing to pursue living shoreline approach?

   What are their perceptions of the problem & possible solutions?

   Avoid unrealistic expectations

3. Basic location & land use suitability considerations

   Any significant natural or cultural resources?

   Is there enough room to access and work on the shoreline?

   Can living habitats be created or enhanced without use conflicts?

   Avoid inevitable conflicts

Next Design Parameters
after passing initial site suitability

Characterize the Shorescape

- Erosion evidence & history
- Local tide range & extreme tide levels
- Wave climate & fetch
- Other standard information for all shoreline projects

- Stormwater runoff patterns & management practices
- Land & recreation uses including water access
- Natural erosion buffers – vegetation & slopes
- Existing shoreline protection structures

Stormwater Runoff Patterns

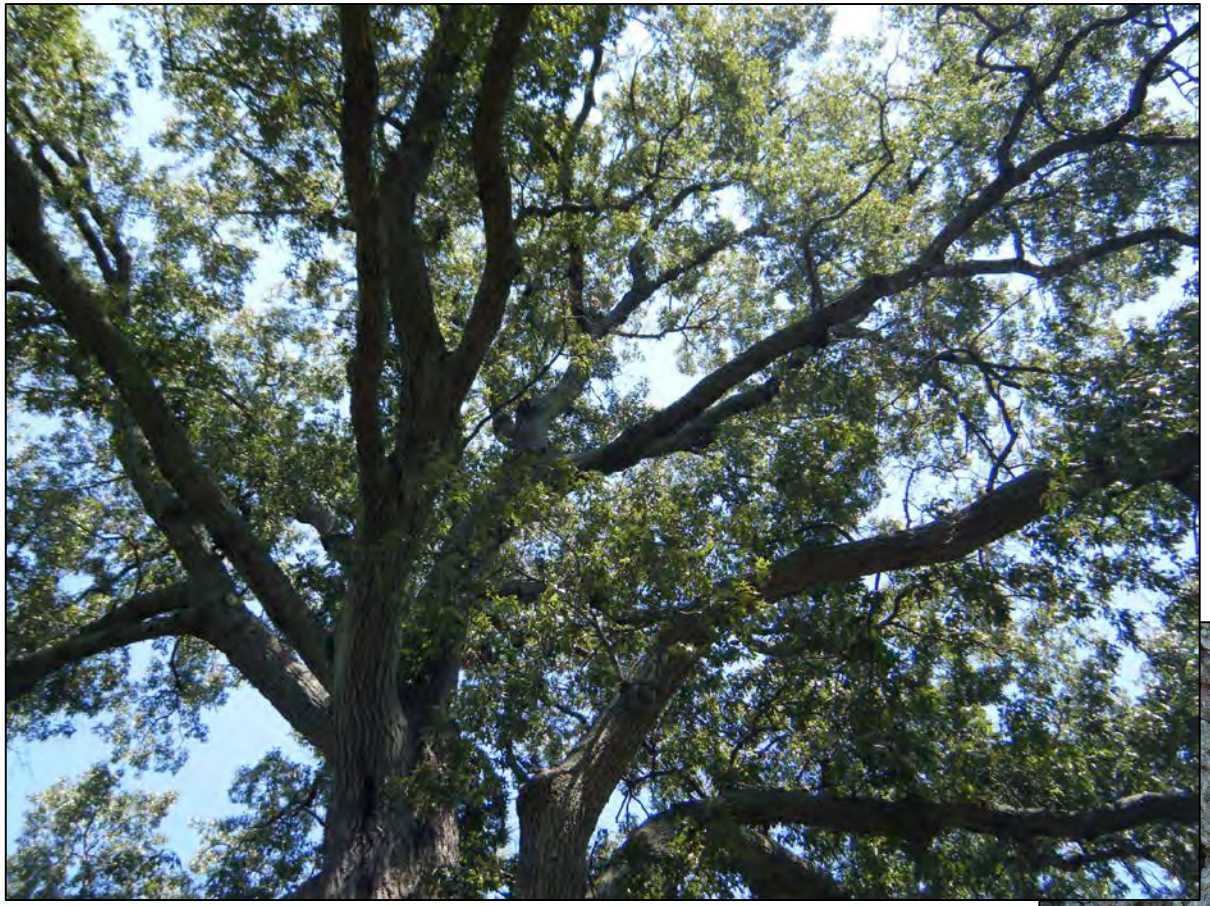
- Map location of impervious areas & topography
- Look for runoff patterns
- Locate existing stormwater management practices
- Does upland drainage need to flow through shoreline area e.g. major outfall, drainage easement?

Dry Channel at Leesylvania State Park

Characterize the Nature of the Shorescape

- Landscape aesthetic *formal or informal*
- Garden types *flowers, vegetable, woodland, water*
- Native plant communities *allowed or suppressed*

Identify Sentimental Trees & Plants



One specimen tree might limit options

Landscape sentiments may suggest willingness & ability to maintain a living shoreline project

Native Plant Community

- Evaluate natural upland & shoreline plant species in vicinity
  - Indicators of erosion, high water tables, salinity, previous disturbance
- Obtain biological benchmark elevations
  - Natural plant zones & elevations related to tide range & storm surge
- Consider recruitment potential
  - Plants growing nearby that readily re-seed may not need to be planted, also look for invasive species like *Phragmites*
- Consider grazing pressure
  - Will any animals be attracted to new plantings?
- Seek advice from local native plant experts & guidelines

Bank Vegetation Cover

Densely Vegetated / Forested vs. Previously Cleared

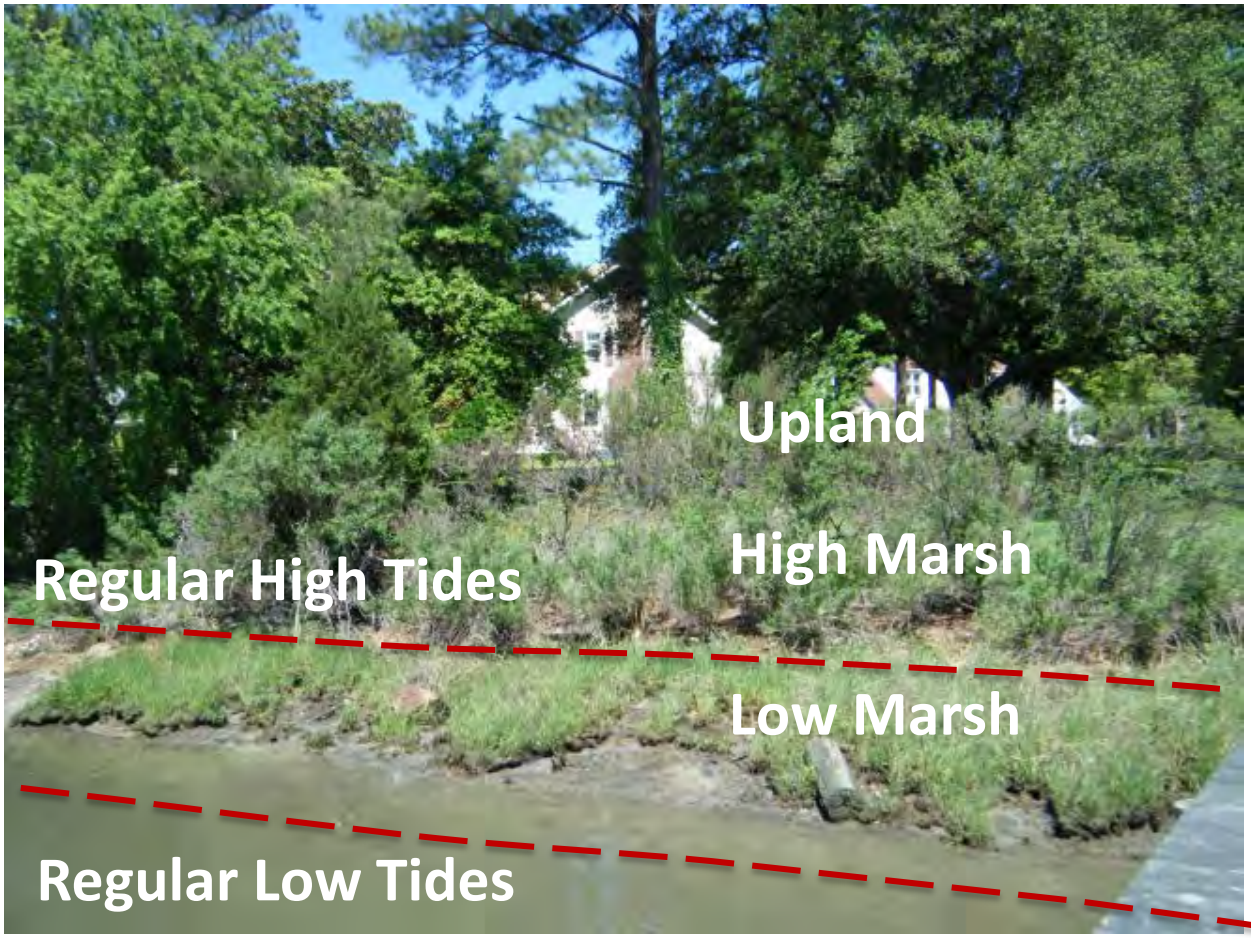
Does vegetation cover contribute to erosion protection or problem?

Can or should the bank be graded or not ?

Is the absence of vegetation due to active erosion or previous land disturbance?

Biological Benchmarks – Target Elevations

Elevation ranges of natural marshes & riparian buffers in vicinity



Chesapeake Bay Landscape Professional Certification
CBLP

CBLP CHESAPEAKE BAY Landscape Professional

cblpro.org

Network of sustainable landscaping professionals

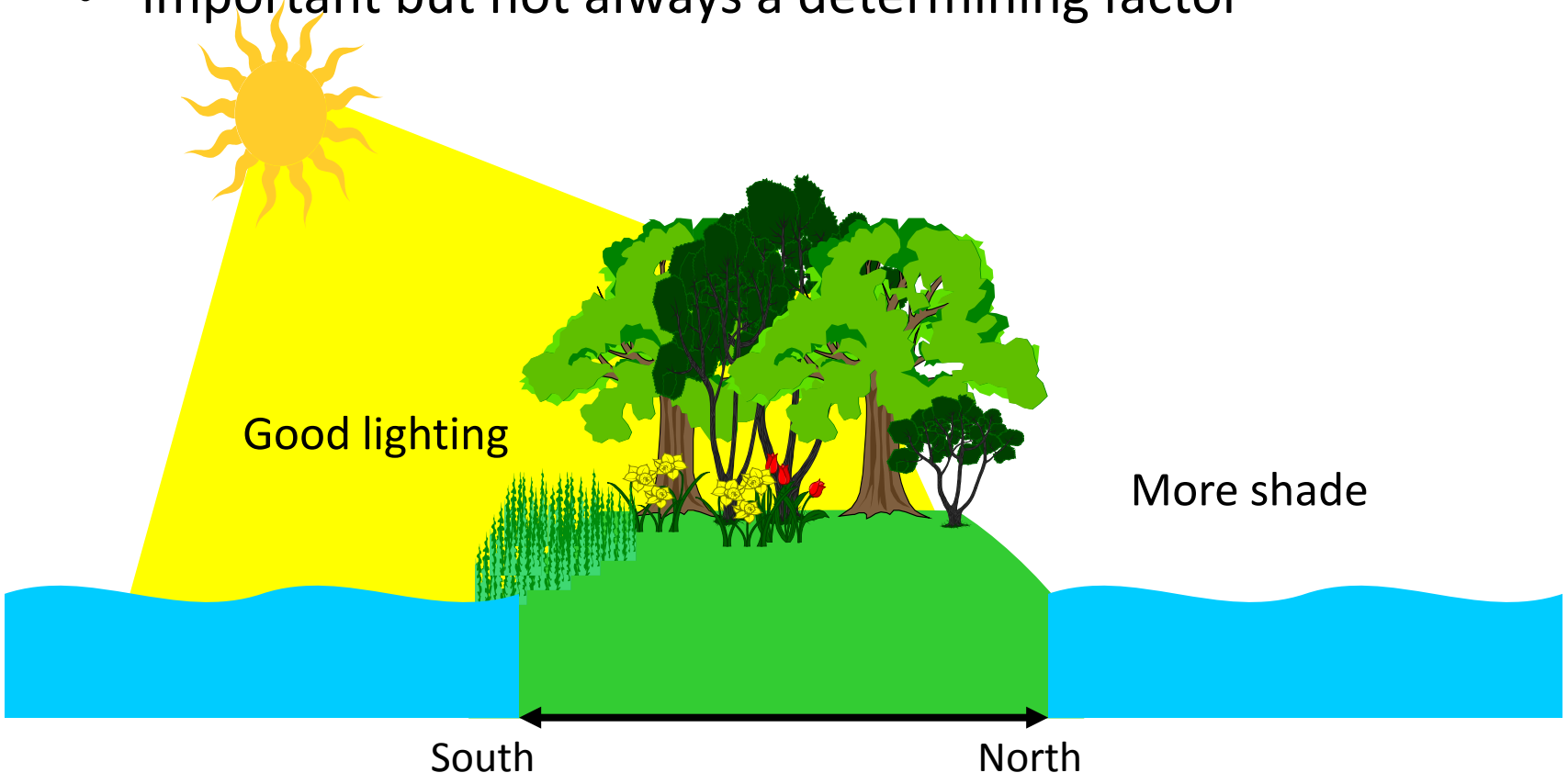
Voluntary credential system for professionals who design, install, and maintain sustainable landscapes

Stormwater retrofit best practices & conservation landscaping

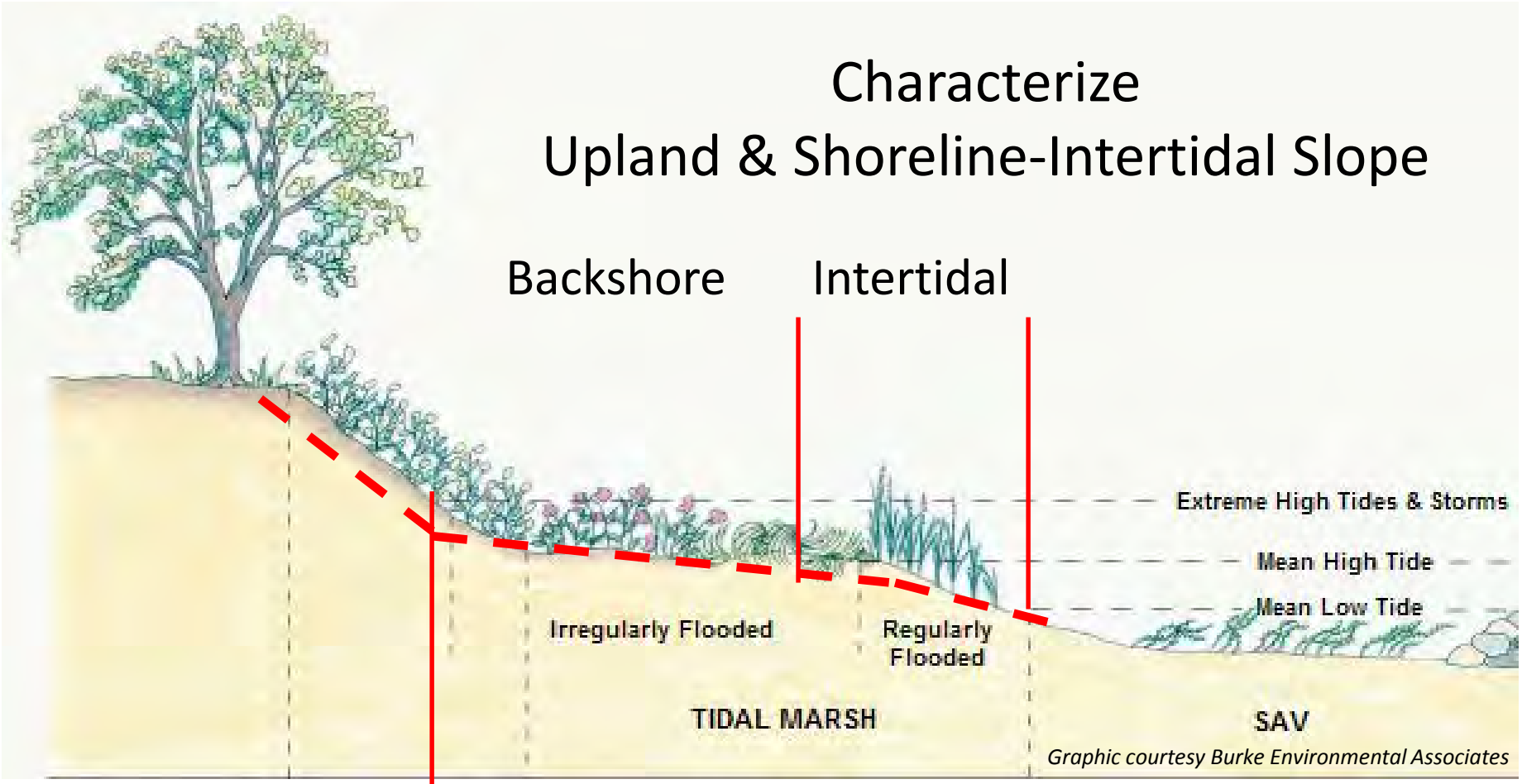
Professional Directory available

Shoreline Orientation – Sunlight Exposure

- Important for upland bank projects with shoreline trees, not as important for wide open marsh edges except for piers
- South & east vs. north & west is rule of thumb
  - important but not always a determining factor



Characterize
Upland & Shoreline-Intertidal Slope



Graphic courtesy Burke Environmental Associates

Upland Slope

Level Ground to Spring Tide

Shoreline Slope

Spring Tide to MLLW

Backshore Zone Features

- Existing high marsh
  - Saltmeadow hay
  - *Phragmites*
  - Salt bushes
- Existing supratidal beach > MHW
  - Overwash sand
  - Primary & secondary dune features
- Backshore terrace
  - Bank slumping
  - Upland grasses and trees

- Measure dimensions of each feature
- Identify plant species
- Do existing features contribute to erosion protection?
- Can they be temporarily disturbed or enhanced?

Intertidal Zone Features

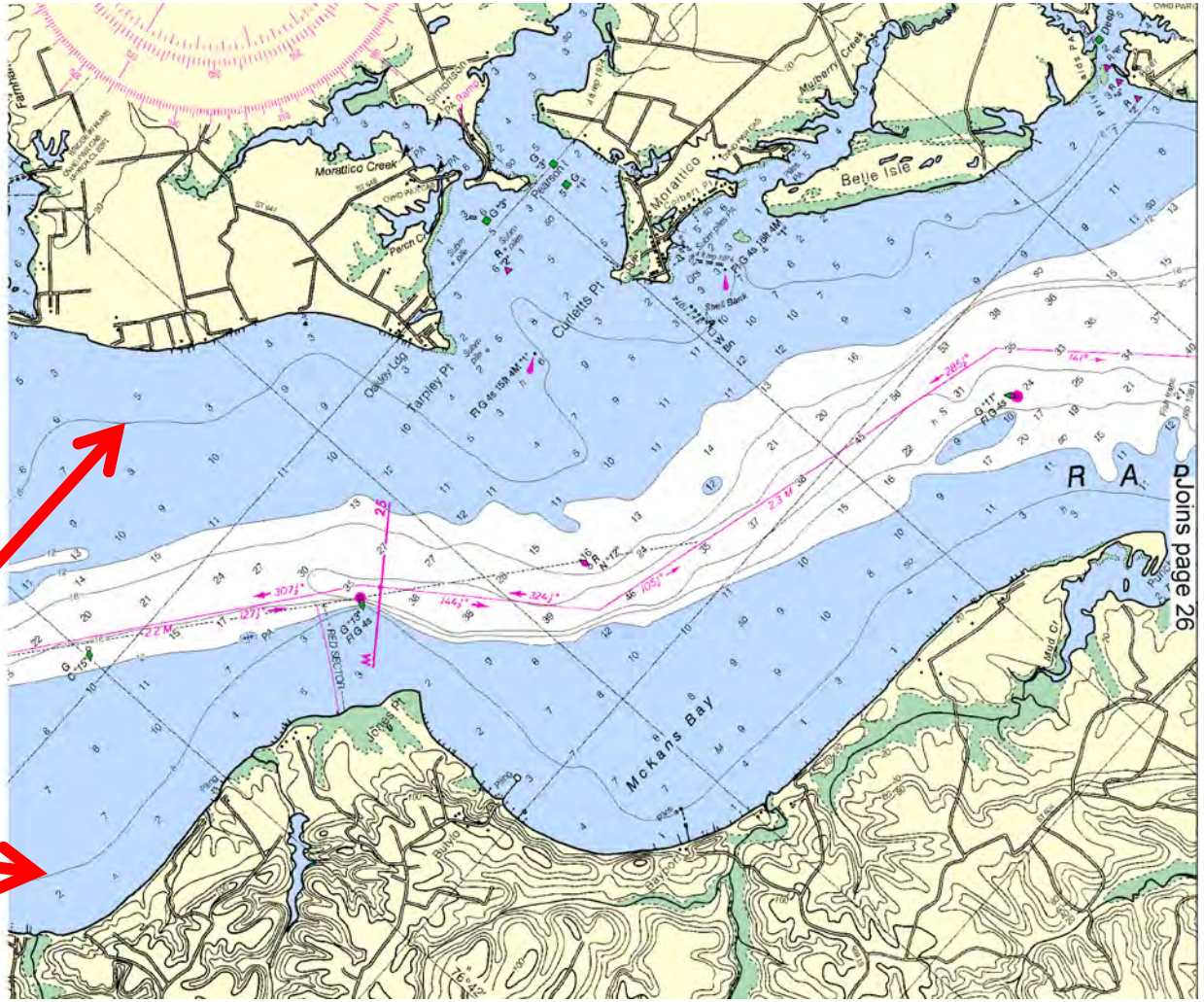
- Existing tidal wetland
  - Non-vegetated
  - Salt or freshwater marsh
  - Cypress trees
- Existing sand beach
  - Intertidal beach
- Combination
  - Patchy marsh headlands with pocket beaches

- Measure dimensions of each feature
- Identify plant species
- Do existing beach and marsh contribute to erosion protection?
- Can they be temporarily disturbed or enhanced?

Depth Offshore
distance to 6 ft or 2m contour

Broad shallow nearshore has different wave attenuation than narrow deep water with same fetch

6 ft contour lines



NOAA Reduced Scale Navigational Charts
http://ocsdata.ncd.noaa.gov/bookletchart/

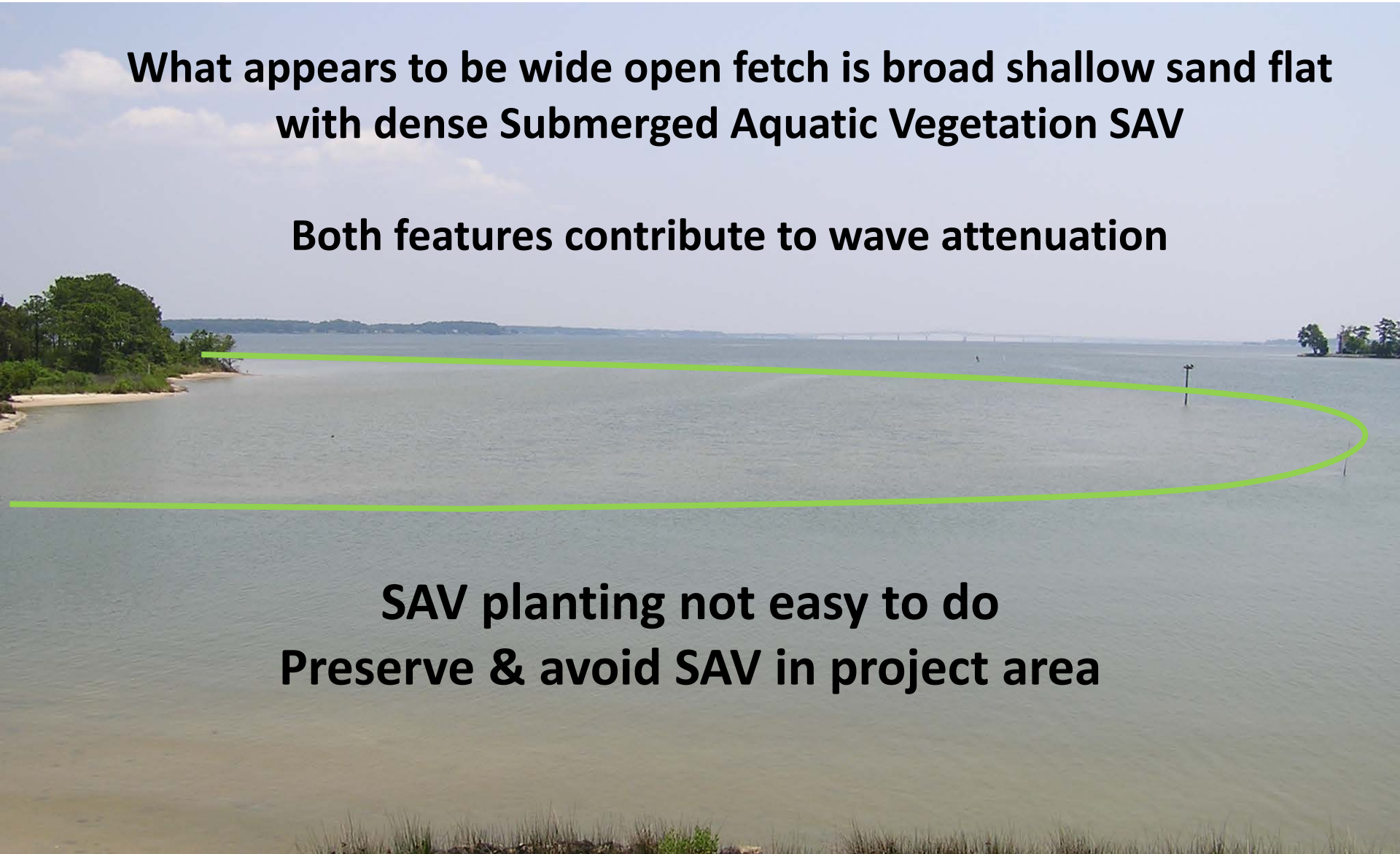
Nearshore Morphology

Presence - absence of nearshore tidal flats & sand bars

Indicates sand supply, bottom conditions

Important consideration to maintain sediment supply & movement patterns

Submerged Aquatic Vegetation



VIMS Submerged Aquatic Vegetation
SAV Inventory and Monitoring

[Interactive Map]

2011-2015 Composite

1971-2015 Composite

Individual Years

Comparison Years

Larger Map also available

Characterize Shellfish Production

- Ribbed mussels present or absent in existing marsh
- Natural oyster bars & spat set visible in local area
- Different oyster sizes indicates disease pressure

- Proximity to artificial restoration reefs
- Proximity to oyster gardeners (diploids)
- Aquaculture activity

For living shoreline projects that might include shellfish reef elements

VIMS Aquaculture Vulnerability

Map Viewer

tool to characterize shellfish productivity

VA oyster reefs

Oyster sanctuaries

Private leases

Salinity composite

Coastal Profile

- Combine all parameters for site-specific shorescape conditions
  - Are all parameters weighed equally?

- Consider how integrated habitats can influence shore protection, water quality & habitat functions

- Each element in the system works to reduce wave & runoff energy impacting the upland

Coastal Profile Features to Choose From

	Riparian Buffer & Bank	Backshore	Intertidal	Nearshore
Natural Features	Forested - undisturbed Forested – disturbed Herbaceous only Bare soil Developed	High marsh Dune Upland trees – grasses	Low marsh Beach Marsh & beach	SAV Shellfish reefs Sand bars Tidal flats Deep water
Human Uses	Visible infrastructure Underground infrastructure Stormwater management Riparian access structures	Existing defense structures Recreation improvements & uses Water access improvements & uses		Boat mooring areas Navigation channels Boat wakes

Design Guidelines for Non-Structural Practices

Riparian Buffer Enhancements – Stormwater Management

Riparian Buffer Enhancements – Vegetation

Bank Grading + Riparian Buffer Planting

Sand Fill & Beach Nourishment

Planted Tidal Marshes

Fiber (coir) Logs & Mats

Shellfish Reefs

Riparian Buffer Enhancements – Stormwater Management

- Divert runoff away from top of bank
  - Impervious surface removal
  - Rainwater harvesting
  - Rain gardens

- Vegetated buffers & conveyance systems
  - Conservation landscaping consistent with property owner's aesthetics

- Create steps or terraces

Steps from parking lot at Reedville Living Shoreline

Riparian Buffer Enhancements - Vegetation

- Waterfront lawn conversion
- Native plant gardens
- Invasive species removal

- Selective tree pruning
- Selective tree removal
  - Dead, dying, severely leaning

New riparian buffer demonstrations at Hull Springs & Capt. Sinclair PRA

Riparian Buffer Design Considerations
for Protection, Planting & Enhancement

- Existing tree protection – where to locate equipment staging & stockpile areas, fueling stations, vehicle parking areas
- Generate desired plant species list & estimate quantity, container stock & seeding
- Investigate plant sources, availability in advance
- Determine ideal planting times *woody trees & shrubs may be different than perennials & ground covers*
- Can temporary irrigation be provided during dry spells until plants are established

Riparian Buffer Native Plants

- Mimic local coastal forest community
  - Pine or hardwood dominated
  - Flooding frequency & tolerance
- Woody species best planted in fall, early spring

Bald Cypress

Eastern Red Cedar

Loblolly Pine

Wax Myrtle - Bayberry

Inkberry

Plant Virginia Natives

regional native plant guides & other information

Eastern Shore

Northern Neck

Northern Virginia

Southeast Virginia

Central Rappahannock

Bank Grading & Riparian Buffer Planting

Before

During

After

Allows for wave run-up

Better vegetation growing conditions with less slipping & soil movement

Highbank, White Stone
JPA #03-2535

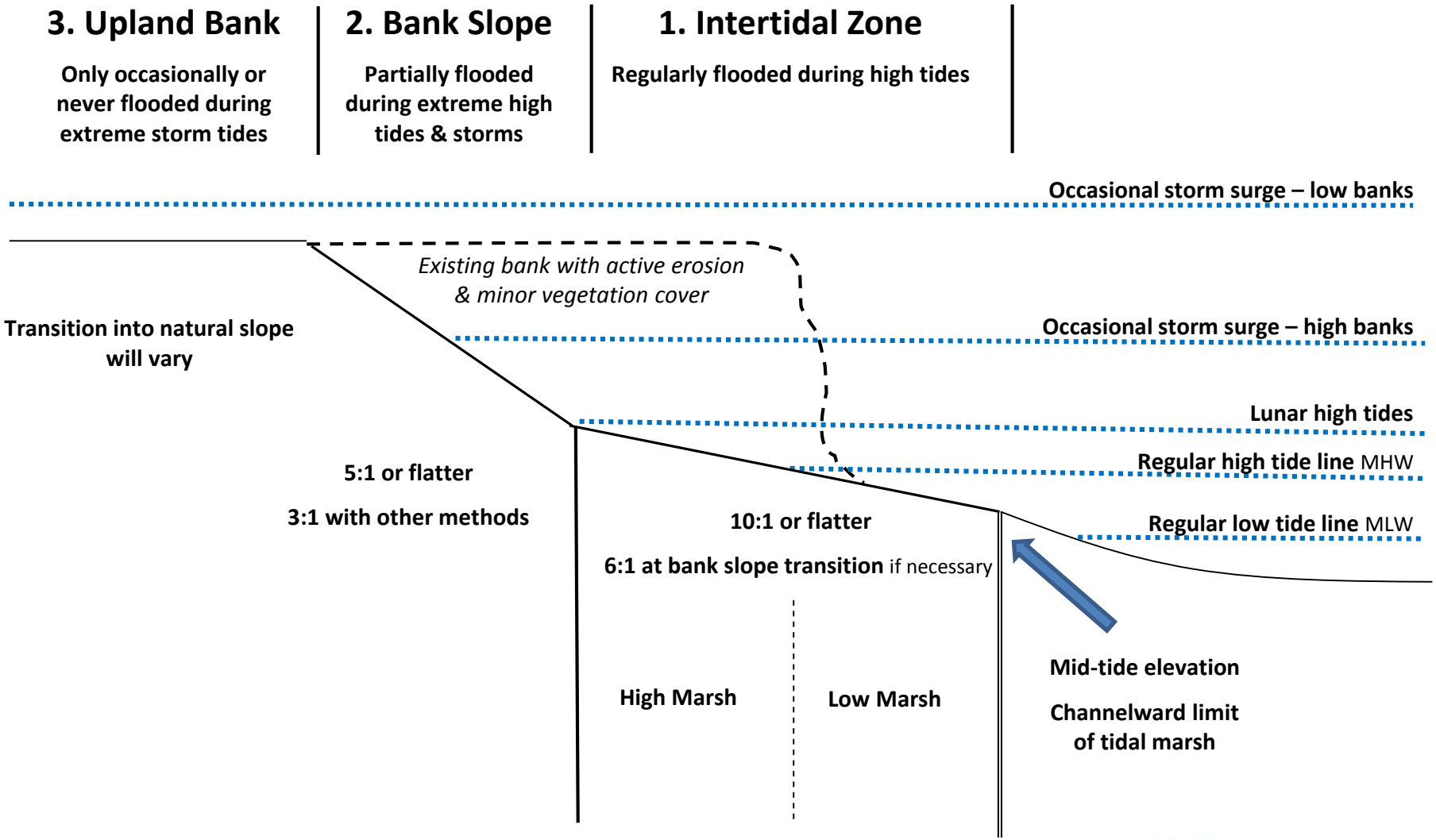
Bank Grading Design Considerations

- Determine tree & other vegetation removal needs
- Look for groundwater indicators, springs & seeps
- Look at soil type at planting elevation
  - Clay or confining layers may preclude vegetation growth
  - Over excavate and backfill with sand for planting
- Equipment access requirements
- Temporary land disturbance, erosion & sediment controls
- Riparian buffer planting plan for vegetation cover
- Watch out for invasive species recruitment

Upland Excavation – Landfill Removal

- Anticipate soil testing expenses & logistics
- Always take soil borings or dig test pits where fill is going to be removed, be ready for surprises & be flexible during excavation even with test results in hand
  - Legacy contamination, solid waste, etc.
- Need excavated material handling & disposal plan
- Possibly over-excavating & backfilling plan, sediment source
- Estimate areas for planting zones

Bank Grading Slopes & Planting Zones



Not to scale – for graphic illustration only

Sand Fill & Beach Nourishment

- Fill in erosion hot spots & where trees fell
- Raise elevation of bare areas in existing marsh
- Raise elevation of entire intertidal zone to plant new marsh
- Increase height & width of existing narrow beach

- Usually combined with planting vegetation
  - riparian, marsh, &/or beach-dune
- Beach nourishment alone may be suitable where natural sand transport will help maintain beach feature
  - Also to allow for recreation access but this should <u>not</u> be primary motivation for expanding beach feature (not consistent with legal definition of living shoreline)

Sand Fill & Beach Nourishment

- Coarse-grained sand typically used
  - No more than 5% passing #200 sieve & no more than 10% passing #100 sieve
- Rounded or semi-rounded grains
  - with median diameter of 0.6 mm (± .25 mm)
- Grain size analysis using visual aids or by sediment lab
- Potential sources include:
  - Upland sand mines trucked to site
  - Suitable bank material
  - Suitable dredged material (beneficial use)

Sand Fill & Beach Nourishment Design Considerations

- Estimate quantity & determine material source
- Locate stockpile areas, transport pathways to shoreline
- Determine equipment needs, is downsizing necessary
- Temporary construction mats to reduce compaction
- Schedule in adequate settling period (2 weeks or more)

VIMS Beach Erosion


After Sand Nourishment
& Dune Planting

6 years later
Only minor recreation uses

Plant Tidal Marsh at Natural Grade

Requires full sun – wide intertidal area – very low wave energy

Fill in erosion areas within existing fringe marsh

Re-plant after removing invasive plants like *Phragmites australis*

Planting Tidal Marshes at Upland Banks

- Estimate planting area size length & width
- Estimate sand fill quantity & potential source(s)
- Pruning overhanging trees & shrubs
  - Avoid removing healthy shoreline trees just to increase sunlight for new marsh
  - Consult with arborist on tree life expectancy & health
- Identify responsible party for post-installation monitoring & maintenance until establishment
- Establish access permission for this purpose

Planting Tidal Marshes at Eroding Marsh Edges

- Fill in between more erosion resistant points, estimate size of planting areas
- Designate marsh edge access paths for equipment & foot traffic – be prepared to restore access routes
- Typically requires temporary or permanent containment
  - Estimate number of fiber logs, mats & stakes needed
  - Additional considerations for stone sills or oyster reefs

Planted Marsh Species List

- Rough estimates of each planting zone (square feet)
  - Low salt marsh *mean tide level to MHW*
  - High salt marsh *MHW to upland transition*
  - Freshwater marsh *use biological benchmarks*
  - Upland transitional area
- Estimate quantity for clumps or row planting
- Include plants that stay above ground during winter
  - Or compensate design for winter conditions if no aboveground stems & leaves will be present, backshore protection

Salinity Differences

Salt Marsh – Brackish Marsh

1. Saltmarsh cordgrass
2. Saltmeadow hay
3. Switch grass

John's Point Public Landing
Gloucester County

Freshwater Marsh

Pickerelweed & Arrow Arum

Big Cordgrass

Three-square

Switch Grass

Leesylvania State Park
Prince William County

Wetland Plant Sources

- Nursery stock recommended
  - Plants for high salinity planting must be brought up to site salinity by grower before delivery
  - Optimum planting time when natural marshes are greening up
- Wild harvest from donor marshes nearby for small projects *if permittable*
  - Hard to dig out plants from natural marshes
  - Eroded marsh edge clumps can be salvaged

Planting Labor

- Professional services
  - In-house or sub-contractor

OR

- Volunteer opportunity
  - Recruitment, coordination, oversight, rewards
  - Follow up quality control

Other Planted Marsh Materials

- Grid device or flags to designate planting zones
- Dibble bars or power augers to drill holes
- Slow release fertilizer (*optional*)
- Buckets to carry plants & fertilizer to shoreline
- Grazing exclusion fencing, stakes, &/or strings

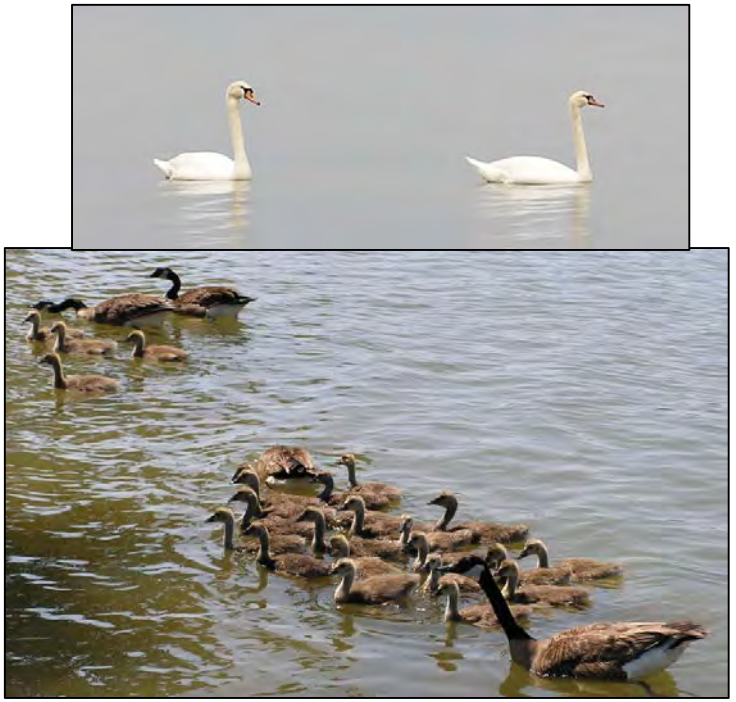
Grazing Exclusion Devices

Mute Swans & Canada Geese can pull new plants out of the ground, but not established well-rooted plants

Other grazers include deer, wild horses, nutria, muskrats

Are any of these known to be around the project site?

Plan for installation & then removal of exclusion devices after marsh establishment



Main Reasons Planted Marsh Does Not 'Take'

- Planted too low - below mid-tide elevation
- Washed out plugs – grazing pressure
- Incomplete drainage & ponding at low tide
- Rapid sediment accretion

Other Reasons

- Flow stresses – bottlenecks, runoff, waves
- Foot traffic & recreational uses
- Soil contamination
- Undetermined

Need monitoring & analysis of monitoring results

Fiber Log & Mat Design Considerations

- Temporary stabilization for planted areas only
  - Not designed to attenuate waves
- Very effective above intertidal zone for graded banks, backshore slope transition
- Effective in intertidal zone at very low energy sites
- Single row or stacked for higher profile

Fiber Log & Mat Design Considerations

- Premium logs are denser for higher energy sites
- Staking & anchoring essential if they are in the water
- Full contact with ground should be maintained
  - Install logs end-to-end, tying them tightly together & reinforcing the break
  - Place stakes in X across top of log
  - Use cotton based twine with breaking strength >800 lbs with every turn around the stake knotted
  - Logs should not be tucked against vertical erosion scarps where waves are abruptly reflected
- Plan for regular inspections & corrections

Fiber Log & Mat Design Considerations

- Sand fill or natural accretion
  - The faster sediments fill in, the less likely installation will fail
  - Include sand backfill if the local sediment supply is limited or to increase likelihood for successful marsh establishment
  - Indicators of local sediment supply are accretion against large woody debris, overwash ‘fans’ in marshes, sediment trapped at groins or jetties
  - Jumpstarting with sand fill will require construction access to place sand

Fiber Log & Mat Design Considerations

- Planting into logs has mixed results
  - Saturation is important for wetland plants
  - Marsh plants easily grow into them
- Seeding with ribbed mussels possible
  - Especially where adjacent marsh not already colonized with mussels

Fiber Log & Mat Materials

- Different lengths & diameter sizes available
- Wood stakes 7-20 per log depending on site energy
- Cotton based twine with breaking strength >800 lbs.
- Mallets
- Possibly sand fill from upland source
- Seek advice from material supplier

What to Expect with Fiber Logs

1. Temporary containment of sand
2. Gradual coir log bio-degradation
3. Marsh expansion


2013


2014


2016

What to Expect with Coir Logs

Planted marsh persists after coir logs disappear

Property owner acceptance & understanding for taking care of marsh

Deltaville Yachting Center +7 yrs.
JPA #10-0141

FOR Friends·of·the RAPPAHANNOCK

Filtrexx® GroSoxx®

Geotextile products designed to promote vegetation growth

Filled with compost & sand

Stacked & staked against bank

Planted with marsh grasses

Urbanna Town Marina JPA #15-0303

FOR Friends of the Rappahannock

Shellfish Reef Design Considerations

- Mimic natural marsh – shellfish association
- Intercept wave action with reef-like structure
- Solo placement or combined with other practices

- Loose shell best used as habitat enhancement only
- Contained shell more effective for wave attenuation
- Strategic placement of pre-cast reef structures another option

Shellfish Reef Design Considerations

- Tide range & water depths at extreme low tide
  - intertidal reefs are exposed to wave action & freezing
- Public health restrictions in waters not approved for shellfish harvesting
- Navigation hazards
- Remote spat setting time needed
- Labor required for filling bags & moving structure units to shoreline

Shellfish Reef Materials

- Geotextile foundation material
- Oyster shell or reef products
- Shell bag filling station
- Material transport equipment

Oyster Shell Bags - Marsh Edge Protection

Oyster shell bags placed along eroding marsh edge

+2 years
3-D growth of new oysters
splitting bags open

Johns Point Landing, Gloucester Co.
JPA #12-1376

Oyster Shell Bag Sill with Sand Fill & Planted Marsh

Pyramid stacked bags *in this case 5 – 4 – 3 – 2 – 1 for 2.5 ft. tide range*

Sand fill to raise elevation for planted marsh &/or allow existing marsh to expand

?? Polyethylene plastic bags suitable material for aquatic environment ??

?? Oyster reef evolution ??

16-0213 Hopkins et al Gloucester Co.

Biogenic Reef Products

ALLIED CONCRETE CO.

Oyster Castles®

http://www.alliedconcrete.com/materials/oyster-castles/

Biogenic Reef Products

READY REEF Inc.

http://www.readyreef.com/

Biogenic Reef Products

REEF BALL FOUNDATION

CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

http://www.reefball.org/

Fiber Log Reinforcement with Oyster Castles & Oyster Shell Bags

Natural Marsh Edge Stabilization

Delaware Estuary, New Jersey

Non-Structural Design Considerations

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