NEW JERSEY AGRICULTURAL EXPERIMENT STATION
RUTGERS COOPERATIVE RESEARCH & EXTENSION

Streambank and Lake Restoration

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Lake Restoration

Lakes and ponds are valuable resources that provide ecological, aesthetic, and recreational services

Lake Restoration

Lakes can be stressed by anthropogenic or natural influences

- Shoreline erosion
- Sediment buildup
- Eutrophication
- Algal blooms
- Invasive species

Lake Restoration

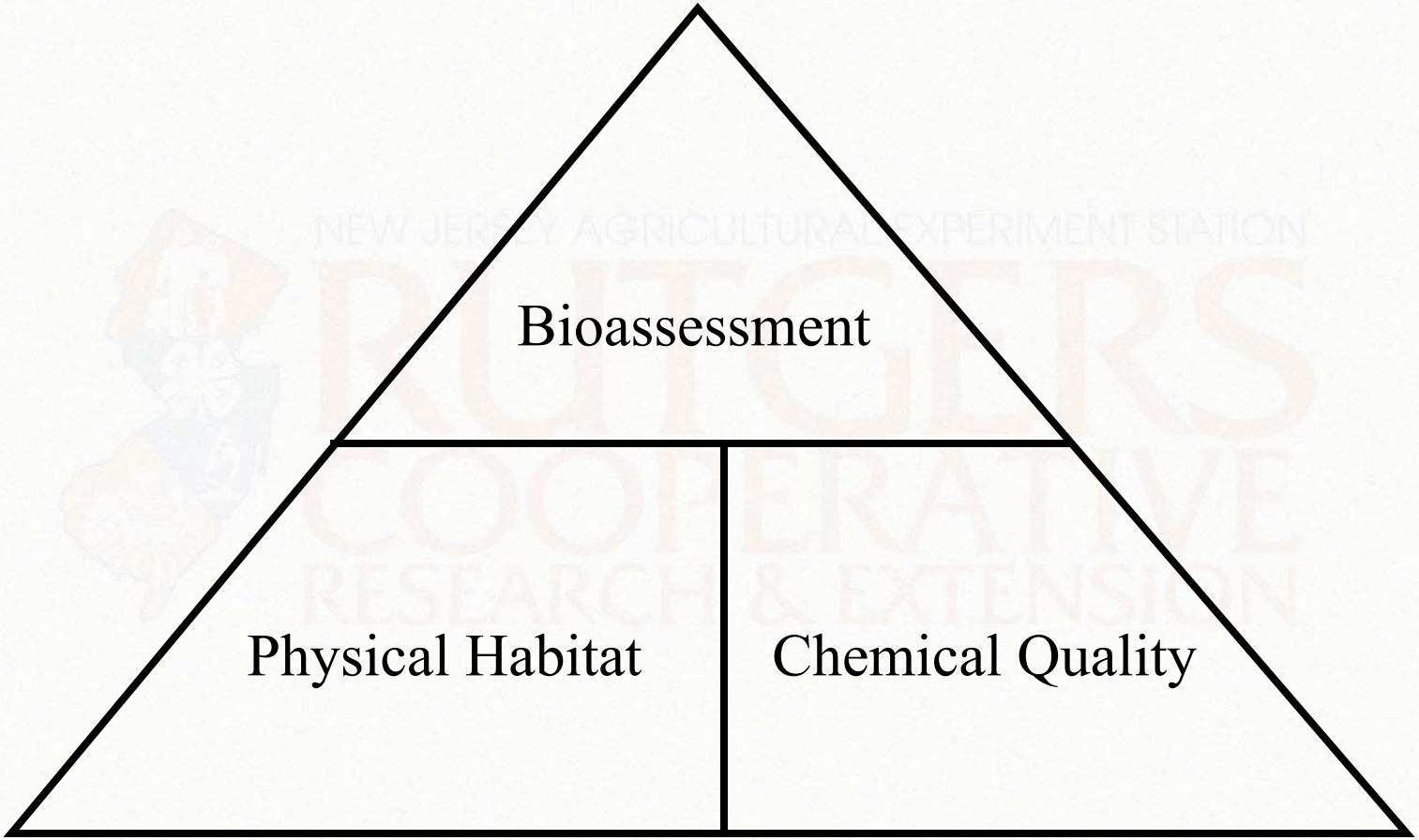
- Lake Ecology
- Eutrophication Issues
- Algae Control
- Biomanipulation
- Lake Dredging
- Stream bank and Shoreline Restoration

Lake Ecology

Lake Ecology

- Lake Morphology
- Water Quality Variables
- Aquatic Organisms

Lake System



Lake Morphology

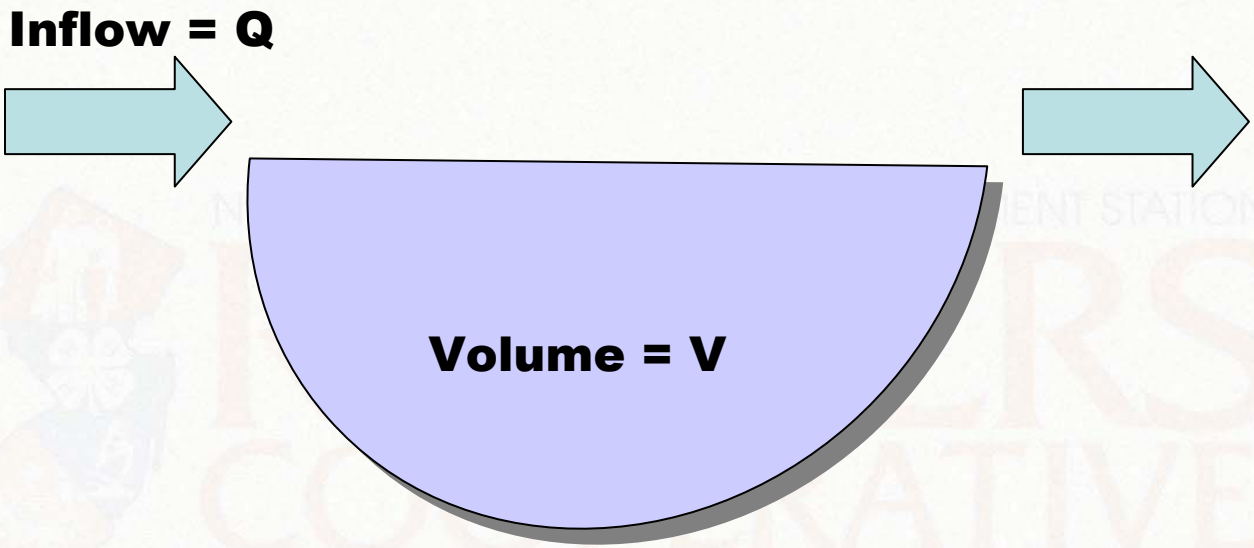
Shape and Size

- Depth
- Surface area
- Volume
- Length of shoreline

Hydraulic residence time

- Determines flushing rate
- Usually a slow resupply of water

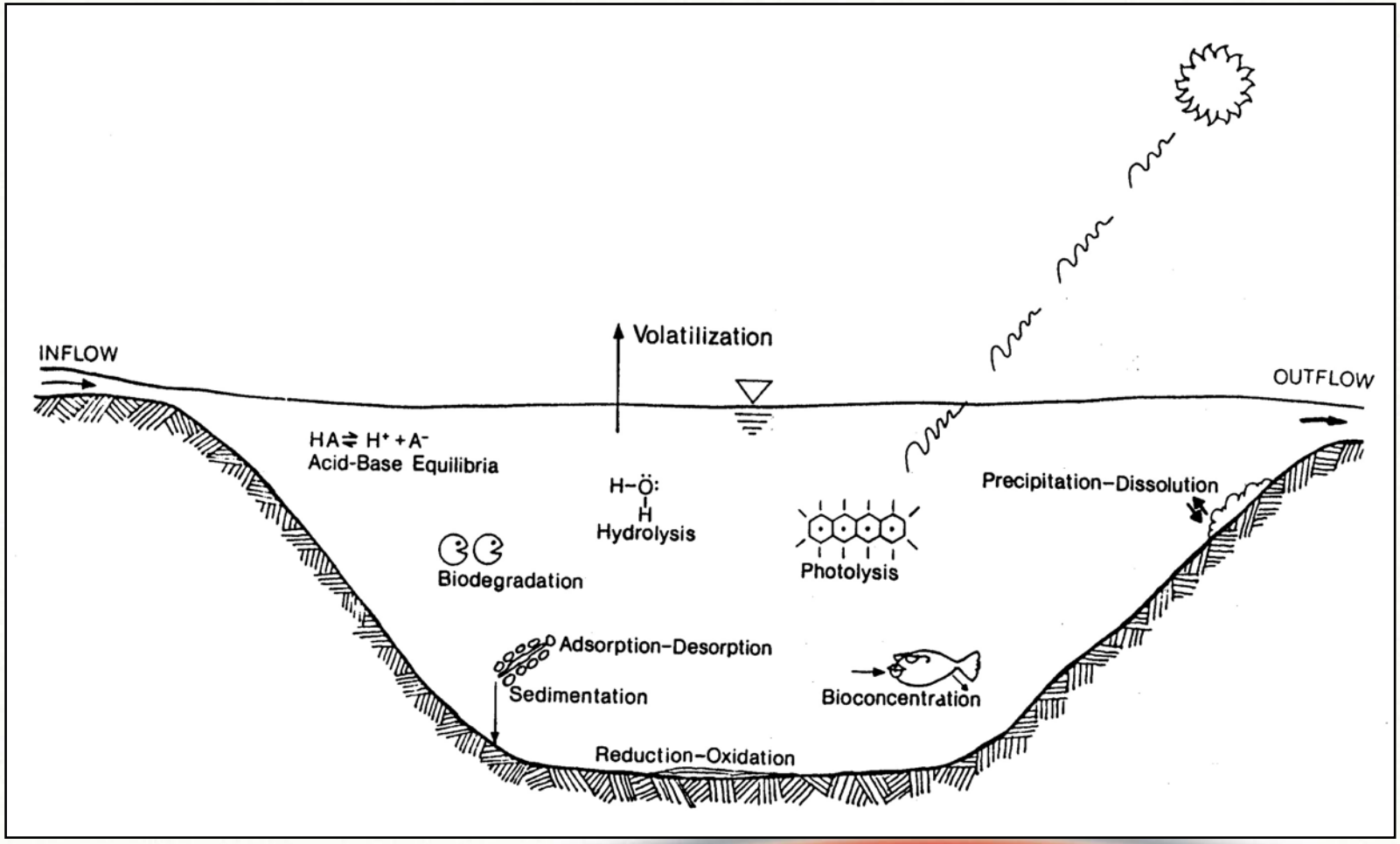
Lake Morphology



Residence Time = T_R

$$T_R = \frac{V}{Q}$$

Water Quality Process



Water Quality

- Tends to vary with depth and season
  - Pollutant loading determined by land use
  - Sediments can be a factor
- Minimal reaeration from surface
- Riparian buffers very important
  - Protection of shoreline
  - Filtration
  - Nutrient uptake

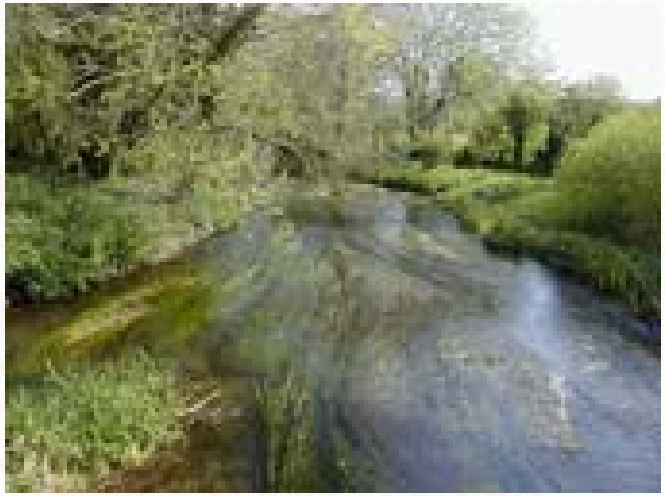
Water Quality

Water Quality Variables

- Acidity
- Alkalinity
- Hardness
- Color
- Turbidity
- Transparency
- Nutrients
- Dissolved Oxygen
- Toxic substances
  - Metals
  - Pesticides
  - Petroleum products
- Microorganisms
  - Bacteria
  - Viruses
  - Protozoa

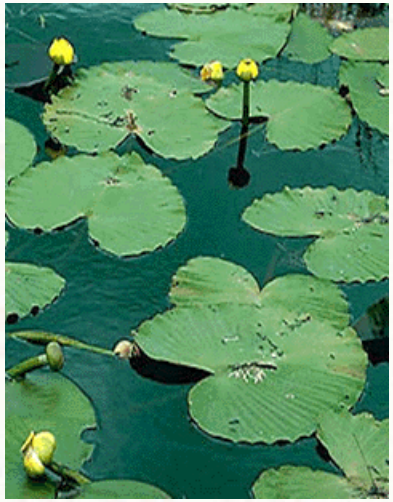
Aquatic Organisms

- Plankton
- Macrophytes
- Invertebrates
- Vertebrates
- Microorganisms



Lake Biota

- Less streamlined than in streams
  - Fish wider bodies
  - Plants wider leaves
- Entire water column
  - Invertebrates swim
  - Planktonic organisms
- Large predators
  - Often hunt
  - Food will swim by



LARGEMOUTH BASS

Eutrophication

Eutrophication

Eutrophication - definition

Excess nutrient and sediment load into lakes at a rate sufficient to increase the potential for high biological production and a decrease in basin volume

Eutrophication

Causes

- Excess nutrients and silt entering lake system from runoff
- Nutrients can be sorbed on silt which can later become available to algae and plants
- Excess plants deplete oxygen and release more nutrients as they decay
- Nutrients can be released from sediments

Eutrophication

Common Symptoms

- Reduced clarity
- Large daily oscillations in dissolved oxygen
- pH shifts
- Algae blooms
- Excessive weed growth
- Fish kills
- Odor, aesthetic, and taste problems

Algae Control

Algae Control

Algae blooms are a tell tale sign of a nutrient enriched system

Algae Control

1st defense: source control of nutrients

- Limit fertilizer use
- Landscaping to limit lawn area
- Native plant buffer to intercept nutrients in runoff - biofilters
- Manage leaf litter
- Maintenance of on-site septic systems
- Restrict boat traffic to prevent resuspension of phosphorous in sediments

Algae Control

Other algae control techniques

- Precipitate phosphorus with chemical addition (buffered alum)
- Dyes
- Aeration
- Barley straw
- Aquascaping
- Algaecides
- Physical removal – nets or booms

Buffered Alum

- Binds with inorganic phosphorus
- Phosphorus precipitates out of the water
- Best for deep lakes
- Use in lakes that flush infrequently

Buffered Alum

Application techniques

- Low dose whole lake application from a boat as a solid or a slurry
- Sediment blanket
- Flow metered dosing
- Integration with sediments
- Apply with an aerator

Buffered Alum

Potential problems

- Alum toxicity
- Stimulated growth
- Elevated bacteria counts (temporary)
- Temporary reduction in benthic assemblage

Cost

- $25 per bag or $0.50 per gallon

Dyes

- Block sunlight
- Reduce algae growth
- Best in shallow lakes with severe benthic or filamentous algae problems
- Can enhance blue color

Dyes

- Liquid or powder form
- Inert dye similar to blue food colorant #5
- Use the dye in lakes or ponds that have limited outlets and a long detention time
- Usually lasts 6 to 8 weeks

Aeration

Artificial circulation brings oxygen-poor water up to the surface

- Surface Spray
- Paddlewheel
- Air Diffusers

Aeration

Benefits

- Provides oxygen for aerobic decomposition of organic matter
- Controls blue-green algae
- Prevents fish kills
- Liberates dissolved gases into the air instead of allowing them to build to harmful levels in the pond (NH_3, CO_2, H_2S, and methane)

Aeration

Surface agitators create turbulence

- Oxygen circulation
- Nutrient consumption
- Temperature control

Aeration

Selecting an aerator

- Oxygen Transfer Rates (OTR) in excess of 1lb/5kg per horse power per hour
- Pumps in excess of 300 GPM or 1200 LP per horsepower
- Recommend 1 to 3HP aerating units per surface acre

Aeration

Surface Spray

- Best vertical circulation in lakes less than 15 ft deep
- Create convection currents
- Break up algae mats

Aeration

Paddlewheel

- Shallow lakes
- Low above surface spraying
- Creates a strong current

Aeration

Air Diffusion

- Best mixing for deep lakes
- Diffuser on lake bottom
- Supplied by an air compressor

Aeration

Considerations

- Keep units off the sediments
- Place aerator to create a positive current
- Align to prevent shore erosion
- Cost $500 to $7000 plus power

Barley Straw

Decomposition produces compounds that inhibit or reduce algal growth

Barley Straw

Application

- Contained in wire mesh and staked to the bottom
- Deployed in spring
- Approximately 225 pounds of straw per acre
- EPA considers barley straw an algicide

Aquascaping

"Water Gardening"

- The use of aquatic plants to create a desirable plant community
- Plants compete with algae for nutrients
- Serve as habitat for zooplankton to compete with algae for nutrients
- Deter geese
- Stabilize shoreline
- Improve aesthetics and habitat

Aquascaping

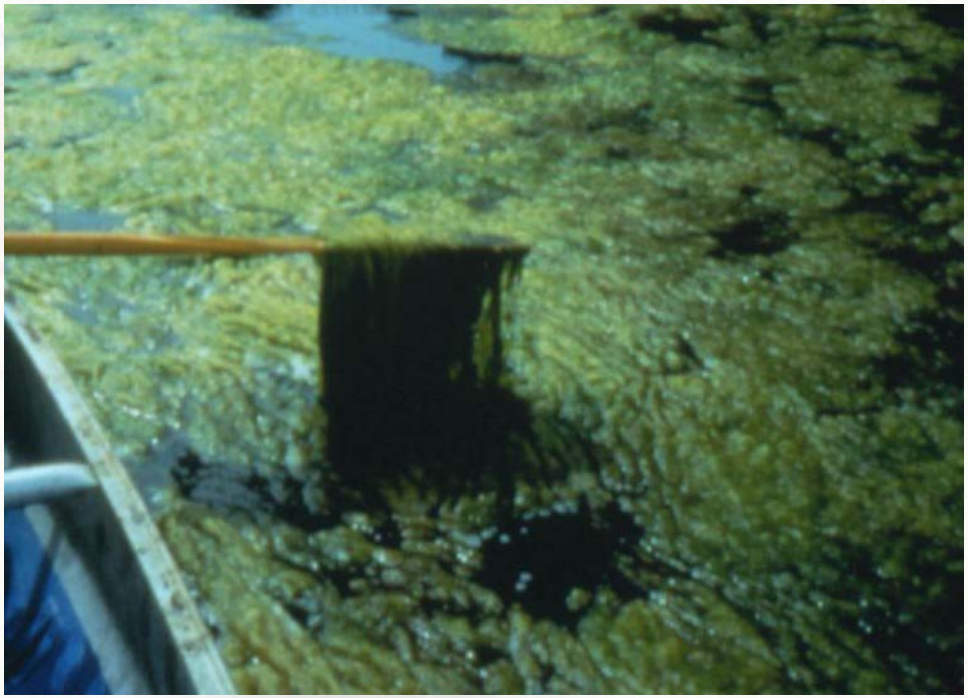
Planting

- Match species to depth
- Use diverse native species
- Be aware of invasive intrusion
- Includes vegetative buffers

Algaecides

Is it an algae or a plant?

- ID the algae
- Establish a nutrient control plan
- Select an appropriate algaecide



Algaecides

Problematic algae

- Filamentous
- Planktonic
- Stalked

Algaecides

Filamentous

- stringy
- grows on bottom
- breaks off and accumulates on surface

Algaecides

Planktonic

- exist throughout water column
- can form surface scums
- includes blue-green algae

Algaecides

Stalked

- *Chara* and *Nitella*
- can look like plants
- no roots
- usually beneficial for habitat
- can be a nuisance in shallow ponds

Algaecides

Active ingredients

- copper
- coppersulfate
- endothol
- percarbonate

AlgaePro from SePro – copper
AquaCure from Gordons – copper

Algaecides

Application

- Like herbicides, must be applied by licensed applicator in New Jersey
- EPA registered algaecides
- Apply according to label
- Water temperature requirements
- Usually apply once start growing, but not so late in the summer that decaying biomass is a problem

Algae Removal

- Removal with nets and booms
- Works best with filamentous algae
- A lot of biomass to dispose of
- Does not control source of problem

Biomanipulation

Biomanipulation

- Ecosystem control
- Manage aquatic plants
  - Introduce grass carp
- Manage algal blooms
  - Add predatory fish to eat the small minnows that feed on the zooplankton that feed on the algae

Biomanipulation

Grass Carp (White Amur)

- Biological tool for weed control
- Not native to US
- Triploid strain (sterile)

Biomanipulation

Grass carp considerations

- Can the problem plant be controlled by grass carp?
- Use only triploid certified fish
- Obtain appropriate permits
- Stock at least 8” fish in spring
- Stocking density 5-15/acre
- Monitoring

Biomanipulation

Palatable plant species

- Milfoil
- Naiad
- Elodea
- Coontail
- Curley leaf pond weed
- Duckweed
- Bladderwort
- Musk Grass
- Water star grass
- Cabomba

Biomanipulation

Regulation of grass carp in New Jersey

- Restricted to ponds less than 10 acres
- Fish certified triploid strain
- Only use if have more than 40% coverage of weeds, palatable to grass carp
- Restrict fish from downstream outlet

Biomanipulation

Algae control

- Limit the population of fish that graze on zooplankton by introducing other predator fish
- Bottom line is to increase zooplankton population

Biomanipulation

Lake Hopatcong

- Considering biomanipulation with a nutrient management plan
- Need to conduct holistic fish survey
- Hybrid striped bass and brown trout considered
- Alewife the dominant zooplankton-eating fish

Oradell Reservoir

- Introduced hybrid striped bass to control perch and gizzard shad

Lake Dredging

Lake Dredging

Why dredge?

- Deepening
- Limit nutrient cycling
- Reduction of macrophyte nuisances
- Removal of toxic sediments

Lake Dredging

Dredging Concerns

- Release of nutrients
- Resuspension of contaminants
- Destruction of benthic fish-food organisms
- Adequate disposal facility
- Cost

Lake Dredging

Sediment source control (root cause analyses)

- ID source of sediments
- Control the source to reduce the need to dredge again in the near future

Lake Dredging

Sediment Sources

- Stormwater outfalls, ditches
- Bank erosion
- Impervious surfaces
- Agriculture
- Construction sites

Lake Dredging

Sediment Testing

- Sampling
  - Sediment cores to project depth
  - Core composition
- Physical Analyses
  - Water content
  - Organic content
  - Particle size distribution

Lake Dredging

Chemical Analyses for upland disposal

- total phenols
- oil and grease
- reactivity
- nitrogen
- phosphorus
- minerals (Ca, Mg, K)
- base neutral priority pollutant organics
- heavy metals
- TCLP
- PCB's, DDT, and metabolites
- pH
- sulfur
- chlorides
- chlordane

Lake Dredging

Standards to compare the results

- If testing of dredge sediments is required, it is compared to the soil cleanup criteria for site remediation (e.g., residential or nonresidential)

Lake Dredging

Permits to dredge

County –

Soil Conservation District S&E Permit, may also need approvals to transport over county roads

State –

NJDEP Freshwater Wetlands

GP 1 Maintenance of existing structure

GP 13 Lake and pond dredging

Lake Dredging

State permits (cont'd)

- NJDEP Stream Encroachment
- NJDEP Bureau of Solid Waste (if landfilling)
- Water Quality Certificate
- NJDEP Lake Lowering, NJDEP Fish & Wildlife
- NJPDES may be required as part of a hydraulic dredging project

Lake Dredging

Public Notice

- Adjacent property owners
- County planning board
- Local planning board
- Environmental Commission

General Permit 13

- May request permit no more than once every 5 years
- DEP may require testing of the sediment if it is suspected to be contaminated

General Permit 13

Required Documentation

- Aerial photography
- Original construction plans
- Core borings
- Show that dredging will go no deeper than the original configuration and bottom contours of the lake
- Show will not enlarge the lake beyond the original configuration

General Permit 13

Lakes larger than five acres

- A USGS quad map showing all of the upstream land and water surface areas draining to the lake
- Land use in the upstream drainage area
- List and locations of sediment sources that discharge directly into the lake or into a tributary within 1,000 feet of the lake
- An estimate of the percent impervious surface cover of upstream drainage area

Lake Dredging

Dredging Process

- Mechanical – best for small projects & shorelines
  - Grab buckets
  - Clam shell
  - Excavation
  - Dragline

Lake Dredging

Hydraulic

- Pumps as a slurry
- Best for large scale projects
- Softer sediments
- Produces a high water content to be disposed

Lake Dredging

Disposal of dredge material

Beneficial reuse vs. disposal at landfill

- Engineered uses
- Agricultural and product uses
- Environmental Enhancement
- Roadway embankments
- Beach nourishment
- Use options depend on material type

Lake Dredging

Cost of dredging

Mechanical

- $8 – $25/ yd^3
- Plus containment

Hydraulic

- $6-$12/yd^3
- Plus travel

Disposal

Site Preparation

- Engineering (for hydraulic must size sedimentation basin)
- Clearing
- Dikes and berms
- Drainage
- Access
- Security

Disposal

Environmental Protection

- Liners
- Monitoring Wells
- Chemical Testing

Site Closure

- Time for dewatering
- Grading and seeding
- Landscaping

Shoreline Restoration

Shoreline Restoration

Predominant shoreline issue is erosion

Causes of erosion

- Runoff
- Wave action
- Ice
- Access points

Shoreline Restoration

Bioengineering and hard structure

- Vegetative buffer enhancements
  - Native plants
  - Water tolerant, sturdy vegetation
- Revetments – riprap, rootrap, gabions
- Outfall retrofitting with BMPs
  - Stormwater treatment wetlands
  - Bioretention systems
  - Premanufactured treatment systems.

Shoreline Restoration

Bioengineering solutions

Plants and other natural materials used to stabilize and restore existing or potential erosion problems

Shoreline Restoration

Benefits of Bioengineering

- Improve aesthetics
- Long term, low maintenance
- Cost
- Environmental quality

Shoreline Restoration

Basic components of bioengineering

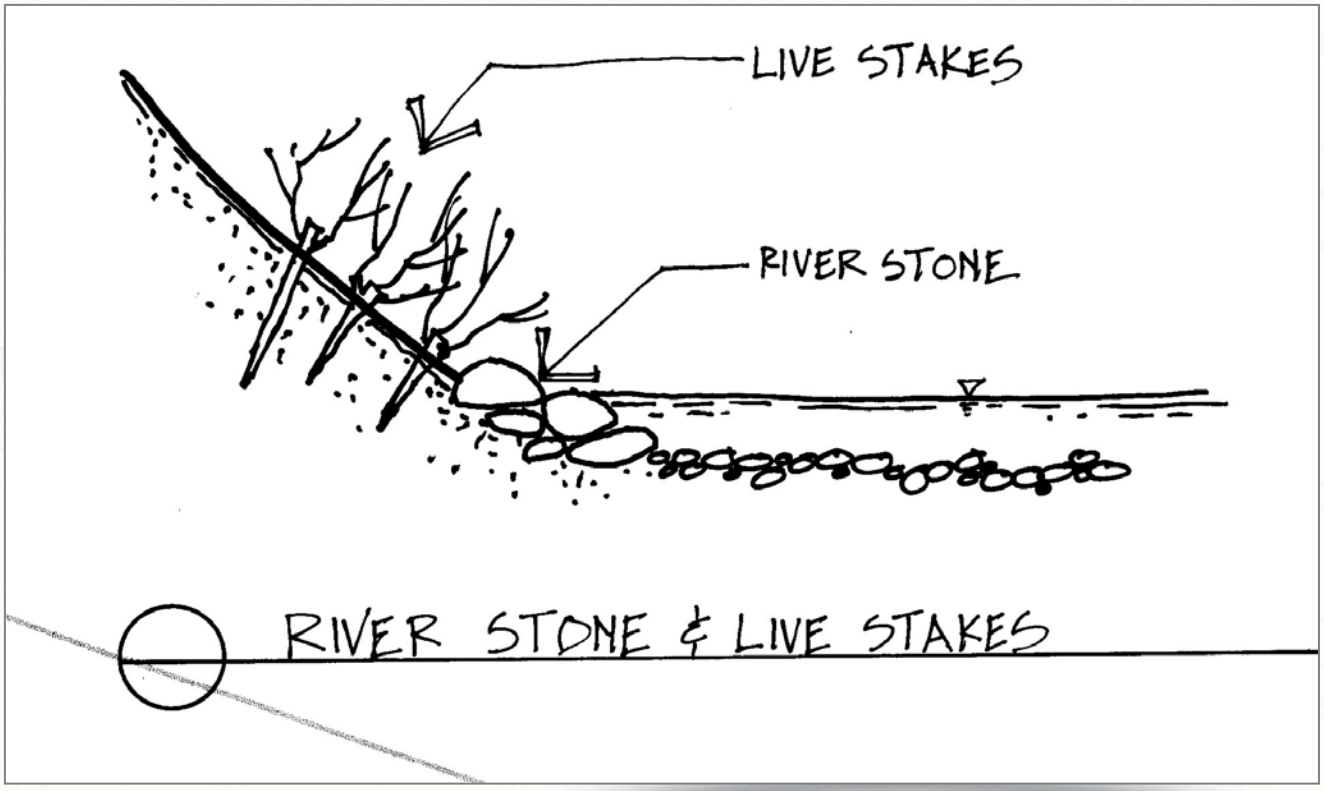
- Grading
- Live cuttings
- Erosion blanket
- Biologs
- Seeding

Shoreline Restoration

Vegetative systems

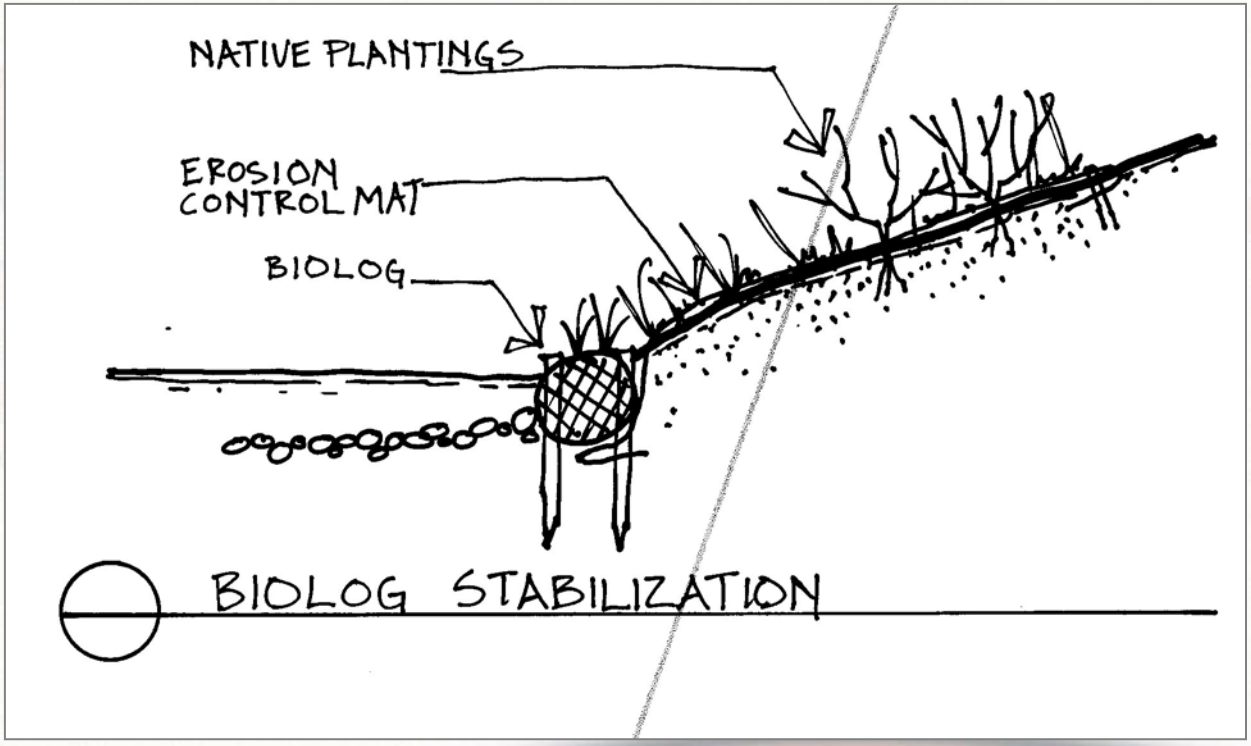
Shoreline Restoration

Structural Design



Shoreline Restoration

Stabilization with biologs



Shoreline Restoration

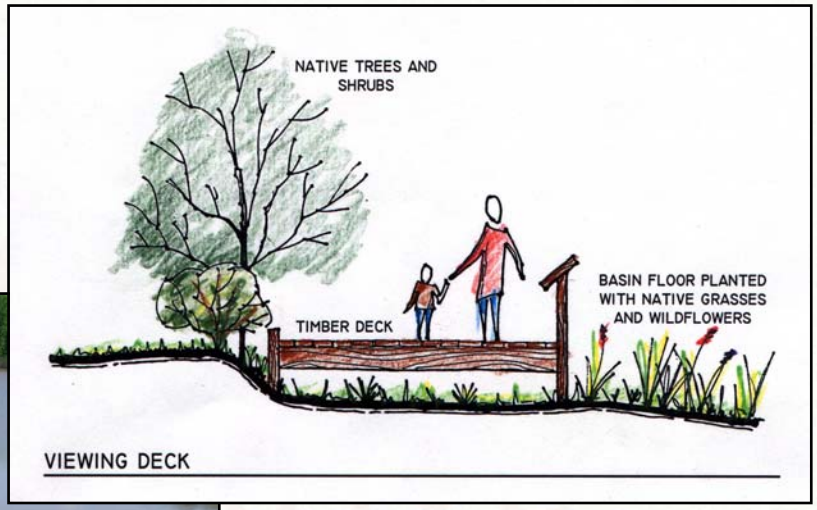
Biologs

Shoreline Restoration

Logs for bank stabilization

Shoreline Restoration

Provide human access points to the lake



Shoreline Restoration

Restoration project

Original Condition

Shoreline Restoration

Restoration in progress

Shoreline Restoration

Restored shoreline

Shoreline Restoration

Outfall retrofitting with BMPs

- Stormwater treatment wetlands
- Bioretention systems
- Pre-manufactured treatment systems

Shoreline Restoration

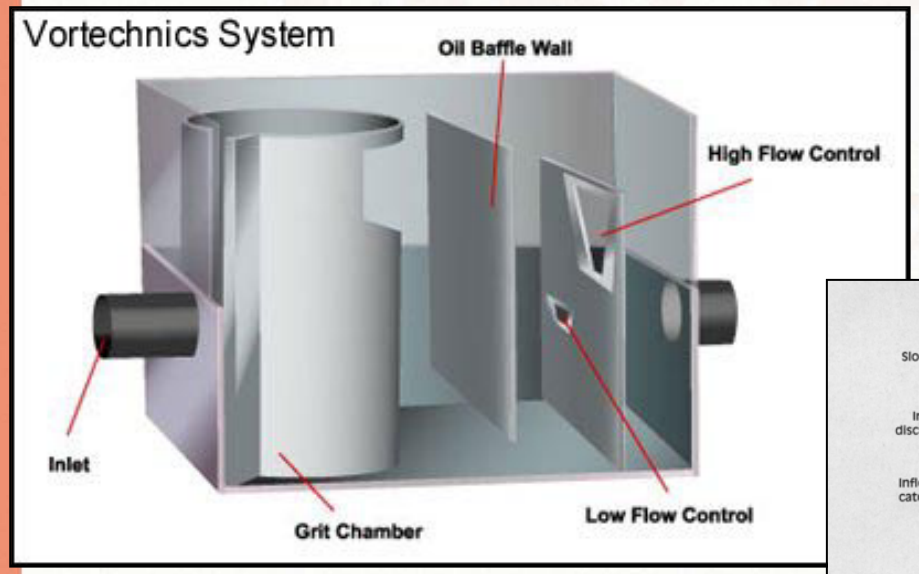
Stormwater treatment wetlands

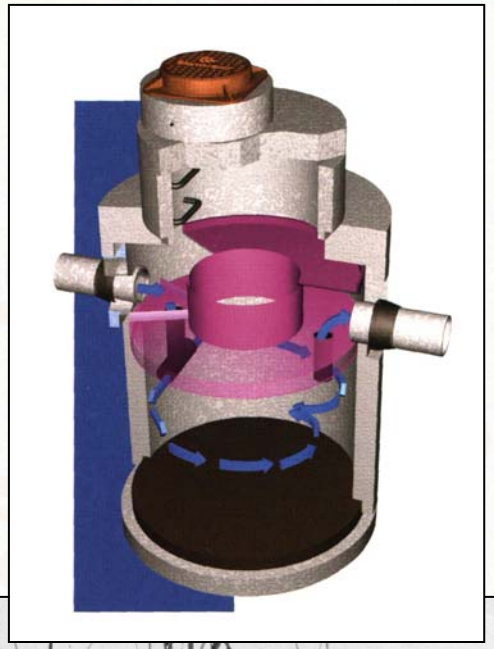
Shoreline Restoration

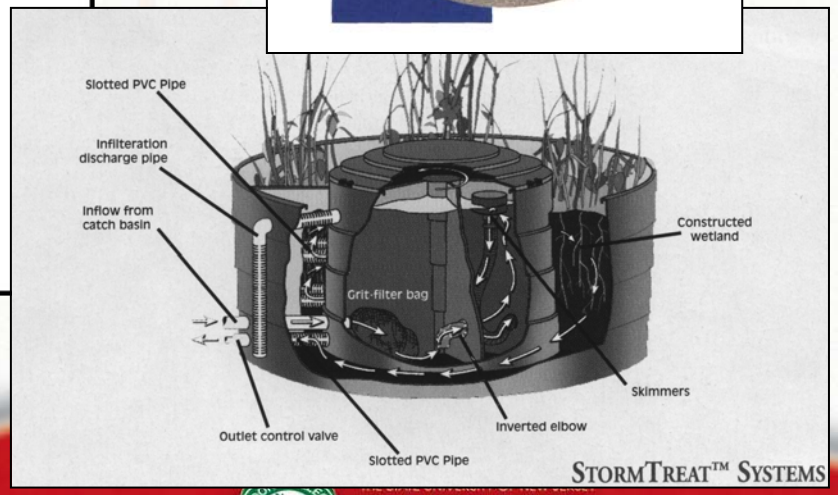
Bioretention Systems

Shoreline Restoration

Pre-manufactured treatment systems







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