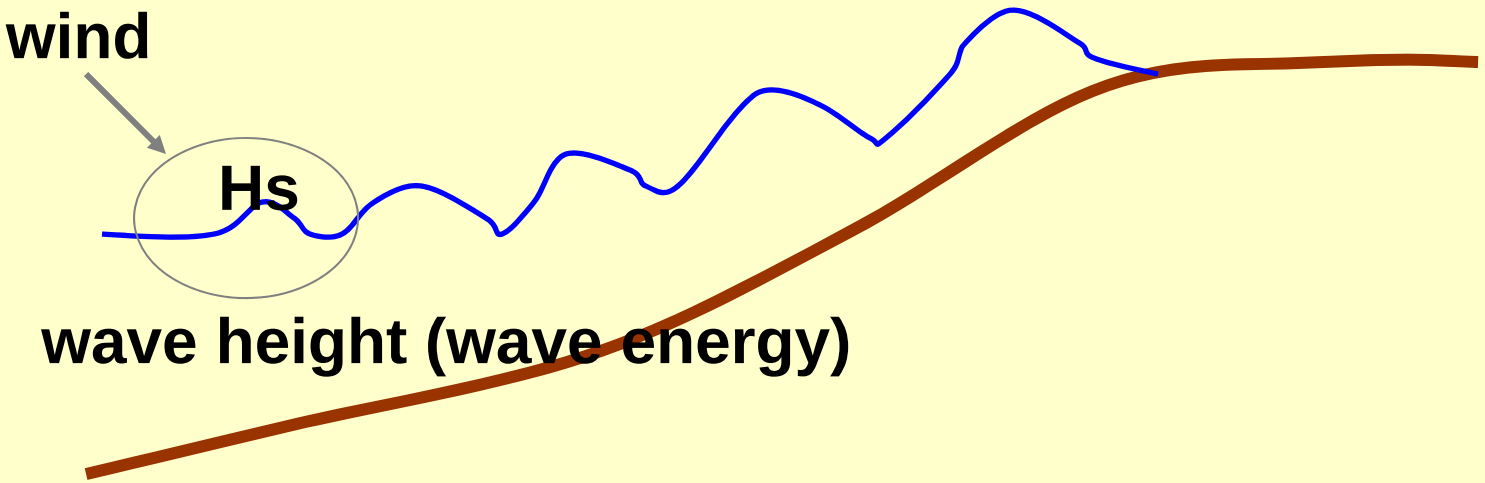
Erosion Control for Wisconsin's Inland Lakes and Flowages

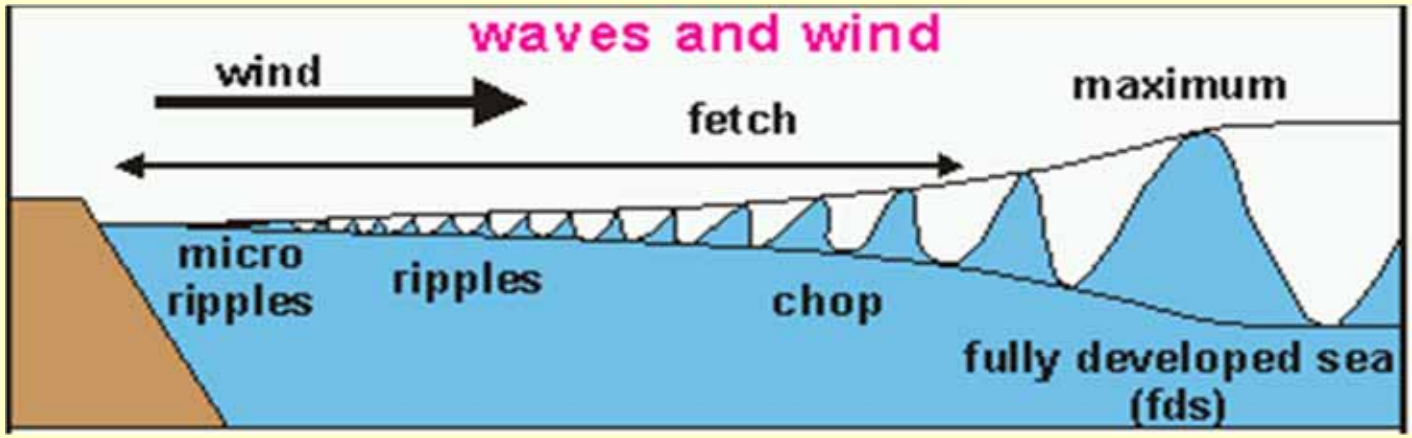
Wind Generated Waves



Hs = function **(1) wind speed U_{10}**
(2) fetch [size of lake], X
(3) water depth, d

Wave Processes

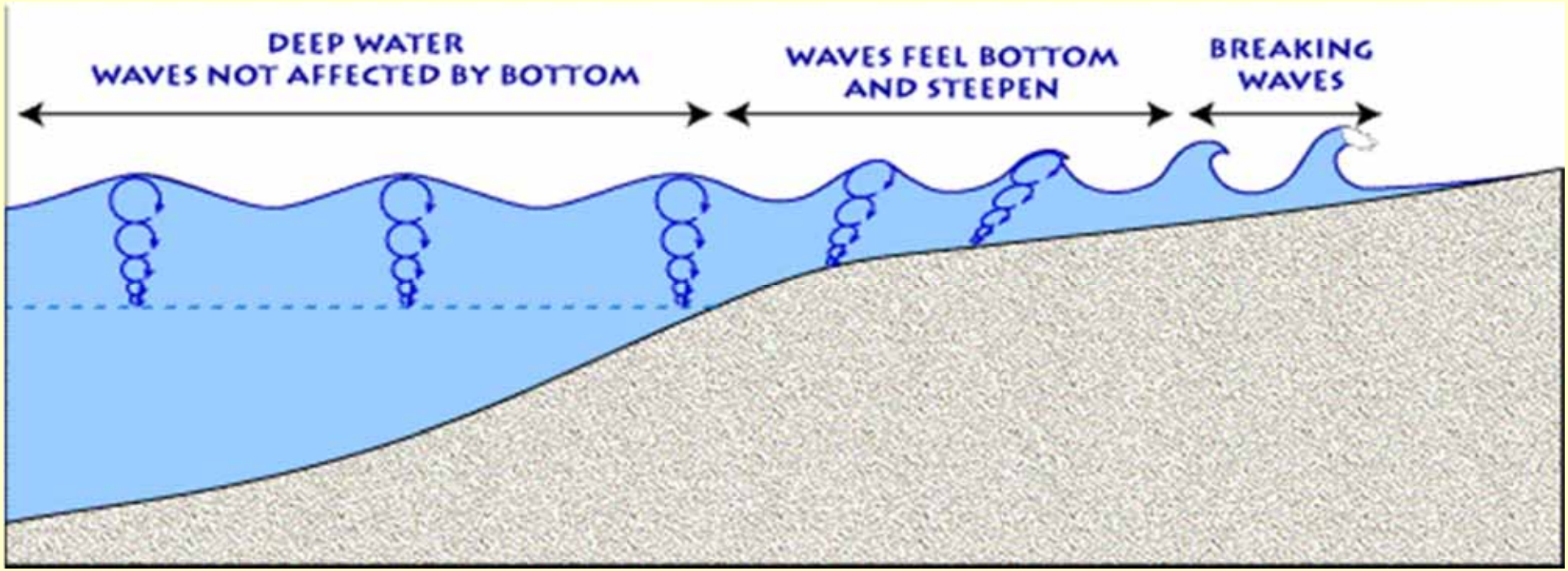
Deep Water – Off Shore Generation



Wave Processes

Shallow Water – Near Shore

- Shoaling
- Breaking



Young's Relationship

$$\frac{gH_s}{U_{10}^2} = 0.241\left\{\tanh A_1 \tanh\left[\frac{B_1}{A_1}\right]\right\}^{0.87}$$

$$\frac{U_{10}}{T_s g} = 0.133\left\{\tanh A_2 \tanh\left[\frac{B_2}{A_2}\right]\right\}^{-0.37}$$

Where

$$A_1 = 0.493\left(\frac{gd}{U_{10}^2}\right)^{0.75}, B_1 = 0.00313\left(\frac{gx}{U_{10}^2}\right)^{0.57}$$

$$A_2 = 0.331\left(\frac{gd}{U_{10}^2}\right)^{1.01}, B_1 = 0.0005215\left(\frac{gx}{U_{10}^2}\right)^{0.73}$$

ELSEVIER

Coastal Engineering 29 (1996) 47–78

COASTAL ENGINEERING

The growth of fetch limited waves in water of finite depth. Part 1. Total energy and peak frequency

I.R. Young [a], L.A. Verhagen [b]

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Received 17 August 1995; accepted 9 February 1996

SHAID_TYP – A two-character code for each region. The code represents areal water features. This item is indexed.

BA Backwater
CB Cranberry Bog
DP Duck Pond
DC Ditch or Canal
FH Fish Hatchery or farm
FE Flooded Excavation (e.g. pits, quarries, old mines)
IA Inundation Area
IW Industrial Waste Pond
LP Lake or Pond
RF Reservoir or Flowage
ST Double-line Stream
SD Sewage disposal pond or filtration beds
TP Tailings Pond
UN Unknown hydrography polygon
ZZ Convoluted Stream

WebView
maps.dnr.state.wi.us/webview

Layers | Refresh Map | Legend | Find Location | Themes | Select | Help

YOU ARE ON WISCONSIN.GOV

Basic Tools

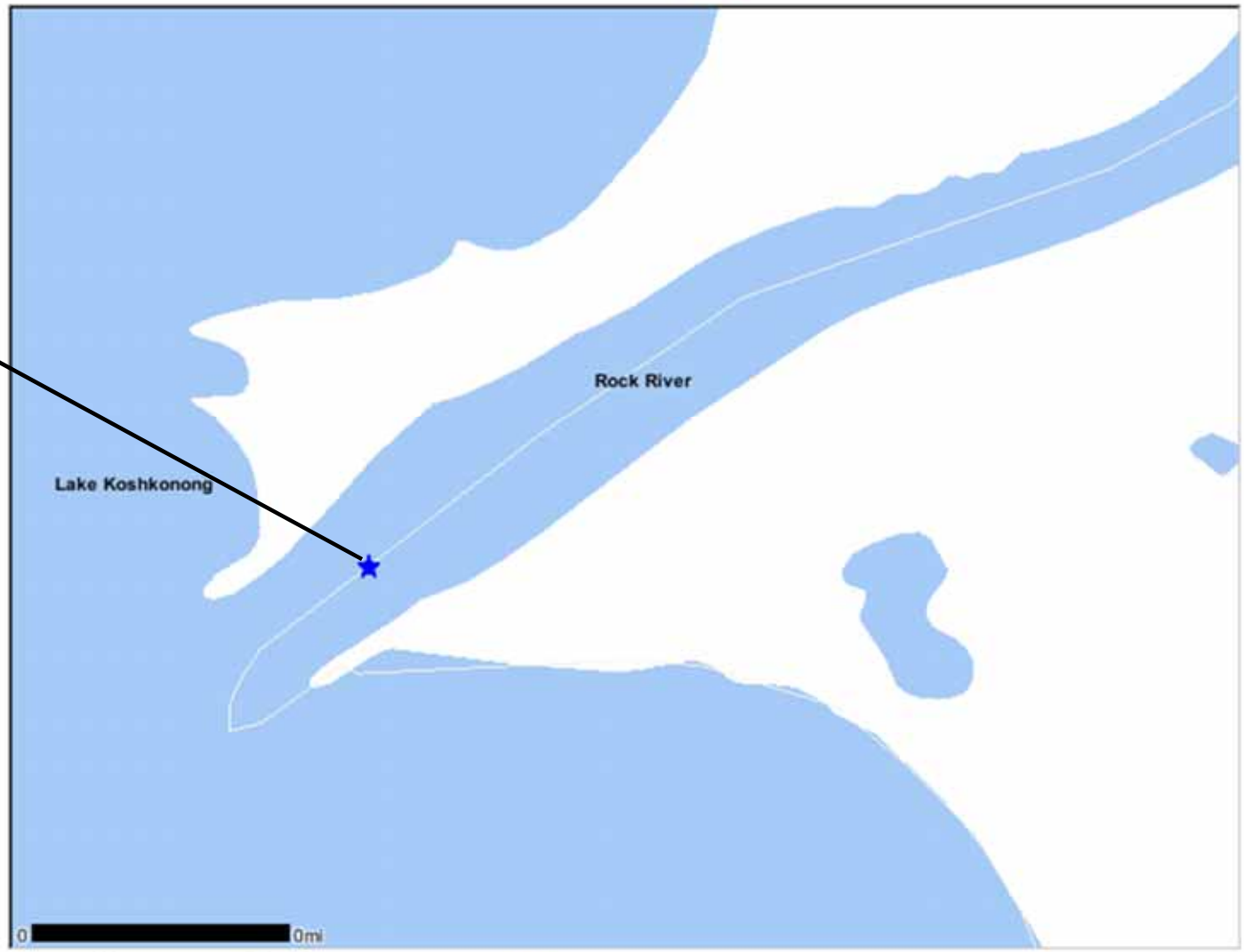
Identify Results

24K Open Water

SHAID No.:	51000183
SHAID Name:	Rock River
SHAID Water Body Id Code (WBIC):	788800
River System Name:	Rock River
River System WBIC:	788800
SHAID Type:	ST
Water Duration Code:	PN
Landlock Code:	NO
Last Update Hydro Version No.:	1

Coordinate Position

Lat/Lon:	88° 54' 54.7" W 42° 53' 26.7" N
UTM (x, y):	343615, 4750463 (zone 16)
WTM:	608575, 269255



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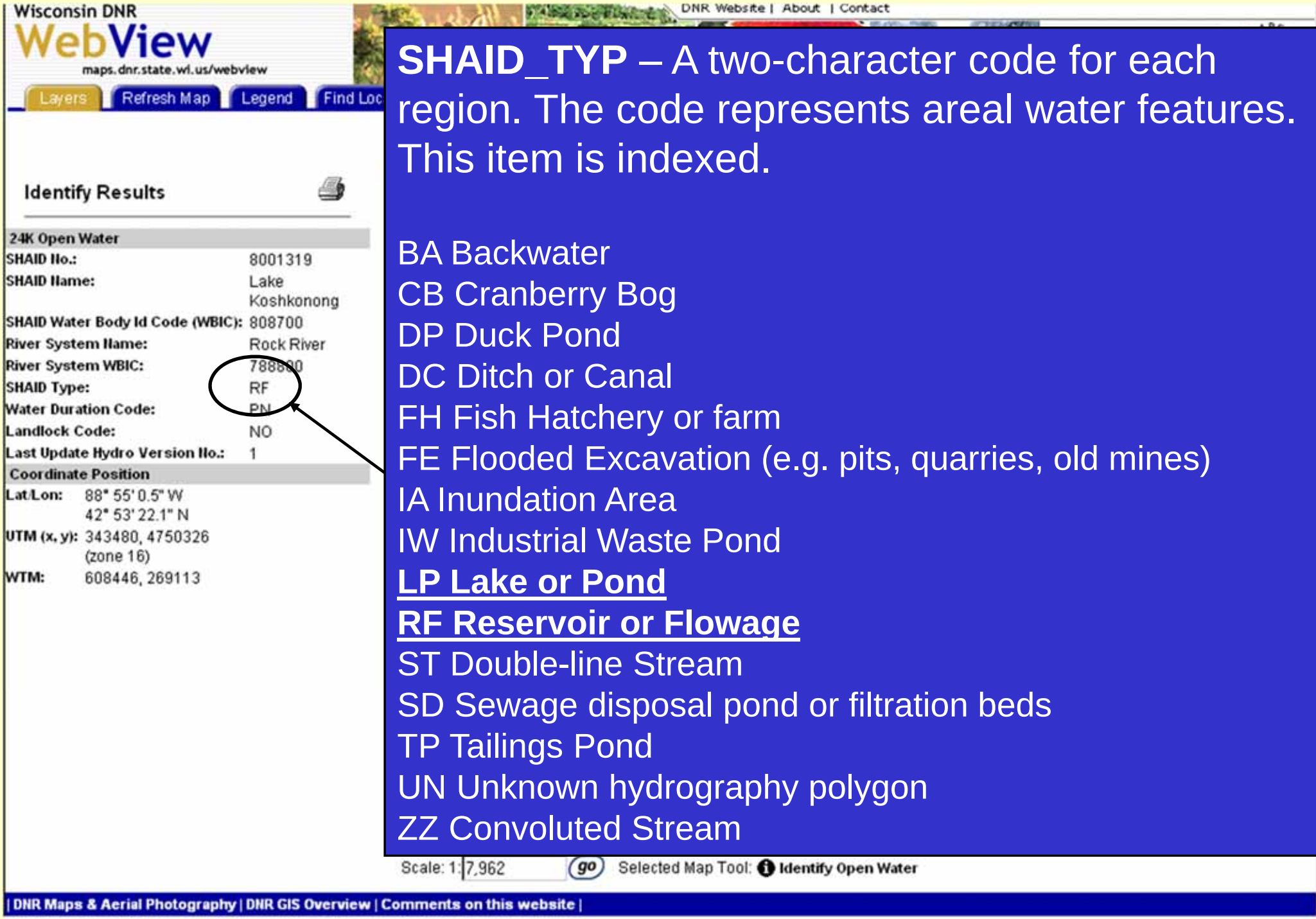

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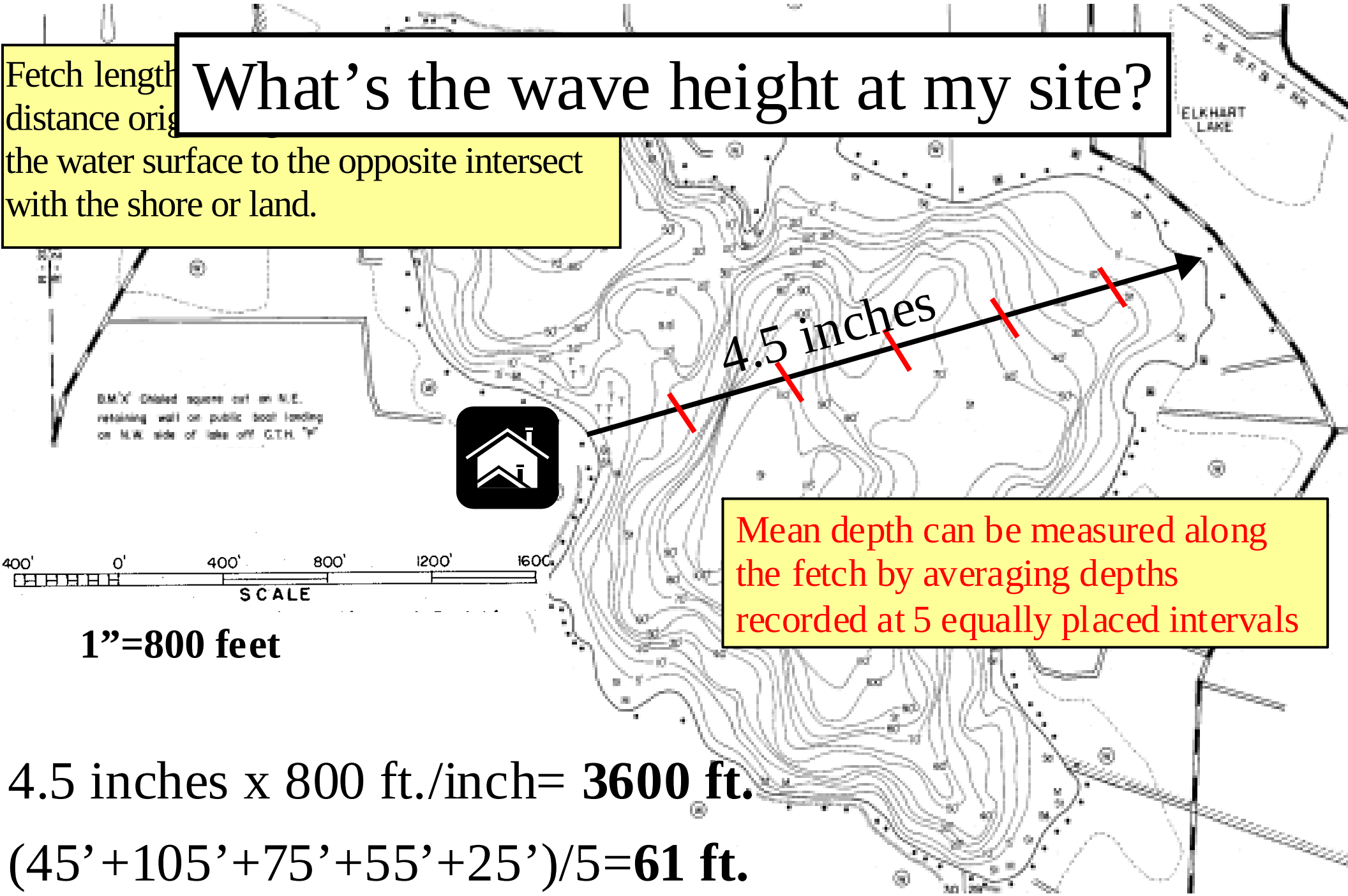
ST Double-line Stream
SD Sewage disposal pond or filtration beds
TP Tailings Pond
UN Unknown hydrography polygon
ZZ Convoluted Stream

What's the wave height at my site?

Fetch length
distance orig
the water surface to the opposite intersect with the shore or land.



Mean depth can be measured along the fetch by averaging depths recorded at 5 equally placed intervals

1"=800 feet

4.5 inches x 800 ft./inch= **3600 ft.**

(45'+105'+75'+55'+25')/5=**61 ft.**

Proposed Rules
Public Hearings
Workshops
Permit Process Today
Emergency Rules Today
Current News
Annual Report

Activities
Aquatic Plant Control
Aquatic Plant Barrier
Beaver Damage
Boathouse Repair
Boat Ramp (Landings)
Boat Shelter
Bridges
Buoys
Culverts
Dams
Dredging
Dry Hydrants
Fish Habitat
Fords
Grading
Irrigation
Lake Levels
Misc. Structures
Nonmetallic Mining
Pea Gravel Blanket
Piers, Docks, Wharves
Pilings
Ponds
Shoreline Erosion Control
Stream Realignment
Swimming Rafts
Utility Waterway Crossing

[ ] inches

6. To convert the ruler measurement of fetch to actual distance, multiply feet per inch (found in step 2) by the measured fetch line (found in step 5):

Lake Fetch = [ ] feet/inch x [ ] inches = 0 feet

7. Measure the mean depth along your fetch line

    1. Locate and mark at least 5 equally-spaced points along your fetch line.
    2. Estimate and record the depths at these equally spaced points (for example: 45', 105', 75', 55' and 25').
    3. Add these depth values together and then divide by the number of sample points taken, and record the result. For example, (45'+105'+75'+55'+25')/5 = 61 feet. Use this example *(PDF, 273KB)* for reference.

8. Using the two values obtained in steps six and seven, *fetch from your site* and *mean depth on your fetch line*, use the wind wave model below to calculate the storm wave height at your site. The storm wave height is used to determine the *energy category* at your site.

Lake Mean Water Depth	22	feet
Lake Fetch From My Site	3.3	miles
Storm Wind Speed	51.33	ft/sec

Calculate

Storm Wave Height **1.80 feet**

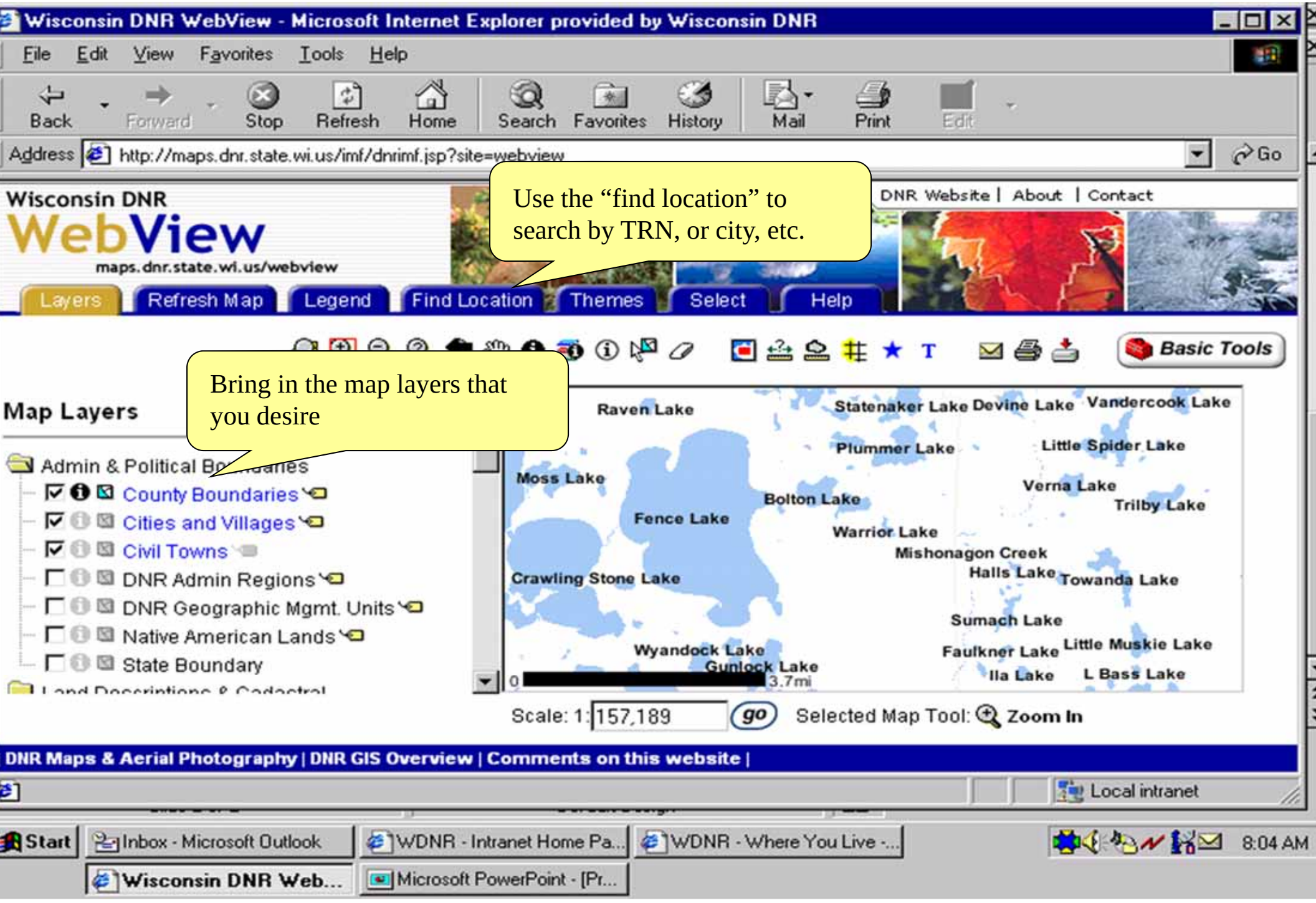
Energy Category **Moderate Energy**

9. Print out this page and submit it with your application.

Note: This page contains one or more Adobe Portable Document Format (PDF) files, which can be viewed and printed with the freely available Adobe® Reader® software.

NR 328-Using DNR WebView (http://maps.dnr.state.wi.us/webview/) to Calculate Maximum Fetch, Average Fetch, and Shore Orientation

Toggle on the Advance Tools button


Wisconsin DNR WebView - Microsoft Internet Explorer provided by Wisconsin DNR
File Edit View Favorites Tools Help
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Address http://maps.dnr.state.wi.us/imf/dnrimf.jsp?site=webview
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County Boundaries
Cities and Villages
Civil Towns
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Native American Lands
State Boundary
Raven Lake
Statenaker Lake
Devine Lake
Vandercook Lake
Plummer Lake
Little Spider Lake
Moss Lake
Verna Lake
Bolton Lake
Trilby Lake
Fence Lake
Warrior Lake
Mishonagon Creek
Halls Lake
Towanda Lake
Crawling Stone Lake
Sumach Lake
Wyandock Lake
Faulkner Lake
Little Muskie Lake
Gunlock Lake
Ila Lake
L Bass Lake
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WDNR - Where You Live -...
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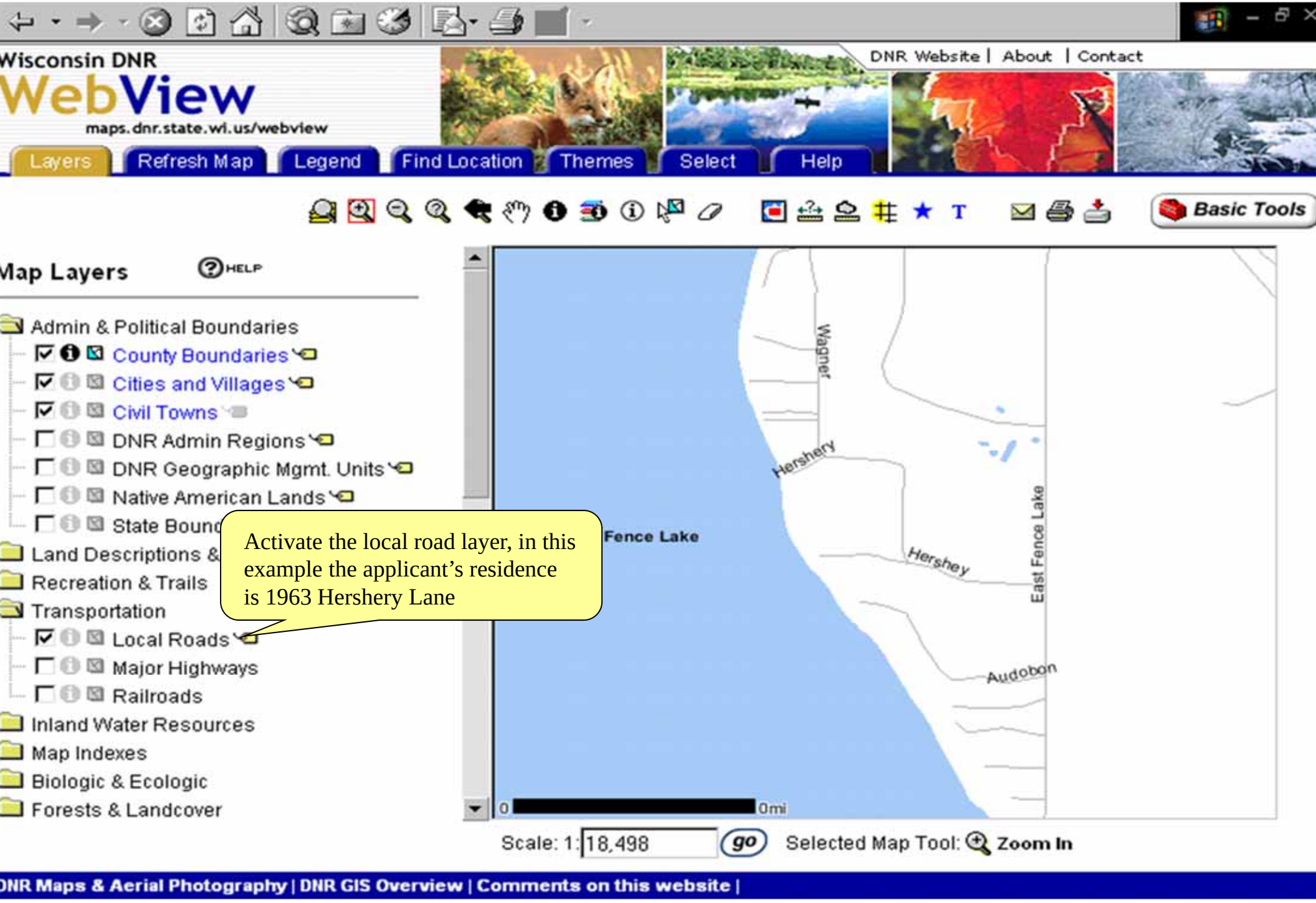
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Select
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County Boundaries
Cities and Villages
Civil Towns
DNR Admin Regions
DNR Geographic Mgmt. Units
Native American Lands
State Bound
Land Descriptions &
Recreation & Trails
Transportation
Local Roads
Major Highways
Railroads
Inland Water Resources
Map Indexes
Biologic & Ecologic
Forests & Landcover
Activate the local road layer, in this example the applicant's residence is 1963 Hershery Lane
Fence Lake
Wagner
Hershery
Hershey
East Fence Lake
Audobon
0
0mi
Scale: 1:18,498
go
Selected Map Tool: Zoom In
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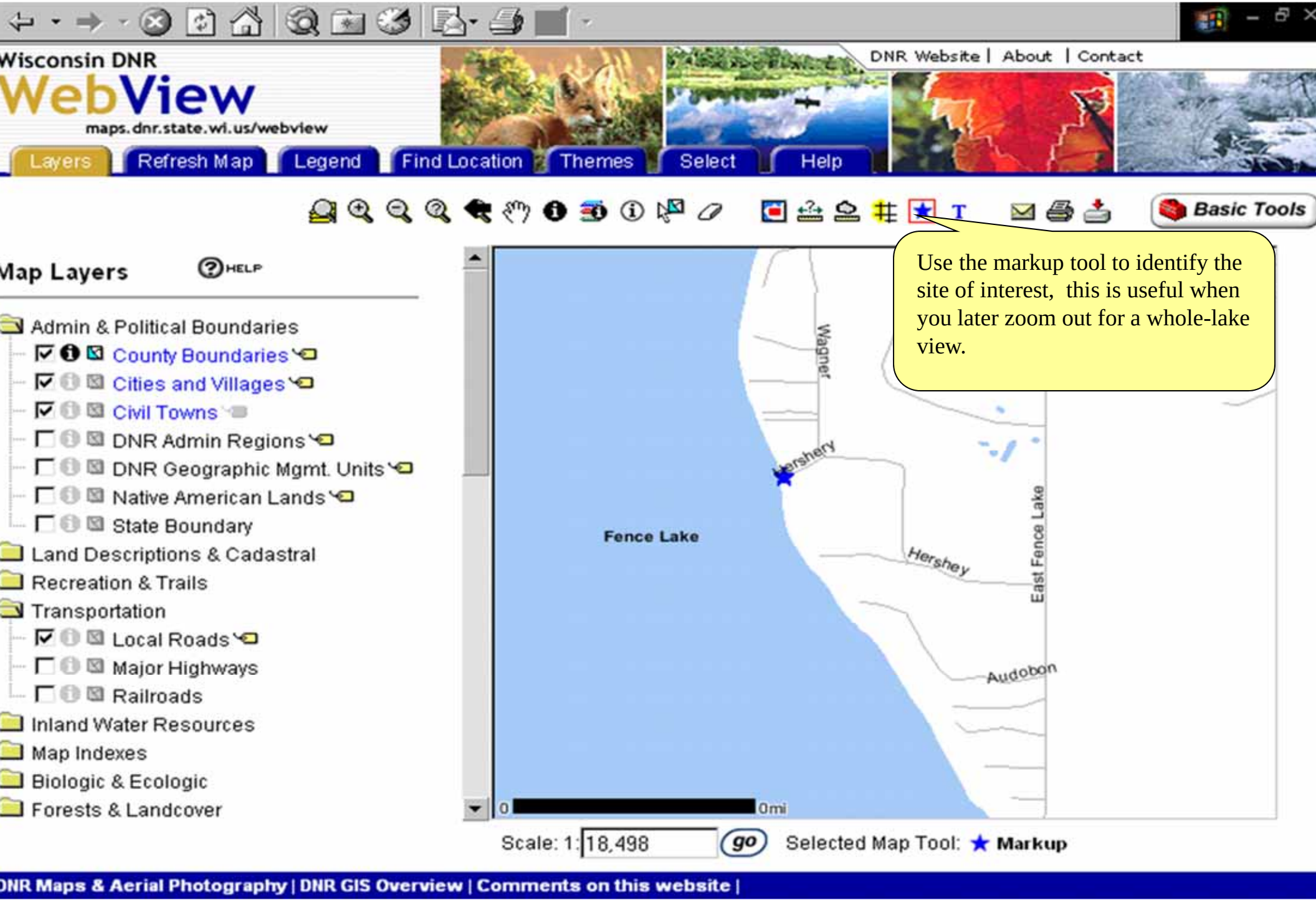
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Local Roads
Major Highways
Railroads
Inland Water Resources
Map Indexes
Biologic & Ecologic
Forests & Landcover
Use the markup tool to identify the site of interest, this is useful when you later zoom out for a whole-lake view.
Wagner
Hershey
Fence Lake
Hershey
East Fence Lake
Audobon
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Scale: 1:18,498
go
Selected Map Tool: Markup
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WebView
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Basic Tools

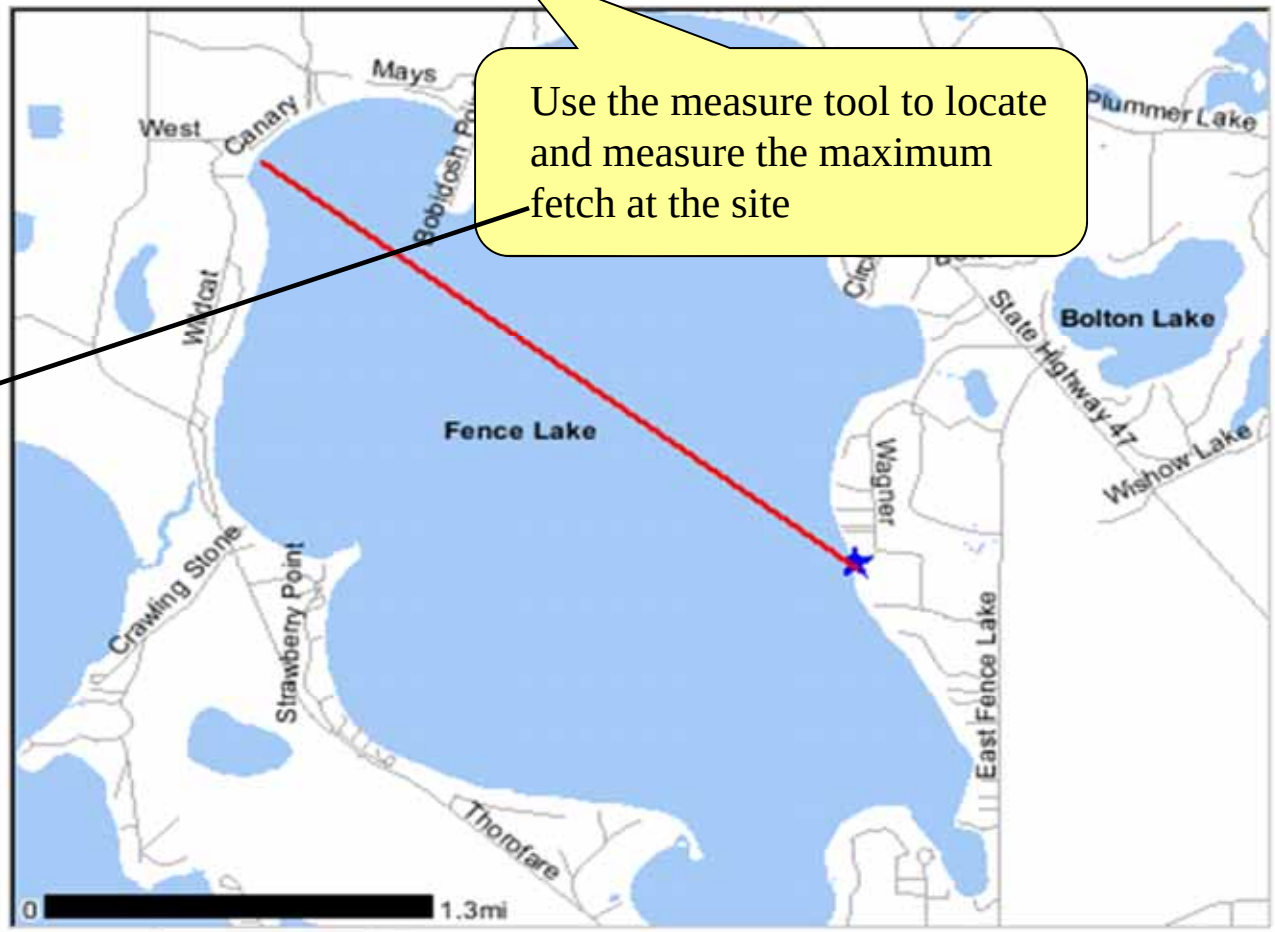
Measure Tool

This document shows the positions of the points that you have clicked on the map using the measure tool, and reports the great circle distance between them.

Position	89° 49' 19" W 45° 56' 42" N
Position	89° 51' 44" W 45° 58' 0" N
Distance	12,927.8 ft
True Course	307.7°

Clear Points

Use the measure tool to locate and measure the maximum fetch at the site



Scale: 1:53,406 go Selected Map Tool: Measure

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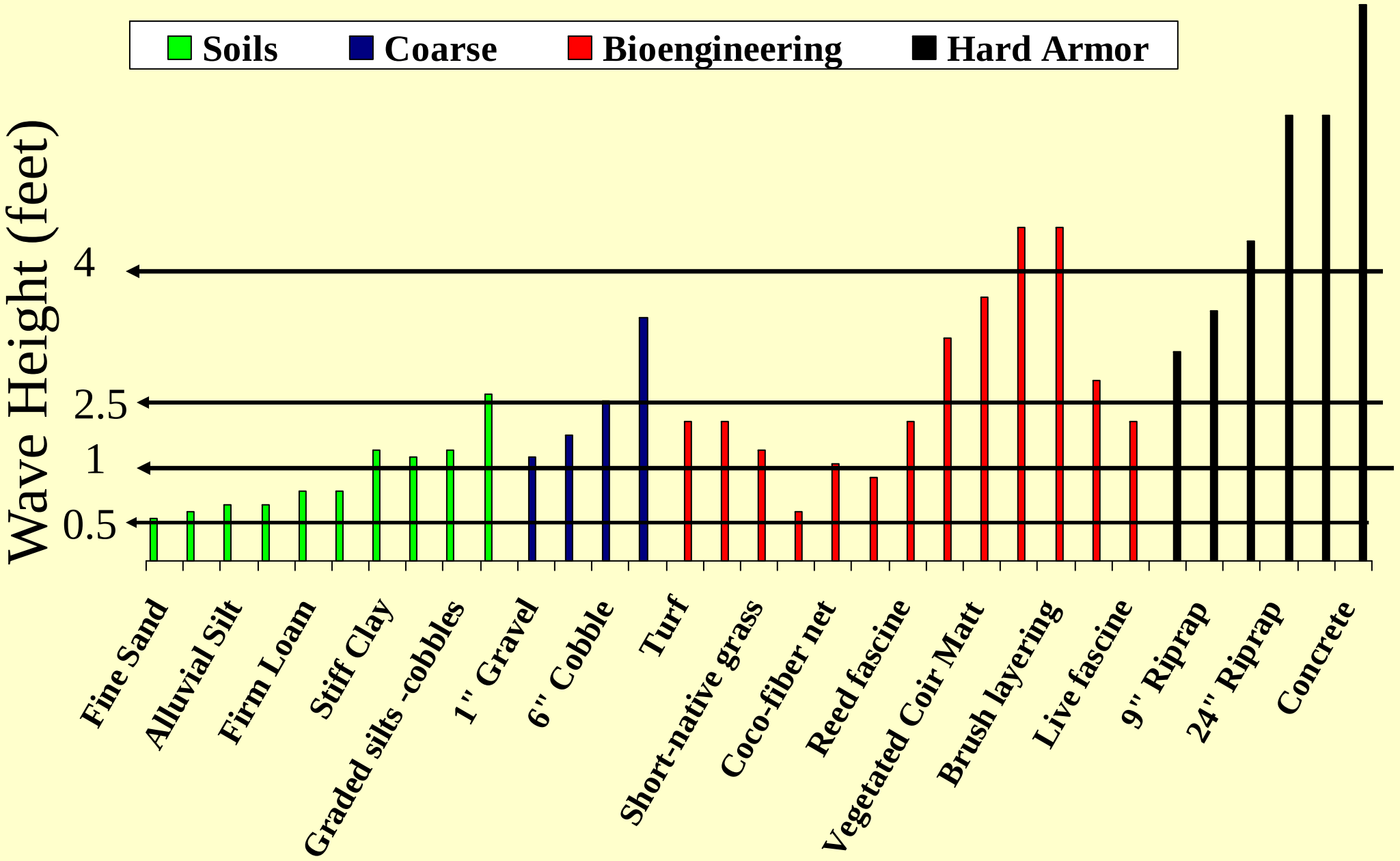
Stability of Shore Protection Materials



Energy Category

- Classifies Shoreline Sites Based on Erosion Severity

Low Energy	Moderate Energy	High Energy
< 1 foot	1- 2.3 feet	>2.3 feet

What Causes Erosion?

- Wind-driven waves
- **Boating Waves**
- **Ice action**
- **Long-shore currents**
- **Removal/loss of bank vegetation**
- **Removal/loss of shallow water aquatic plants**
- **Tributary areas and flowing water**

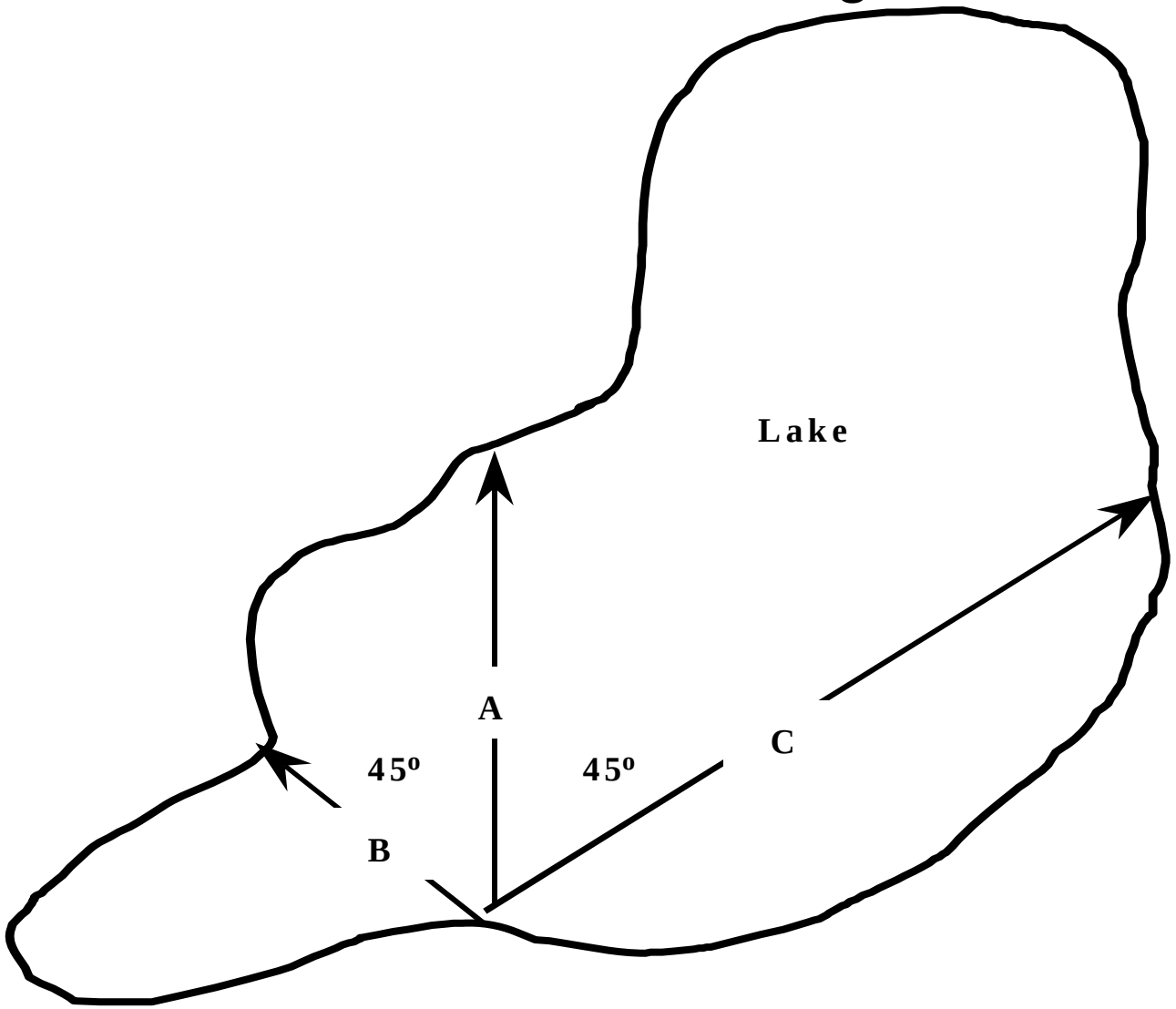
Erosion Intensity

Alternative Site Assessment Method

- **Fetch**
- **Shoreline Geometry**
- **Shoreline Orientation**
- **Boat Wakes**
- **Bank Height**
- **Bank Composition**
- **Influence of Adjacent Structures**
- **Depth at 20 Feet**
- **Depth at 100 Feet**
- **Aquatic Vegetation**
- **Bank Stability**
- **Bank Vegetation**

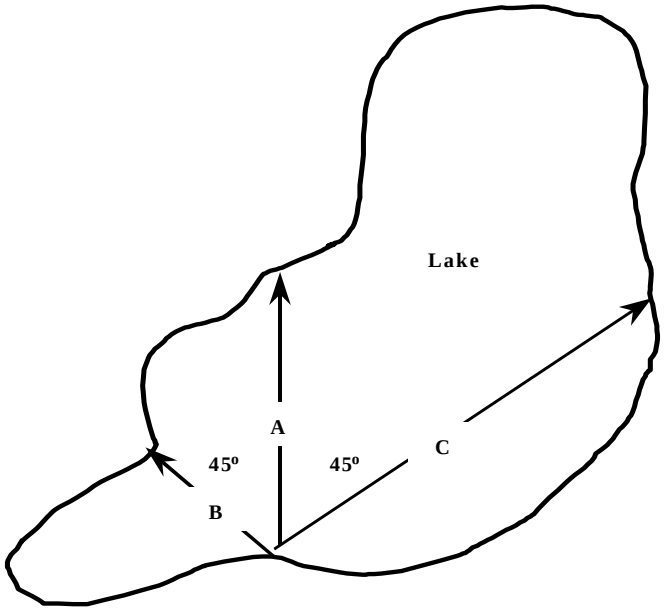
Locating and Measuring Average Fetch

Note: Average fetch; The following diagram describes the calculation of average fetch.

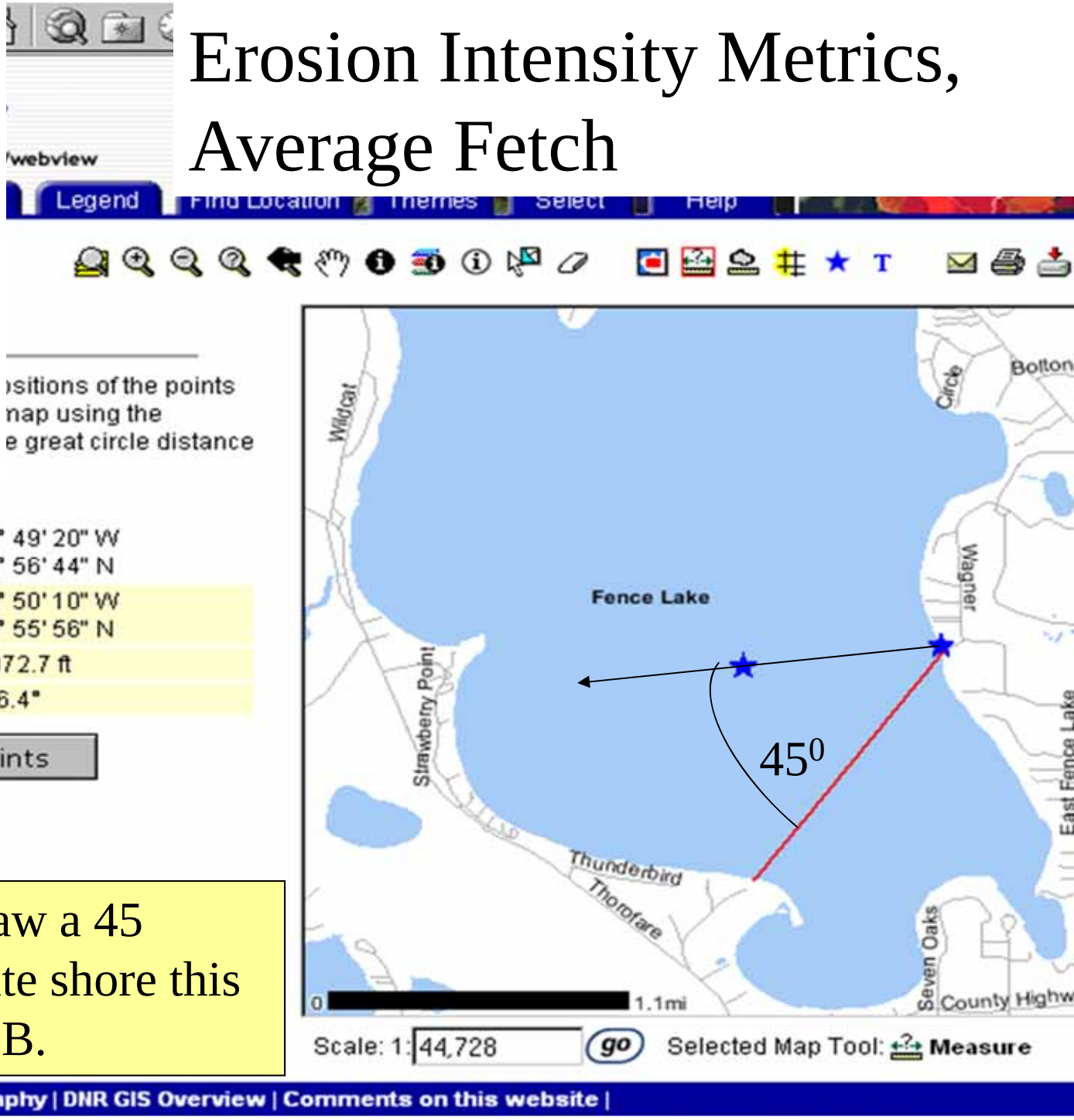


$$ave.\ fetch = (B + C)/2$$

Erosion Intensity Metrics, Average Fetch

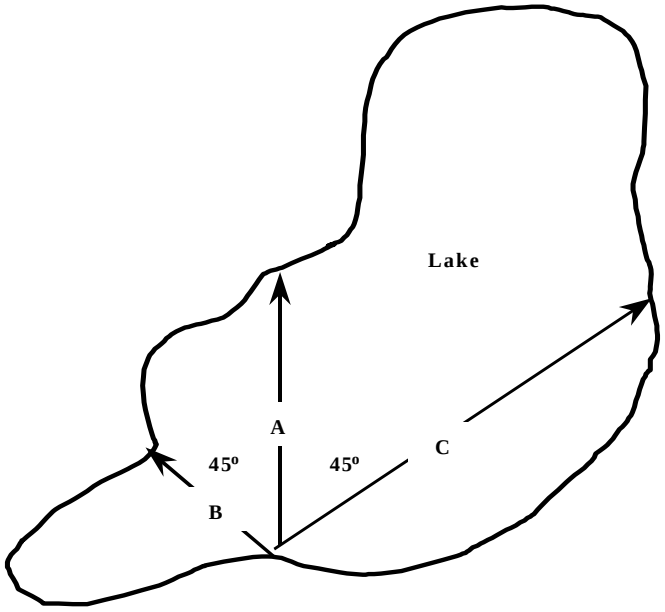


Ave. Fetch = (B + C) / 2

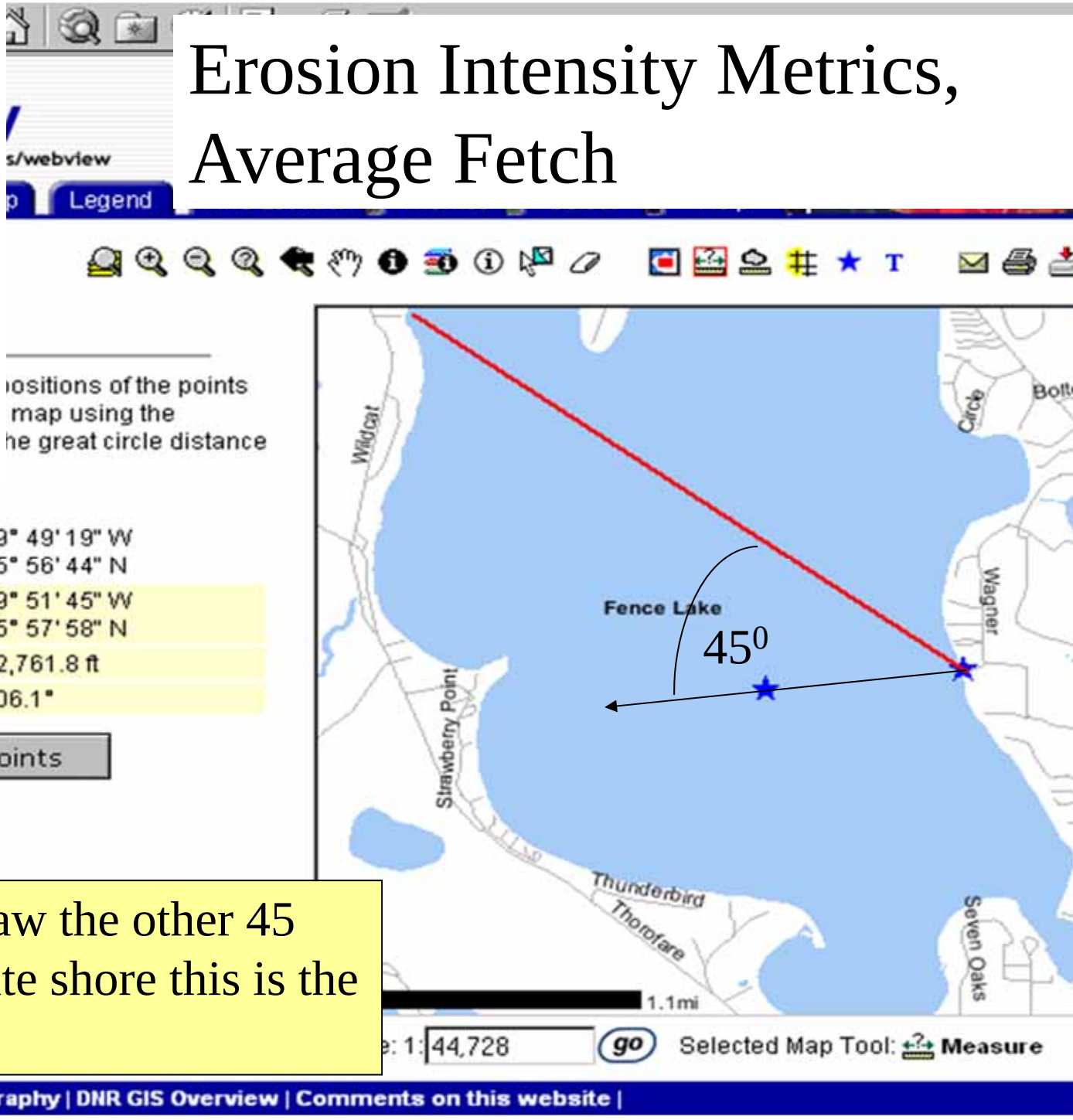


Using the measure tool draw a 45 degree offset to the opposite shore this is the measure of distance B.

Erosion Intensity Metrics, Average Fetch



Ave. Fetch = (B + C) / 2



Using the measure tool draw the other 45 degree offset to the opposite shore this is the measure of distance C.

Erosion Intensity

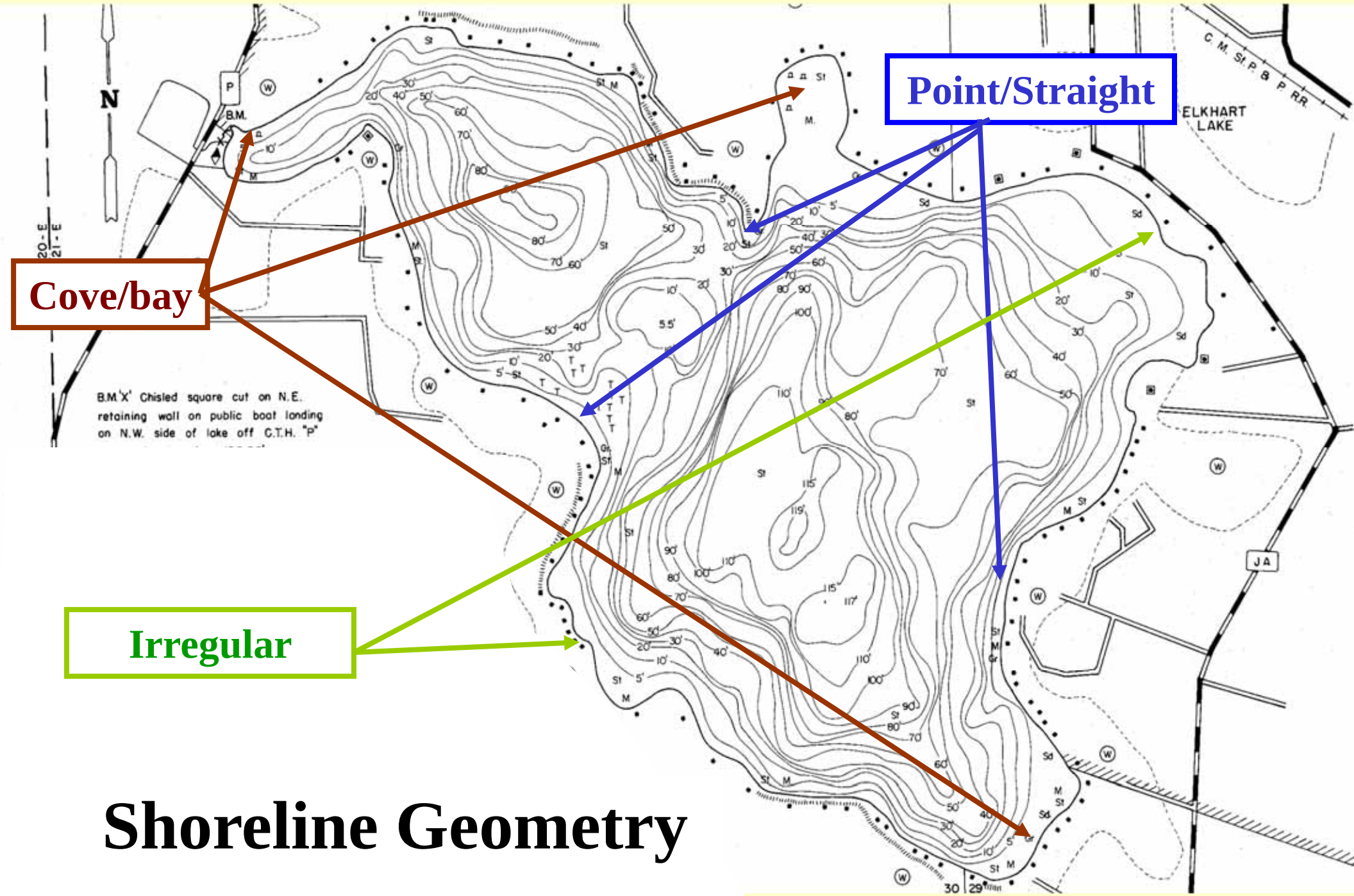
Lake Map

- Fetch (you just measured from the storm wave height exercise)
- Shoreline Geometry (3 choices)

  cove/bay (1)

  irregular shoreline (4)

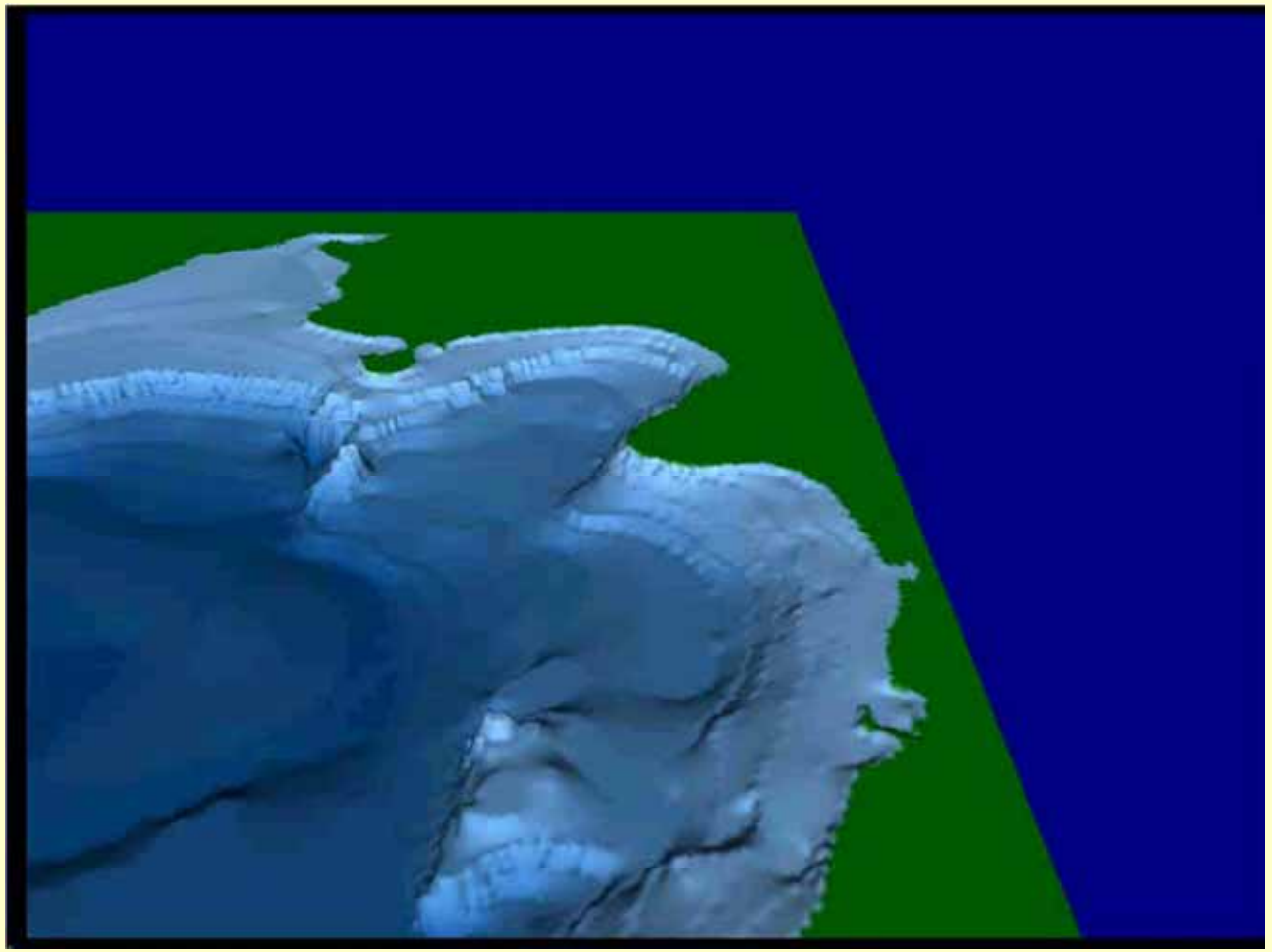
  headland, point, or straight shoreline (8)



Shoreline Geometry

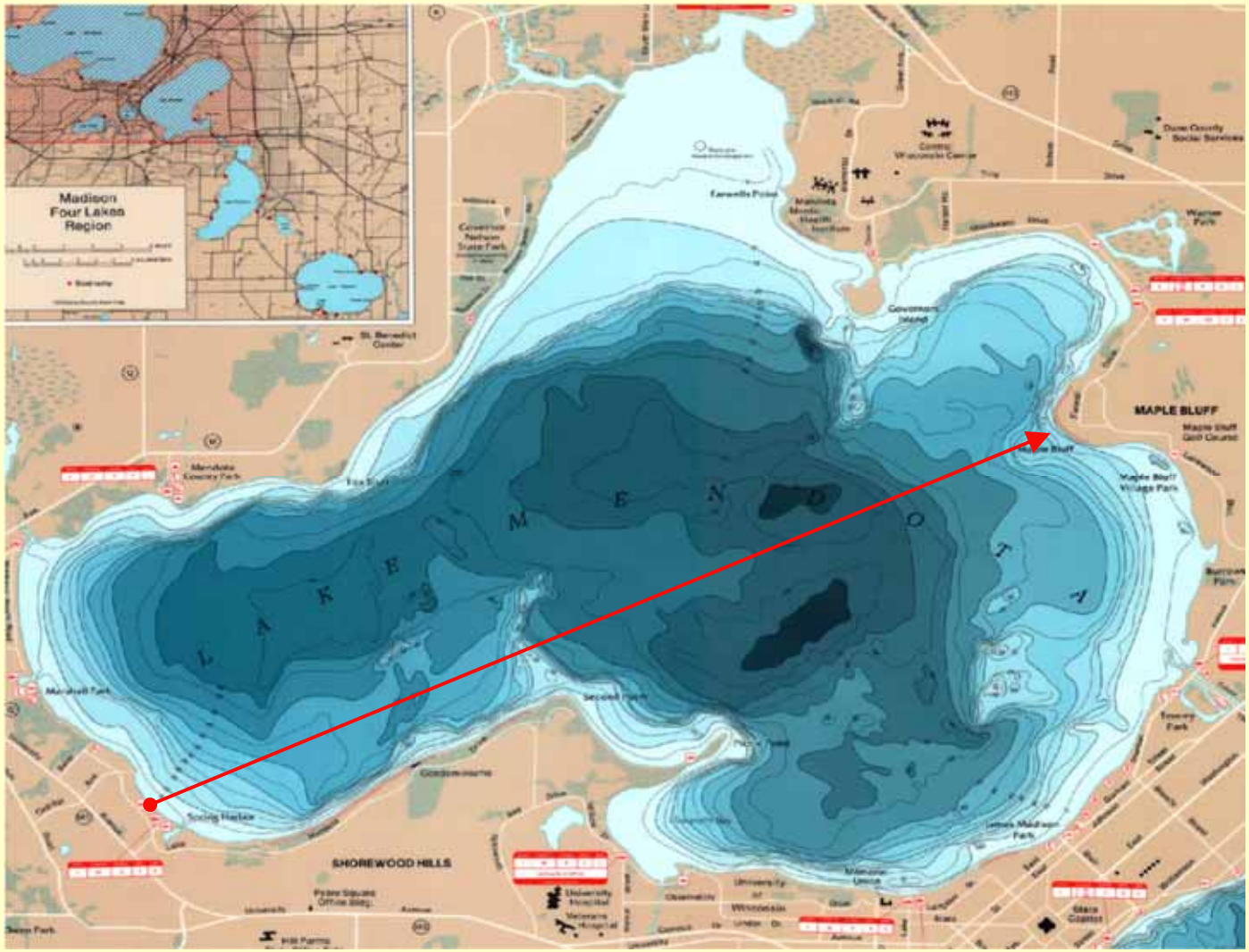
Shoreline Geometry

Maple Bluff, Lake Mendota



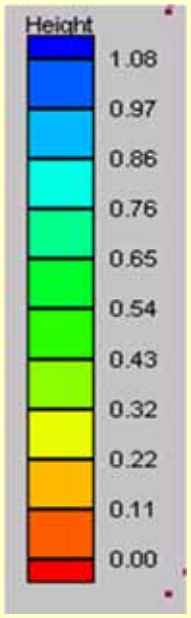
Shoreline Geometry

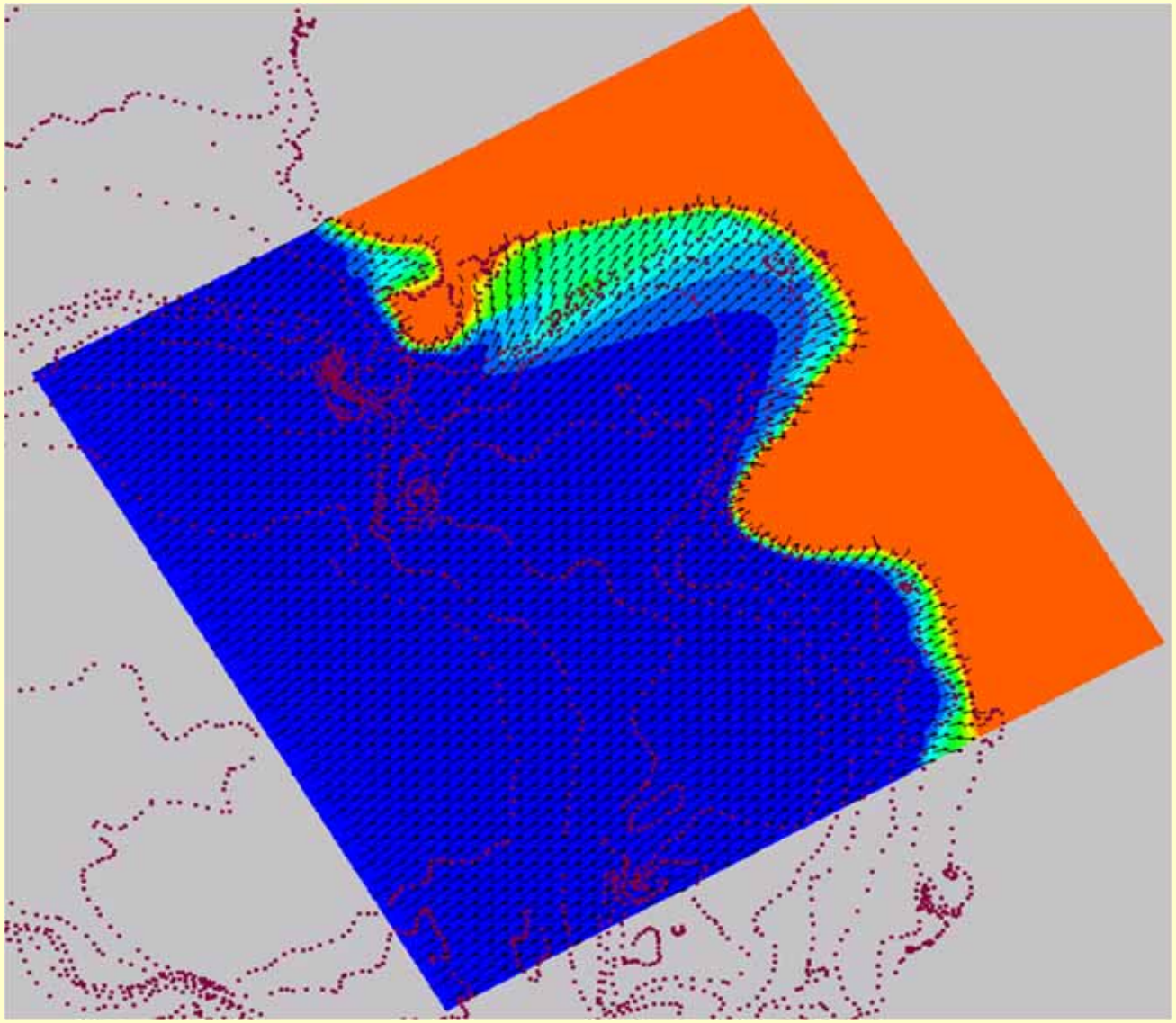
Maple Bluff, Lake Mendota



Shoreline Geometry

Maple Bluff, STWAVE Model



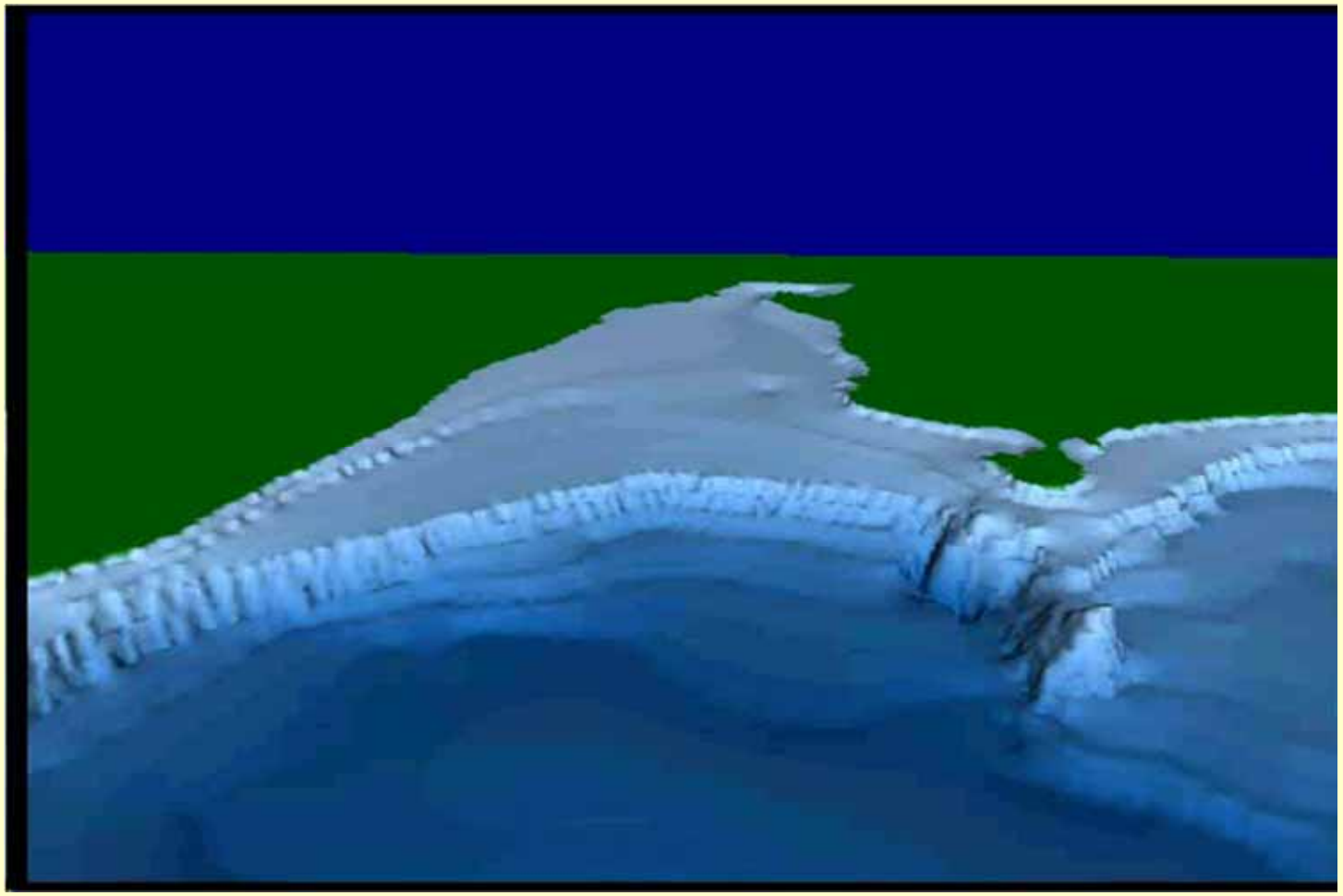


H_o = 1.14 m

T = 4.38 sec

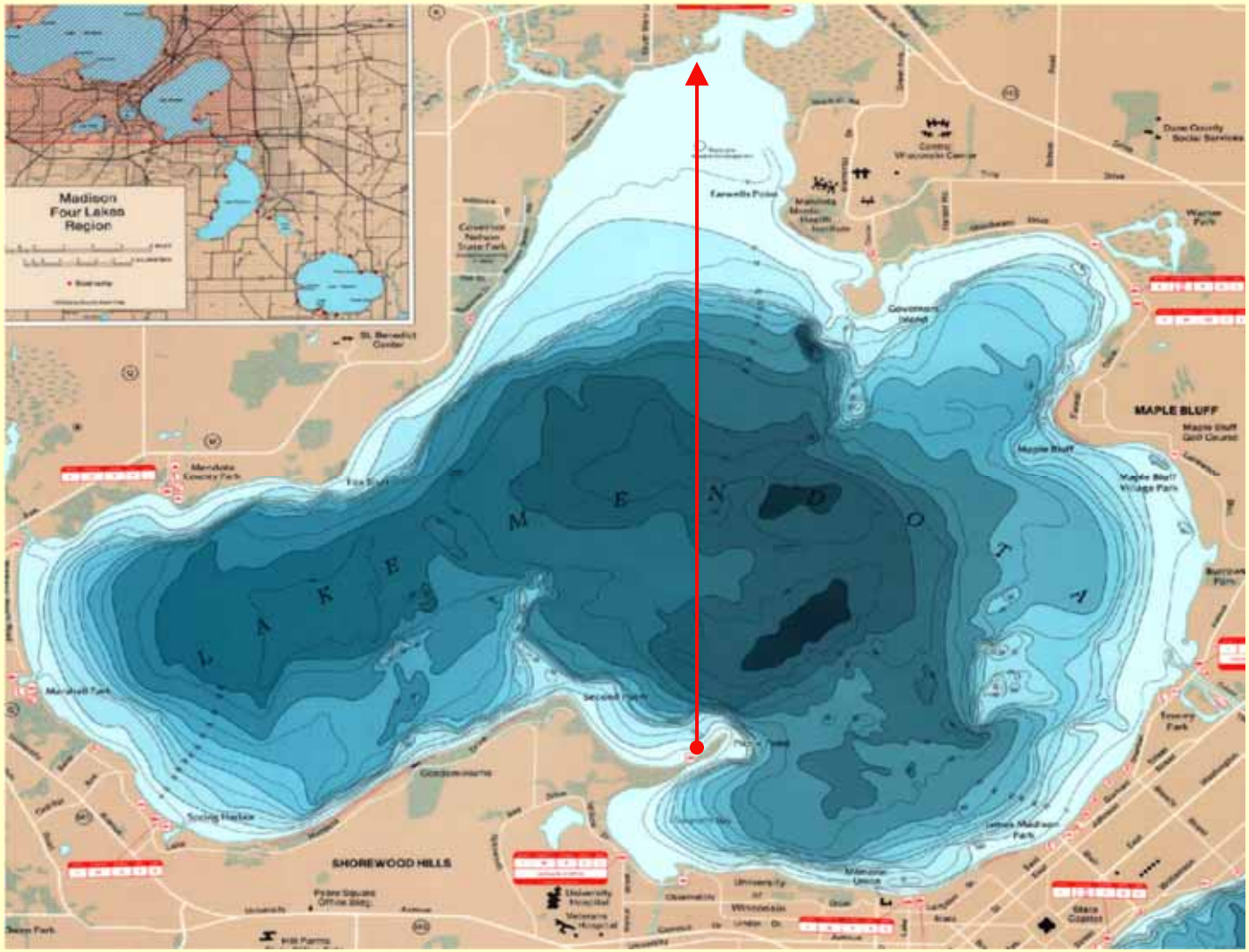
Shoreline Geometry

Yahara Inlet, Lake Mendota



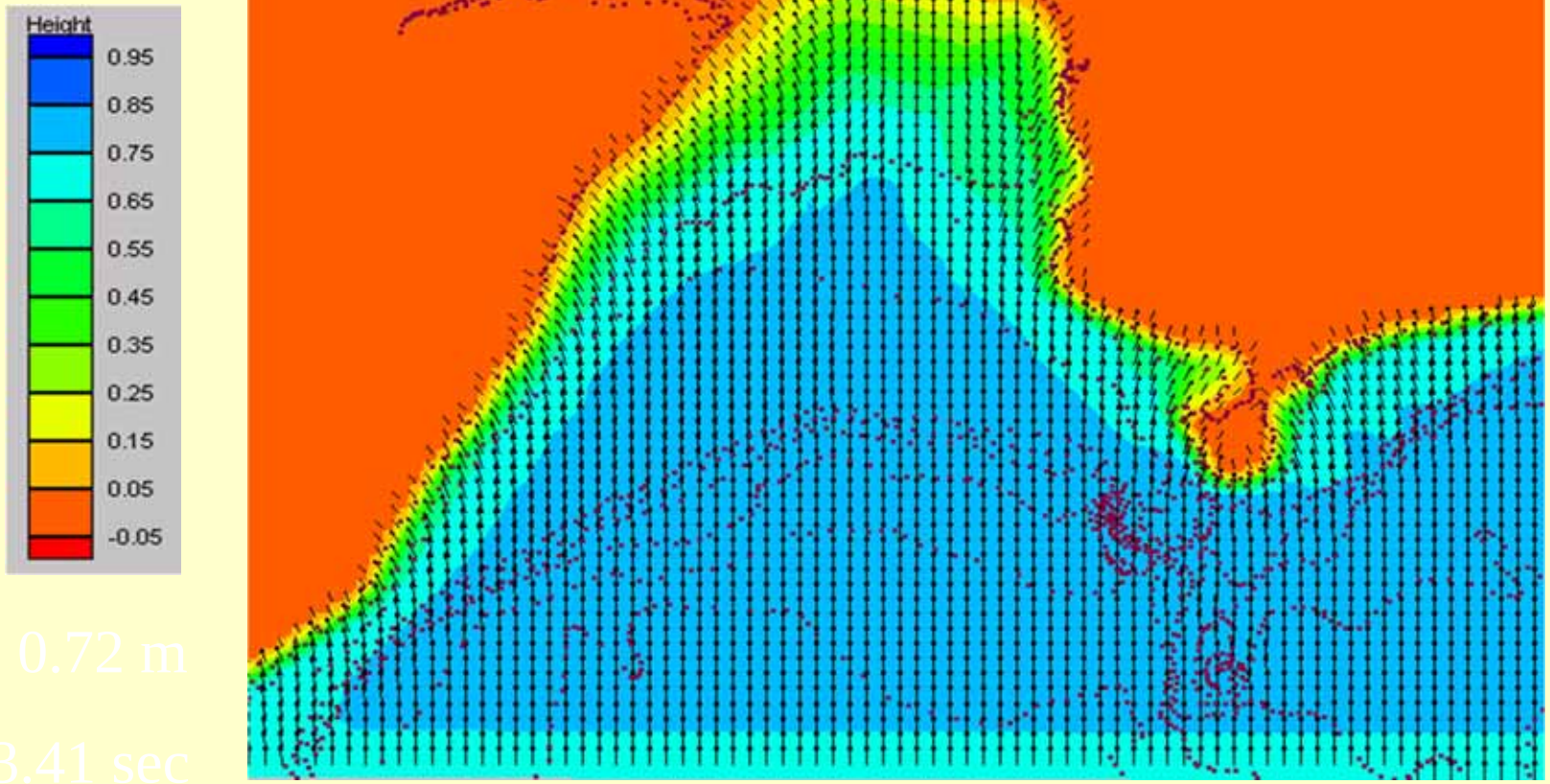
Shoreline Geometry

Yahara Inlet, Lake Mendota



Shoreline Geometry

Yahara Inlet, STWAVE Model



H_o = 0.72 m

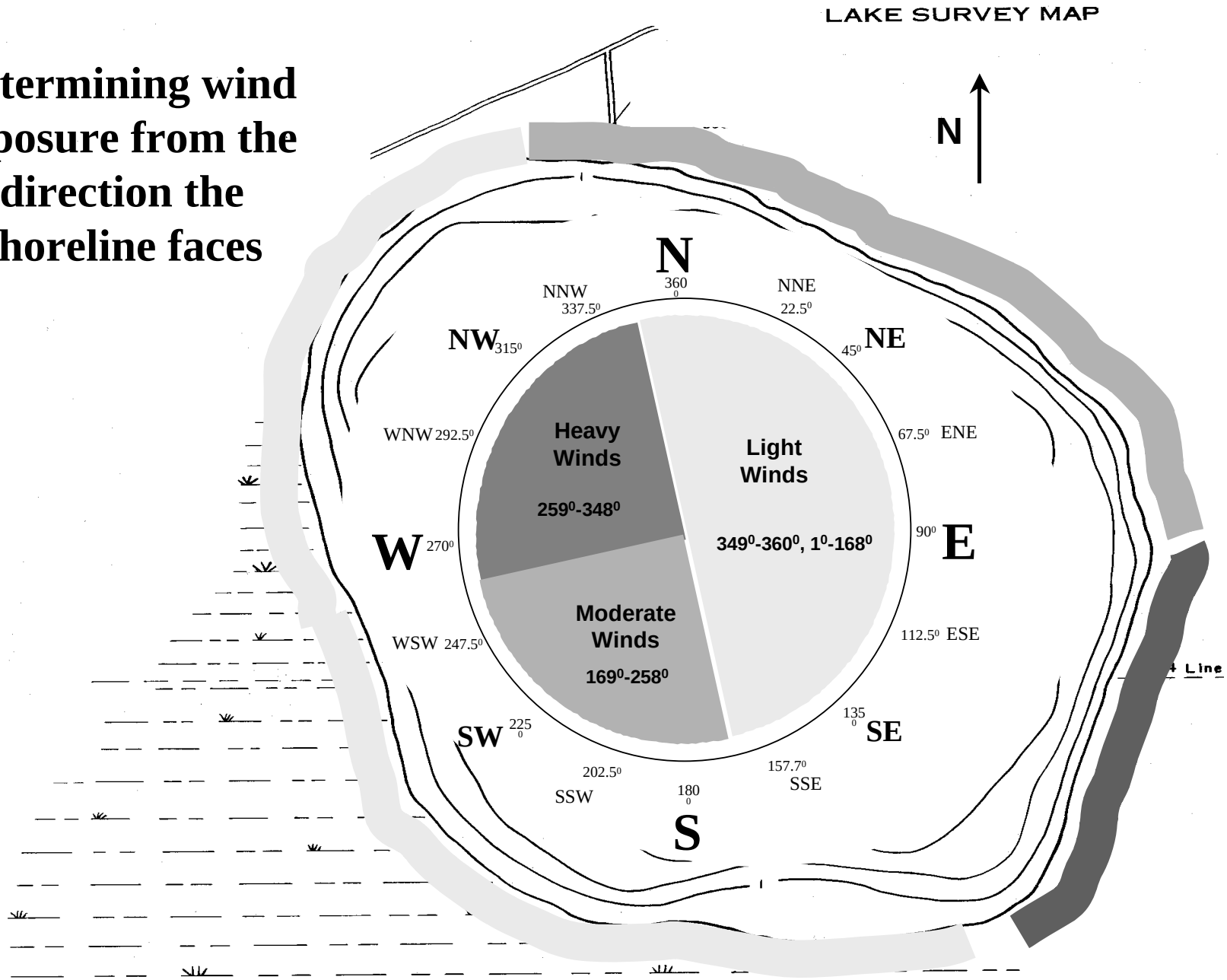
T = 3.41 sec

Determining Shore Orientation

The following lakemap shows an example of classifying shore orientation exposed to prevailing winds. Shorelines are exposed to one of the following:

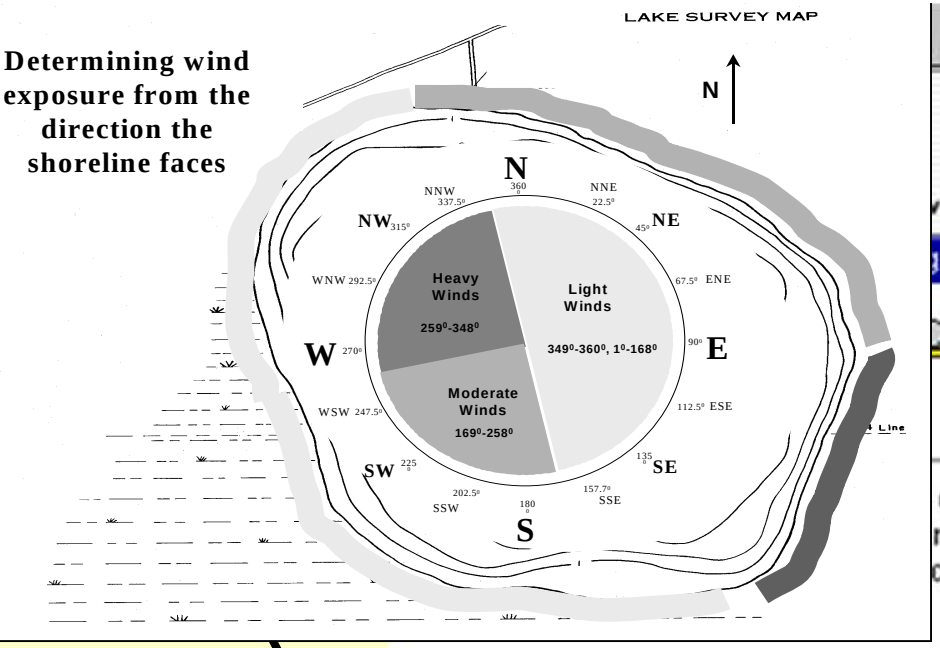
- Light Winds
- Moderate Winds
- Heavy Winds

Determining wind exposure from the direction the shoreline faces



Erosion Intensity Metrics, Shore Orientation

Determining wind exposure from the direction the shoreline faces

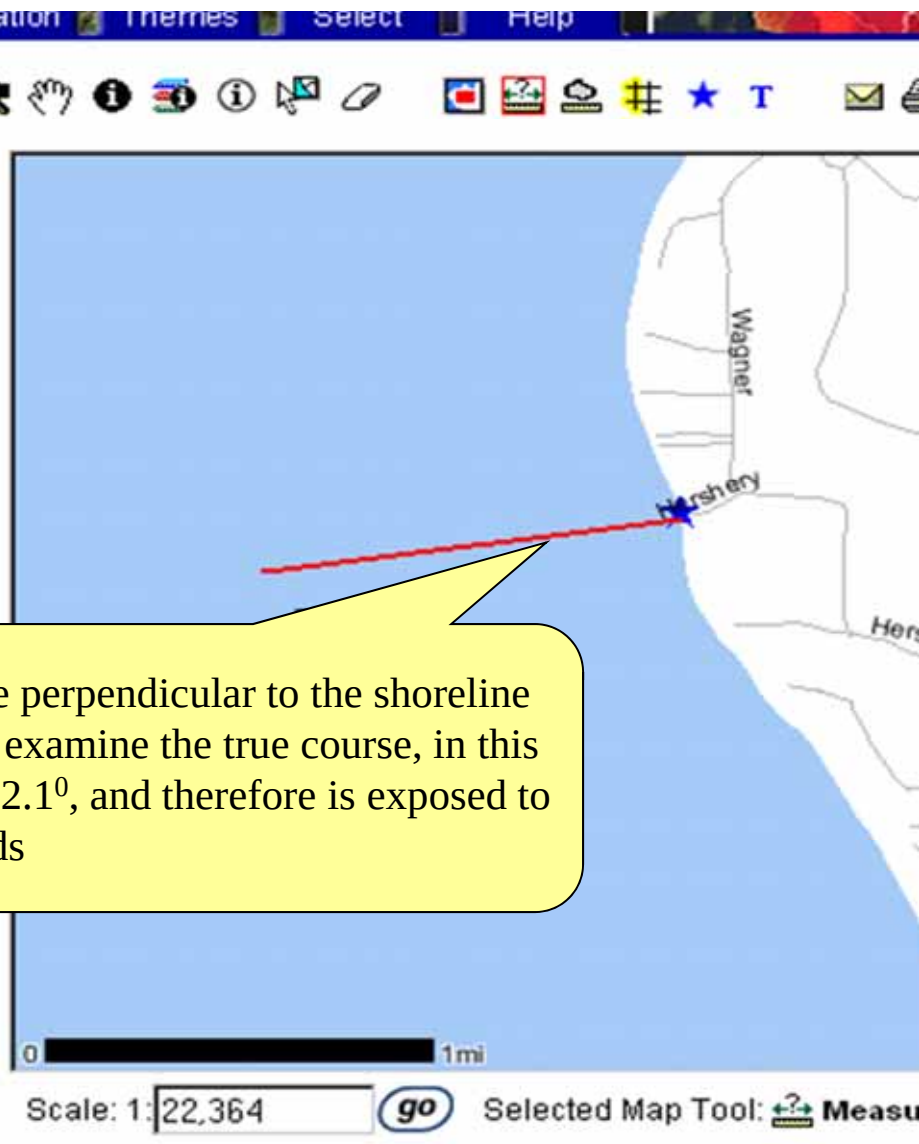


of the points
ng the
circle distance

Position	89° 49' 20" W 45° 56' 44" N
Position	89° 50' 3" W 45° 56' 39" N
Distance	3,058.9 ft
True Course	262.1°

Clear Points

Draw a line perpendicular to the shoreline of interest, examine the true course, in this case it's 262.1^0, and therefore is exposed to heavy winds



Erosion Intensity

Lake Map

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes (proximity to and use of boat channels)
  - 3 choices are: (1) no channels within 100 yards, broad open water body, or constricted shallow water body; (6) minor thoroughfare within 100 yards of shore carrying limited traffic, or major channel 100 yards to ½ mile offshore; (12) major thoroughfare within 100 yards carrying intensive traffic.

Erosion Intensity

Lake Map

- Boat Wakes (proximity to and use of boat channels)

Note: Boating; A thoroughfare is identified as physical narrowing of the waterbody that by its nature intensifies boating activity near the shore. Thoroughfares which are 250 yards or wider are not scored 12 points, unless the depth contours of the thoroughfare constricts boating activity in close proximity to one shore, and the traffic is intensive.

Note: Boating; Intensive traffic is defined by a location where at least 50% of the public boating access available must pass through the thoroughfare to reach the open water of the lake, provided the waterway has a total of more than 60car-trailer units.

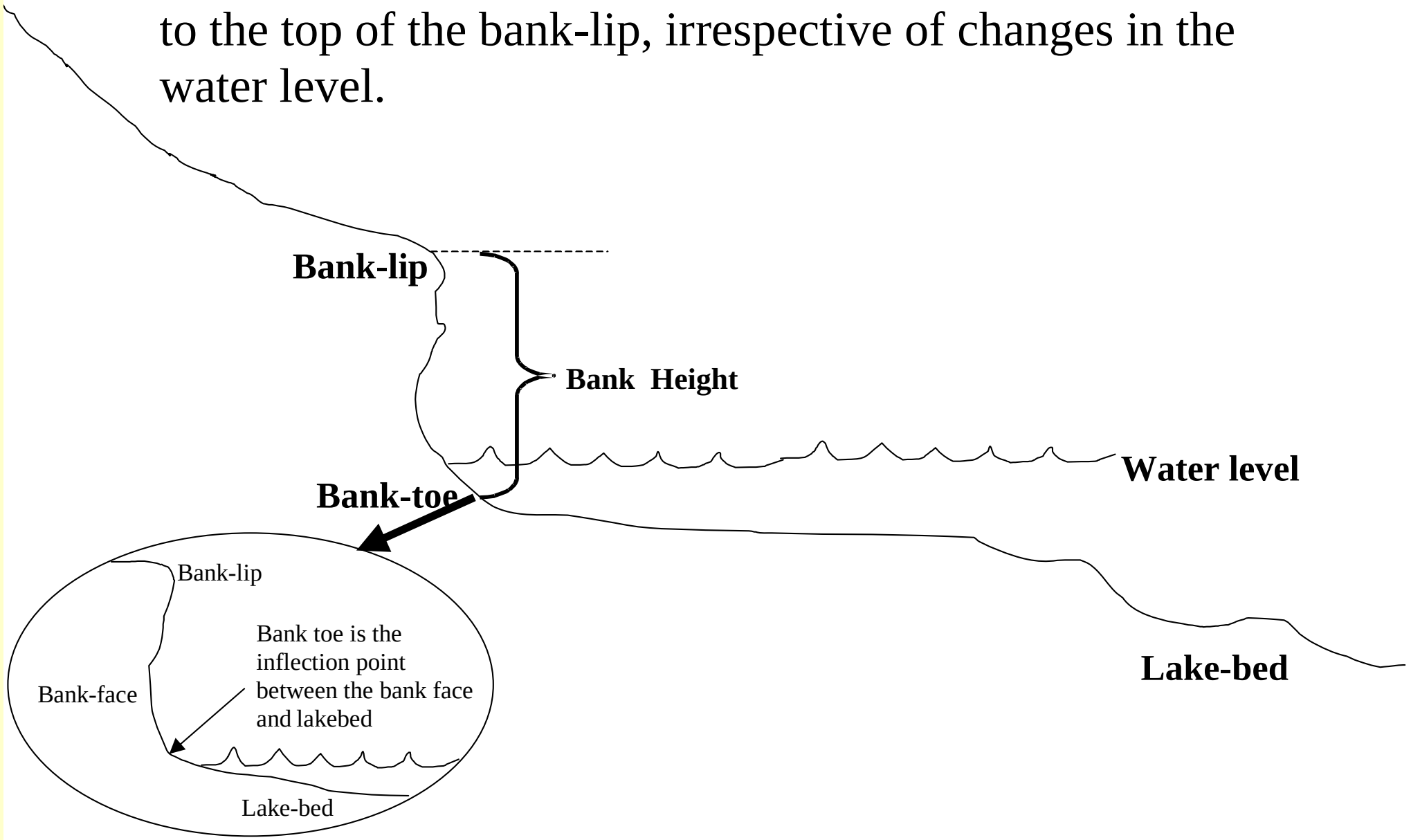
Note: Boating; Limited traffic is defined by a location where at least 30% of the public boating access available must pass through the thoroughfare to reach the open water of the lake, provided the waterway has a total of more than 40 car trailer units.

Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- **Bank Height (anchor the measure stick at the bank toe, walk back waterward on the pier, and estimate the bank height (ft)).**
  - 5 Choices are: <1, 1-5, 5-10, 10-20, or >20

Erosion Intensity

Bank height is the vertical measure (feet) from the bank-toe to the top of the bank-lip, irrespective of changes in the water level.



Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- **Bank Composition (examine the composition and degree of cementation of the bank sediments)**
  - 3 choices are: (0) rock, marl, tight clays and cemented sands that must be dug with a pick; (7) soft clay, clayey sand, moderately cemented easily dug with a knife; (15) uncemented sands or peat easily dug with your hand.

Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- **Influence of Adjacent Structures**
  - 5 choices are: (0) no armoring on either side; (1) hard armoring on one side; (2) hard armoring on both sides; (3) hard armoring on one side with noticeable recession; (4) hard armoring on both sides with noticeable recession.

Erosion Intensity

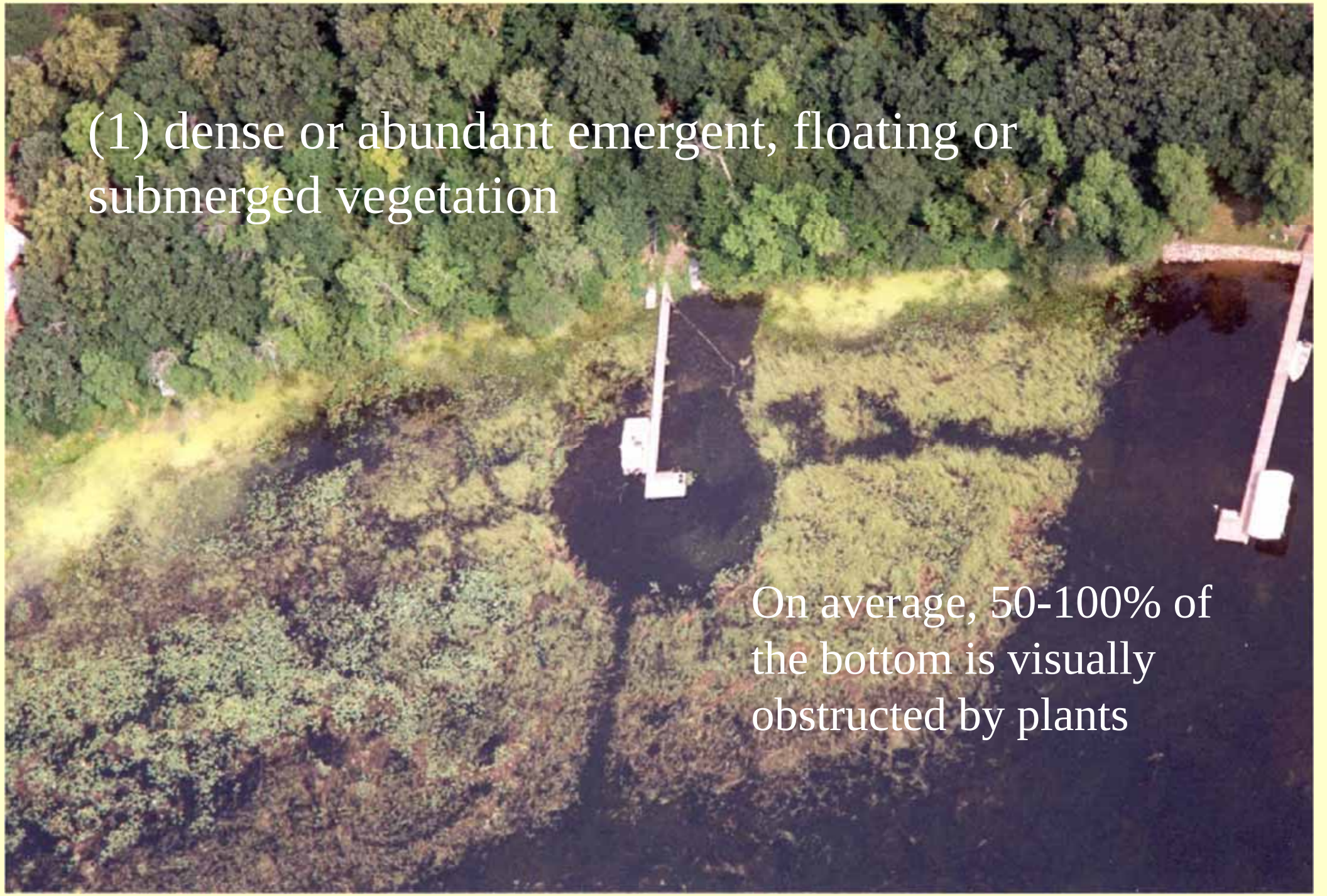
- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- **Depth at 20 Feet (depth of the water 20 feet from the shore)**
  - 5 choices are: <1; 1-3; 3-6; 6-12; >12.

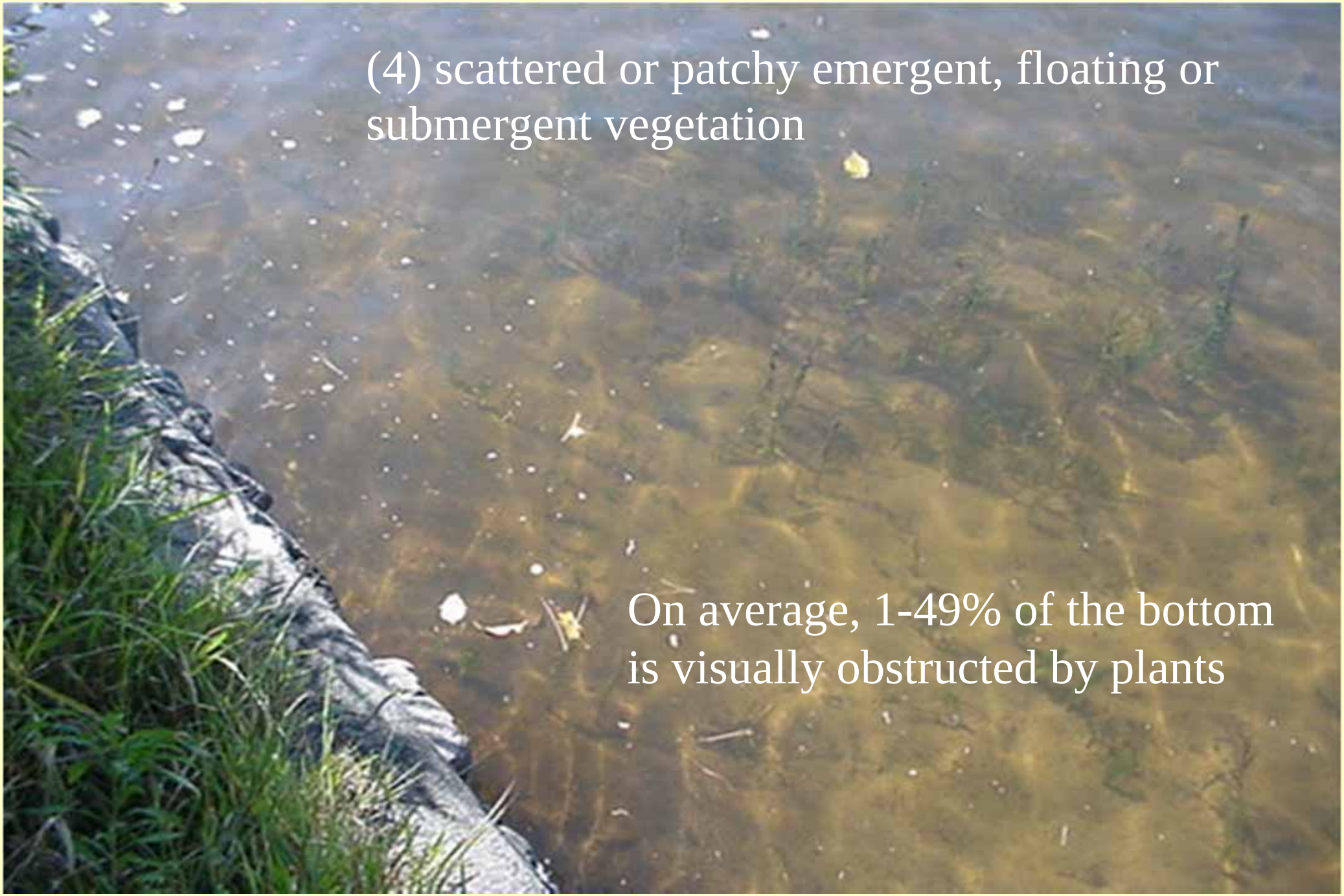
Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- Depth at 20 Feet
- **Depth at 100 Feet (depth of the water 100 feet from the shore)**
  - 5 choices are: <1; 1-3; 3-6; 6-12; >12.

Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- Depth at 20 Feet
- Depth at 100 Feet
- **Aquatic Vegetation (type and abundance of vegetation occurring in the water off the shoreline)**
  - 3 choices are: (1) dense or abundant emergent, floating or submerged vegetation; (4) scattered or patchy emergent, floating or submergent vegetation; or (7) lack of emergent, floating or submergent vegetation.


(1) dense or abundant emergent, floating or submerged vegetation
On average, 50-100% of the bottom is visually obstructed by plants

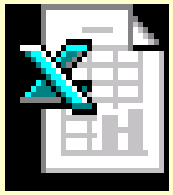

(4) scattered or patchy emergent, floating or submergent vegetation
On average, 1-49% of the bottom is visually obstructed by plants

Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- Depth at 20 Feet
- Depth at 100 Feet
- Aquatic Vegetation
- **Bank Stability**

Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- Depth at 20 Feet
- Depth at 100 Feet
- Aquatic Vegetation
- Bank Stability
- **Bank Vegetation (type and abundance of vegetation occurring on the bank face and immediately on top of the bank lip)**
  - 3 choices are: (1) dense vegetation, upland trees and shrubs; (4) clumps of vegetation alternating with areas lacking vegetation; (8) lack of vegetation (cleared), crop or agricultural land.



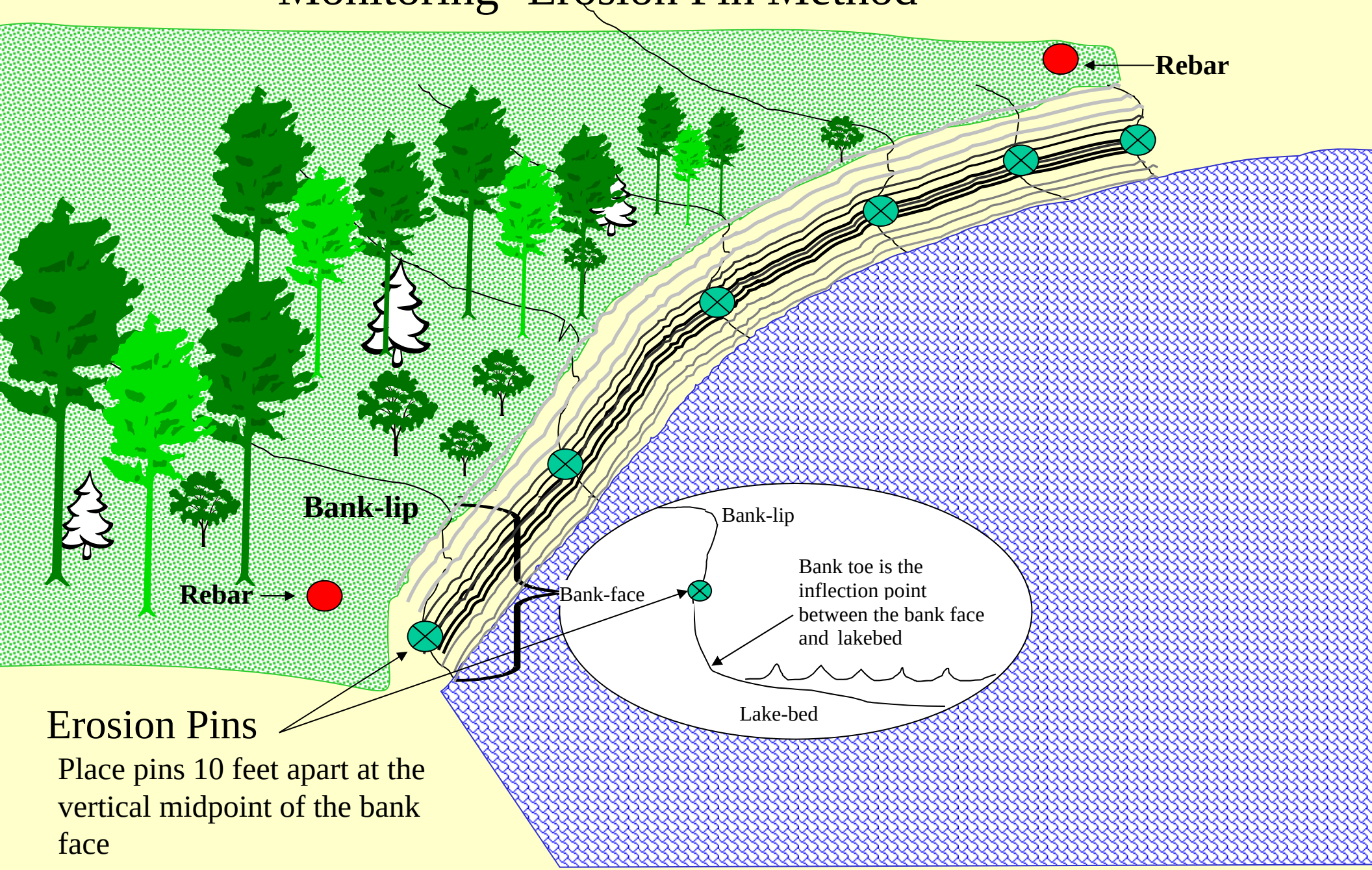
Erosion Intensity Calculator

SHORELINE VARIABLES	DESCRIPTIVE CATEGORIES EROSION INTENSITY VALUE IS LOCATED IN PARENTHESIS ON LEFT SIDE OF EACH CATEGORY BOX							ASSIGNED EI
FETCH-AVERAGE, longest continuous linear distance the site across the water surface to the opposite intersect with the shore or land.	(0) <1/10	(2) 1/10 –1/3	(4) 1/3-1	(7) 1 –3	(10) 3-10	(13) 10-30	(16) >30	
DEPTH AT 20 FEET, Depth of water (feet) 20 feet from shoreline	(1) <1	(2) 1-3	(3) 3-6	(4) 6-12	(5) >12			
DEPTH AT 100 FEET, depth of water (feet) 100 feet from shoreline	(1) <1	(2) 1-3	(3) 3-6	(4) 6-12	(5) >12			
BANK HEIGHT, height of bank (feet) at the shoreline or just behind the sediment beach	(1)<1	(2) 1-5	(3) 5-10	(4) 10-20	(5) >20			
BANK COMPOSITION composition and degree of cementation of the sediments	(0) Rock, marl, tight clay, well cemented sand (dig with a pick or swamp forest)		(7) soft clay, clayey sand, moderately cemented (easily dug with a knife)		(15) uncemented sands or peat (easily dug with you hand)			
INFLUENCE OF ADJACENT STRUCTURES, likelihood that adjacent structures are causing flank erosion at the site	(0) no hard armoring on either adjacent property	(1) hard armoring on one adjacent property	(2) hard armoring on both adjacent properties	(3) hard armoring on one adjacent property with measurable recession	(4) hard armoring on both adjacent properties with measurable recession			
AQUATIC VEGETATION type and abundance of vegetation occurring in the water off the shoreline	(1) dense or abundant emergent, floating or submerged vegetation		(4) scattered or patchy emergent, floating or submergent vegetation		(7) lack of emergent, floating or submergent vegetation			
SHORE VEGETATION type and abundance of the vegetation occurring between the bank and shoreline	(0) rocky substrates unable to support vegetation.	(1) dense continuous vegetation, marsh fringe and shrubs		(4) scattered or patchy vegetation, upland trees and shrubs		(7) lack of vegetation		
BANK VEGETATION, type and abundance of the vegetation occurring on the bank and immediately on top of the bank lip	(1) dense vegetation, upland trees, shrubs and grasses		(4) clumps of vegetation alternating with areas lacking vegetation		(7) lack of vegetation (cleared), crop or agricultural land			
SHORELINE GEOMETRY general shape of the shoreline at the point of interest plus 200 yards on either side.	(1) coves		(4) irregular shoreline		(8) headland, point or straight shoreline			
SHORELINE ORIENTATION general geographic direction the shoreline faces	(0) < 1/3 mile fetch	(1) south to east		(4) south to west		(8) west northwest to north to east-northeast		
BOAT WAKES proximity to and use of boat channels	(1) no channels within 100 yards, broad open water body, or constricted shallow water body		(6) minor thoroughfare with 100 yards carrying limited traffic, or major channel 100 yards to ½ mile offshore		(12) major thoroughfare within 100 yards carrying intensive traffic.			
EROSION INTENSITY SCORE (EI) →								

Energy Category

Method	Low Energy	Moderate Energy	High Energy
Wind-wave	< 1 foot	1- 2.3 feet	>2.3 feet
Erosion Intensity	≤47	48-67	>67

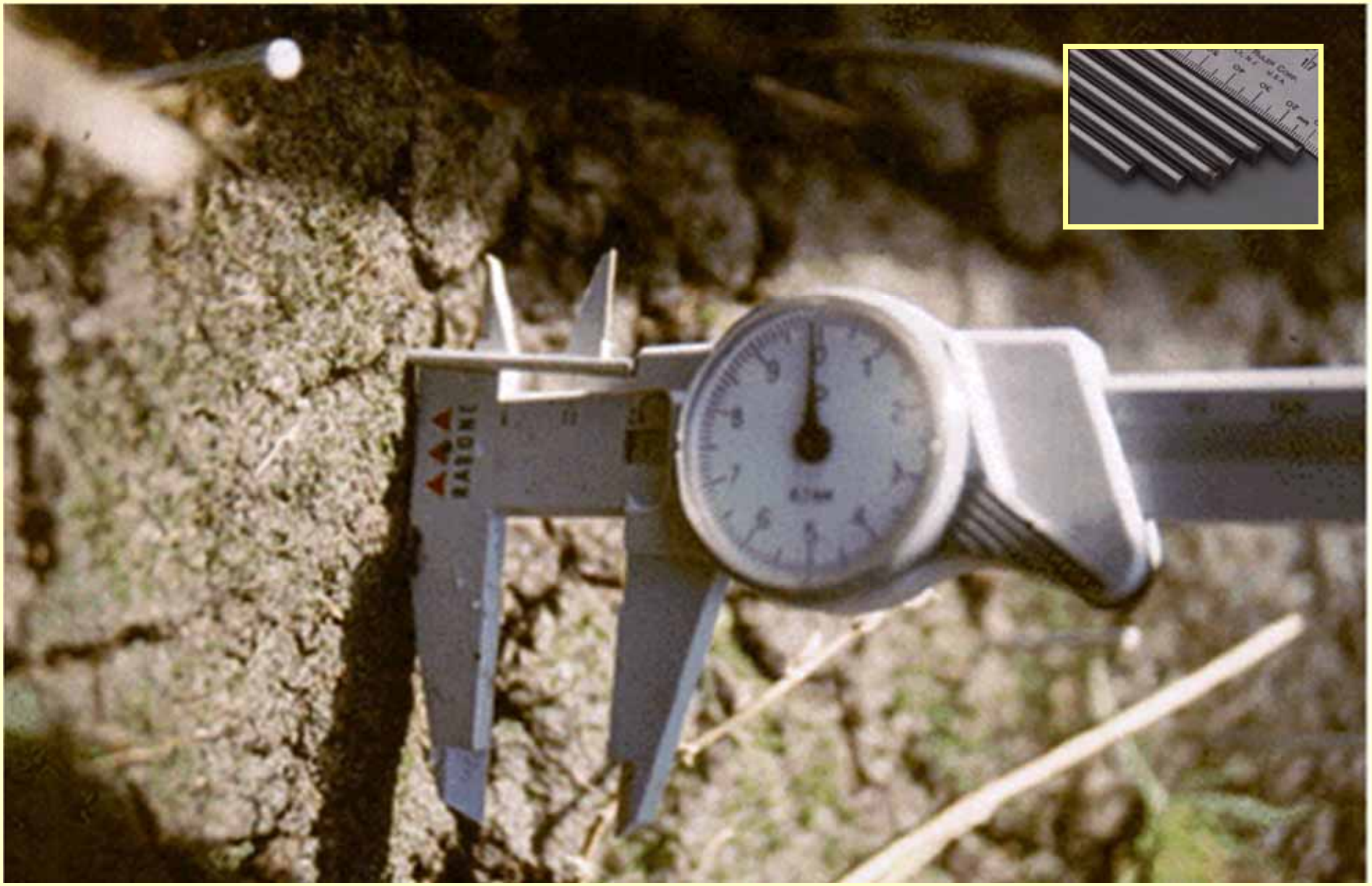
Monitoring- Erosion Pin Method



Erosion Pins

Place pins 10 feet apart at the vertical midpoint of the bank face

Monitoring- Erosion Pin Method



Monitoring- Erosion Pin Method

Waterway Bank Pin Erosion Monitoring Datasheet

Attention: Within a week after installation you must submit your photos, the erosion pin monitoring form, and a copy of your initial pin exposure distance data to your water management specialist.

Landowner Name_____
Phone Number _____
Mailing Address
_____
_____
_____

Date of Erosion Pin Installation:_____
Total Number of Pins Installed:_____
Recorder Name:_____

Pin #	Date of Initial Measure	Initial Pin Exposure Distance (Nearest 1/16" or mm)	Date of 2nd Measure	Pin Exposure Distance @ 2nd measurement (Nearest 1/16" or mm)	Date of 3rd Measure	Pin Exposure Distance @ 3rd measurement (Nearest 1/16" or mm)	Net Change over the period (Nearest 1/16")
1 (left most pin when facing the bank)							
2							
3							
4							
5							
6							

Shoreline Type

- Low Energy
- Moderate Energy
- High Energy

X

Treatment Type

- Biological
- Biotechnical
- Technical

Shore Protection Techniques

Biological

- Live stakes
- Brush mattresses with jute roping
- Coir fiber rolls with jute netting

Biotechnical - “Vegetated Armoring”

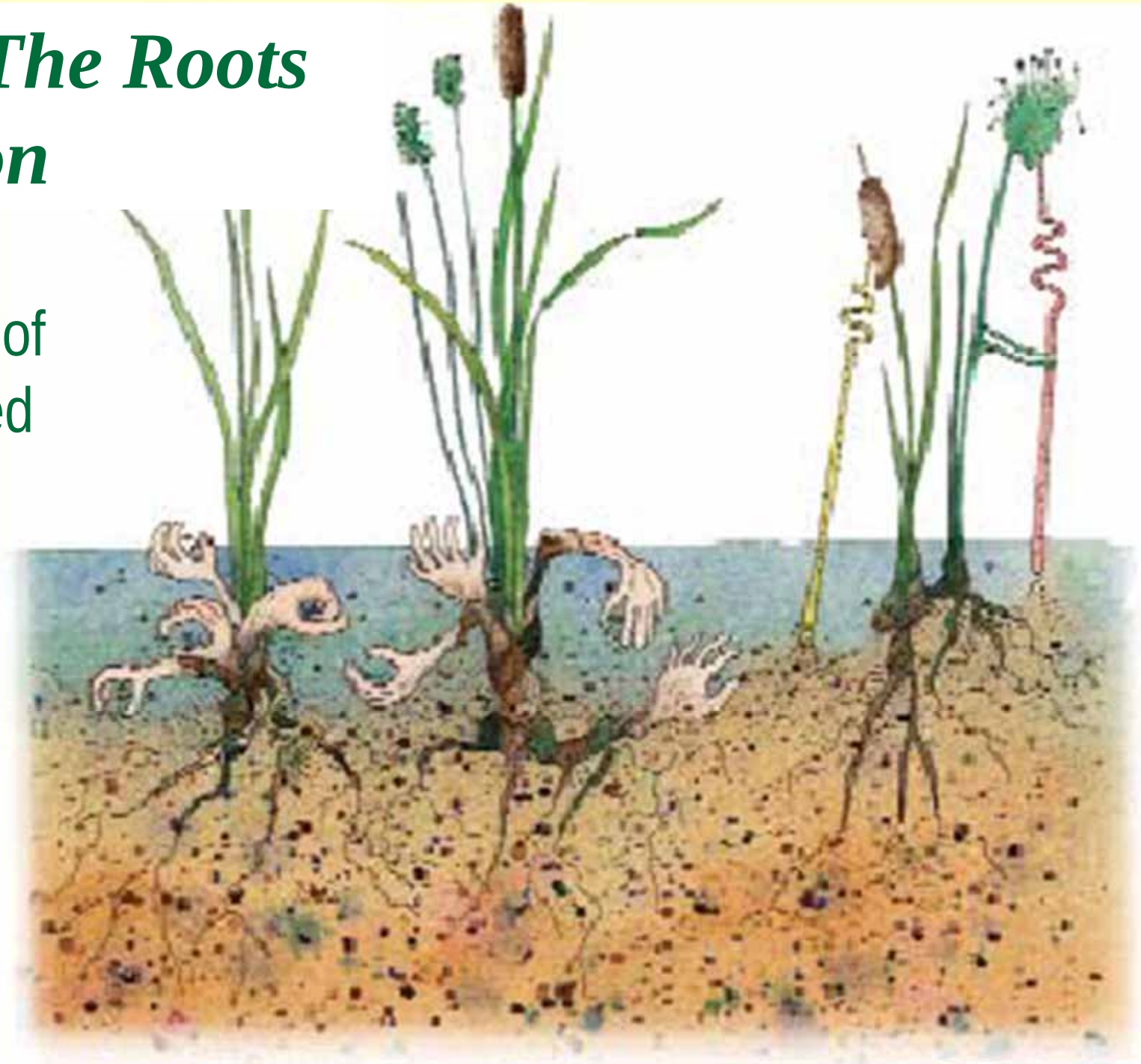
- Integrated Toe Protection
- Joint plantings among riprap

Technical - “Hard Armoring”

- Rock riprap
- Wooden vertical seawalls
- Concrete retaining walls

Vegetation - The Roots of the Solution

The riparian areas of shorelines are glued together by a diversity of plants with strong, deep root systems, especially those of woody plants.



Vegetation - The Roots of the Solution

Biological

Improve Water Clarity

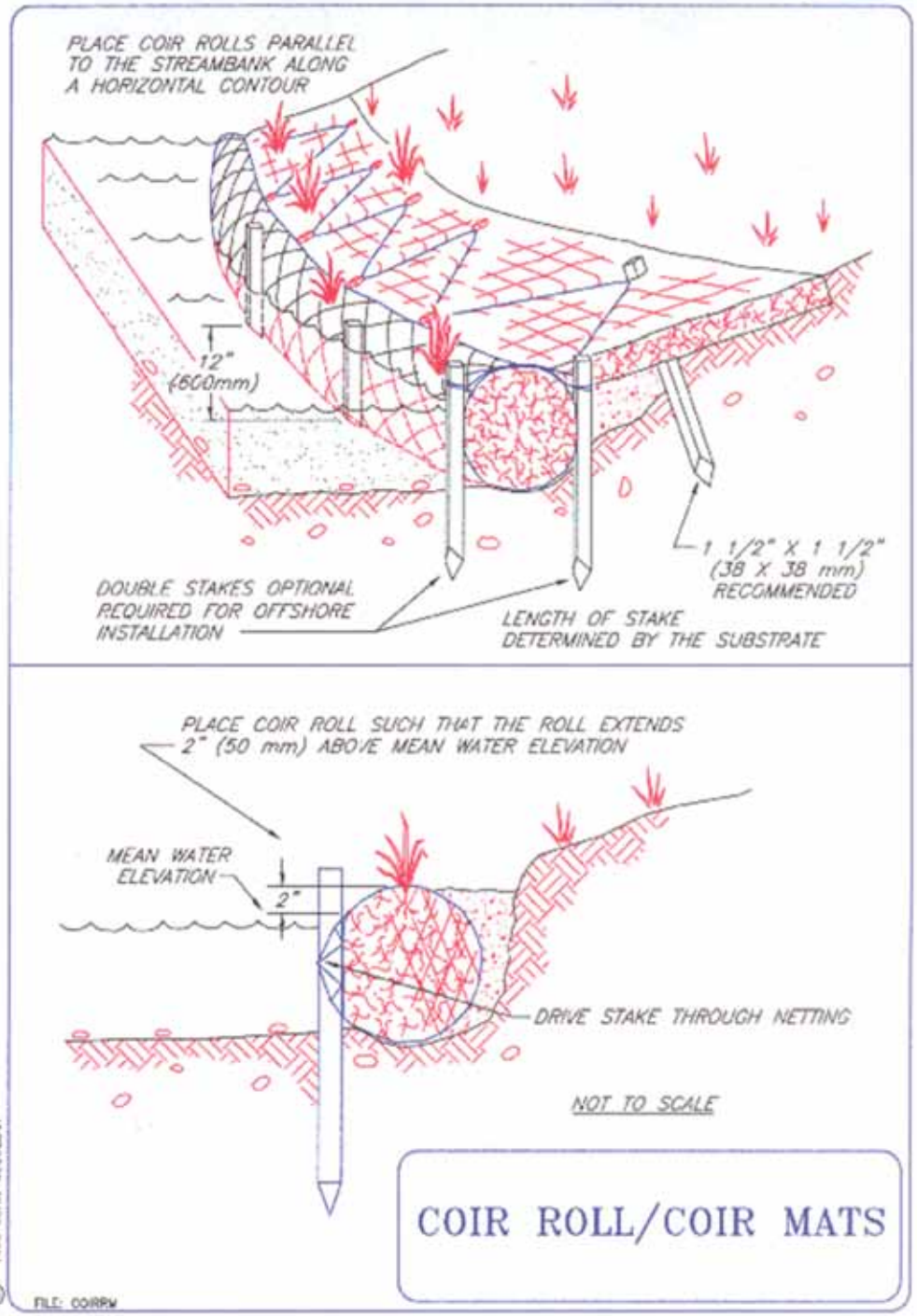
Fish and Wildlife Habitat

Hold Sediments

Nutrient Cycling

Invertebrates

Aesthetics


PLACE COIR ROLLS PARALLEL TO THE STREAMBANK ALONG A HORIZONTAL CONTOUR
12" (600mm)
1 1/2" X 1 1/2" (38 X 38 mm) RECOMMENDED
DOUBLE STAKES OPTIONAL REQUIRED FOR OFFSHORE INSTALLATION
LENGTH OF STAKE DETERMINED BY THE SUBSTRATE
PLACE COIR ROLL SUCH THAT THE ROLL EXTENDS 2" (50 mm) ABOVE MEAN WATER ELEVATION
MEAN WATER ELEVATION
2"
DRIVE STAKE THROUGH NETTING
NOT TO SCALE
COIR ROLL/COIR MATS
1995 JOHN McCULLAH
FILE: COIRRM


Biological

Biological

Figure 16–36 Coconut fiber roll details

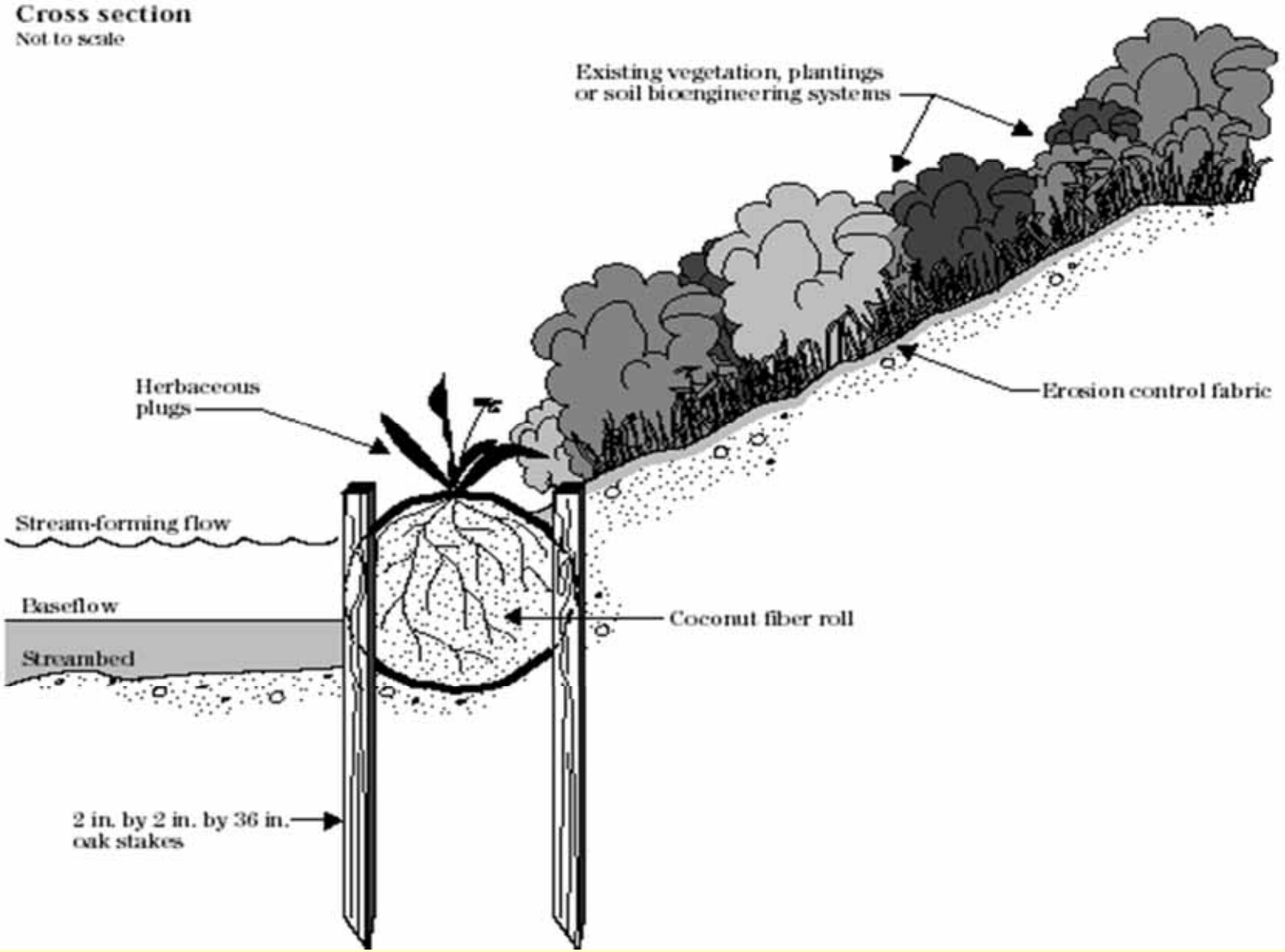
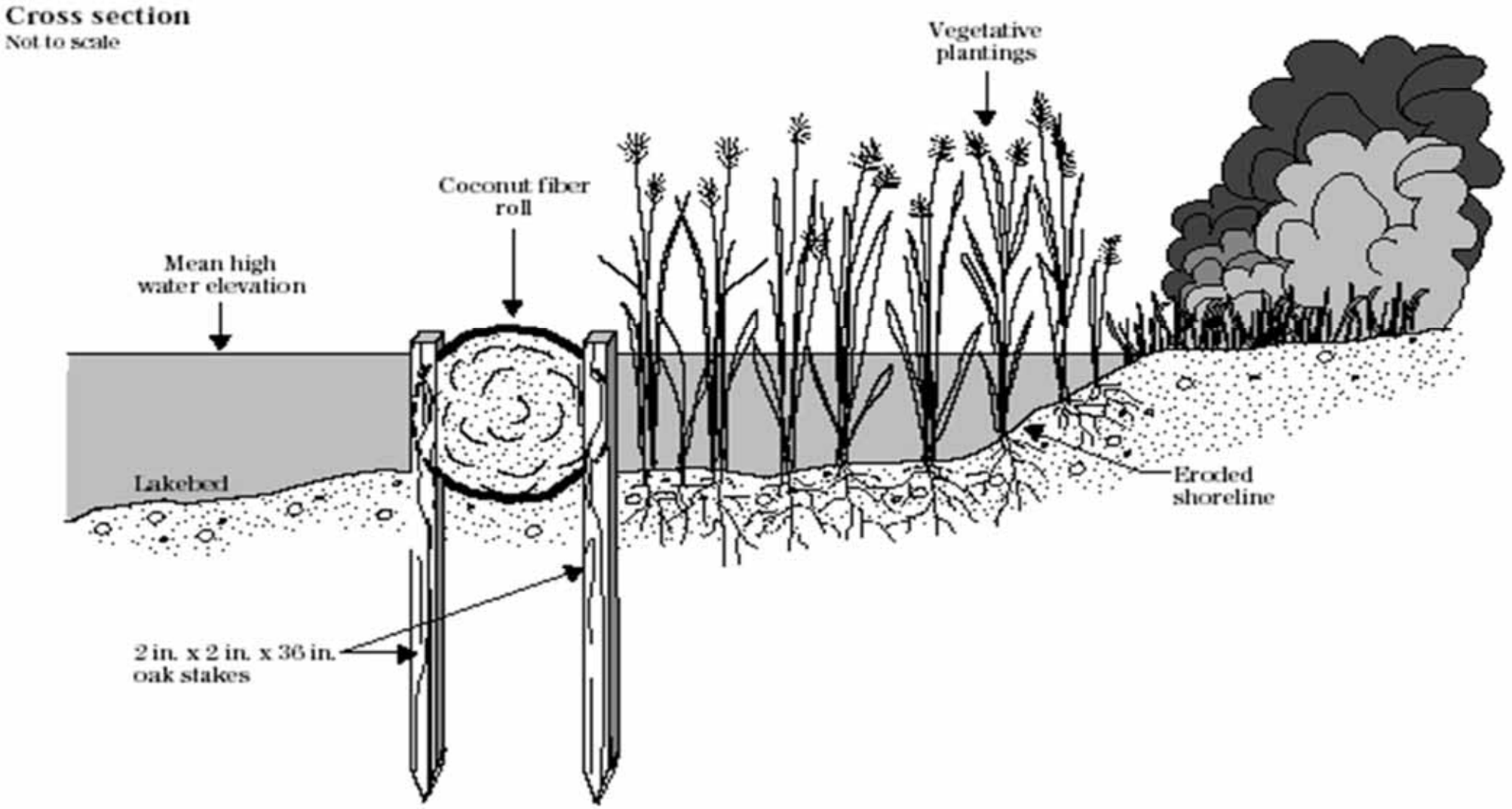
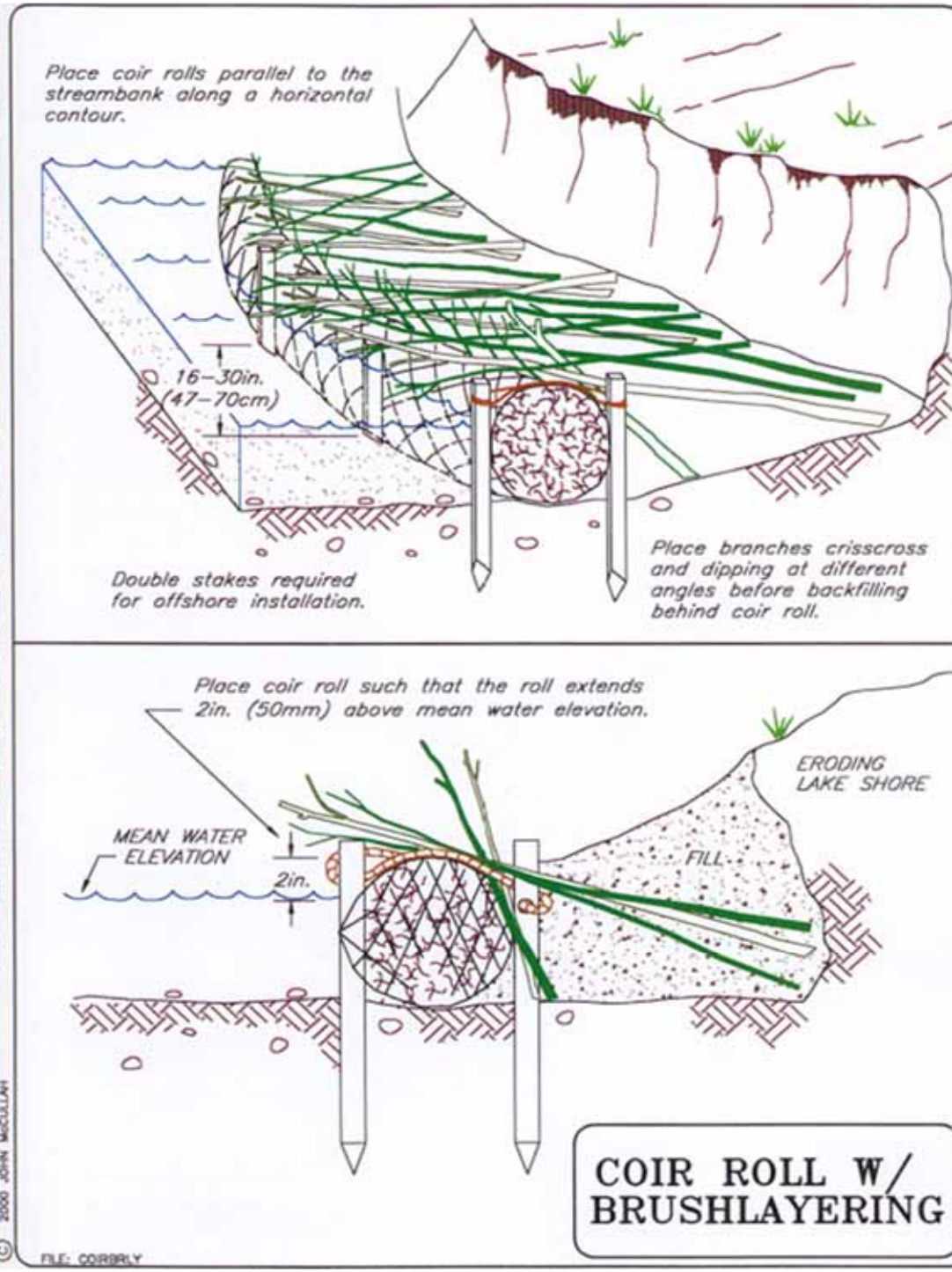


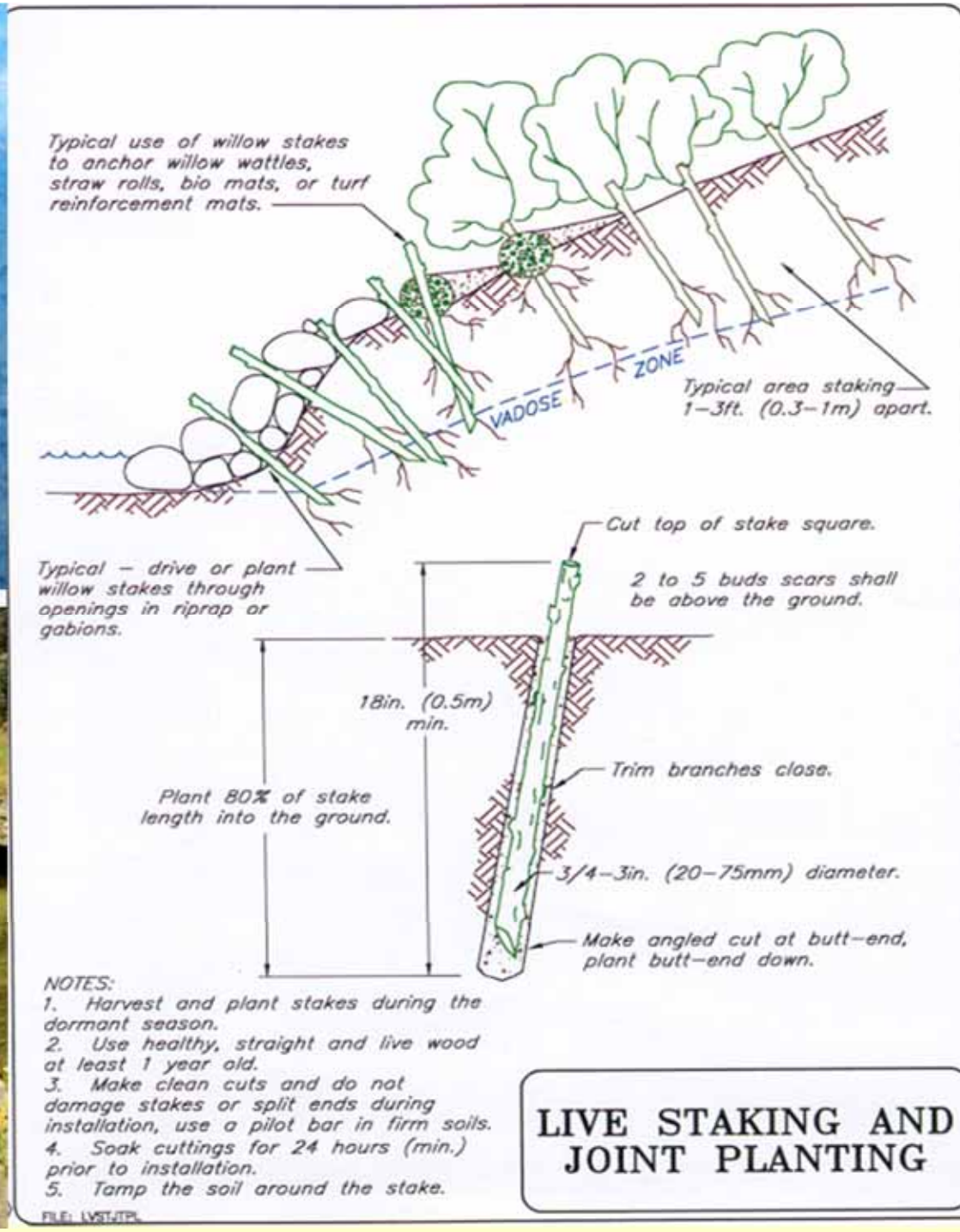
Figure 16–56 Coconut fiber roll details



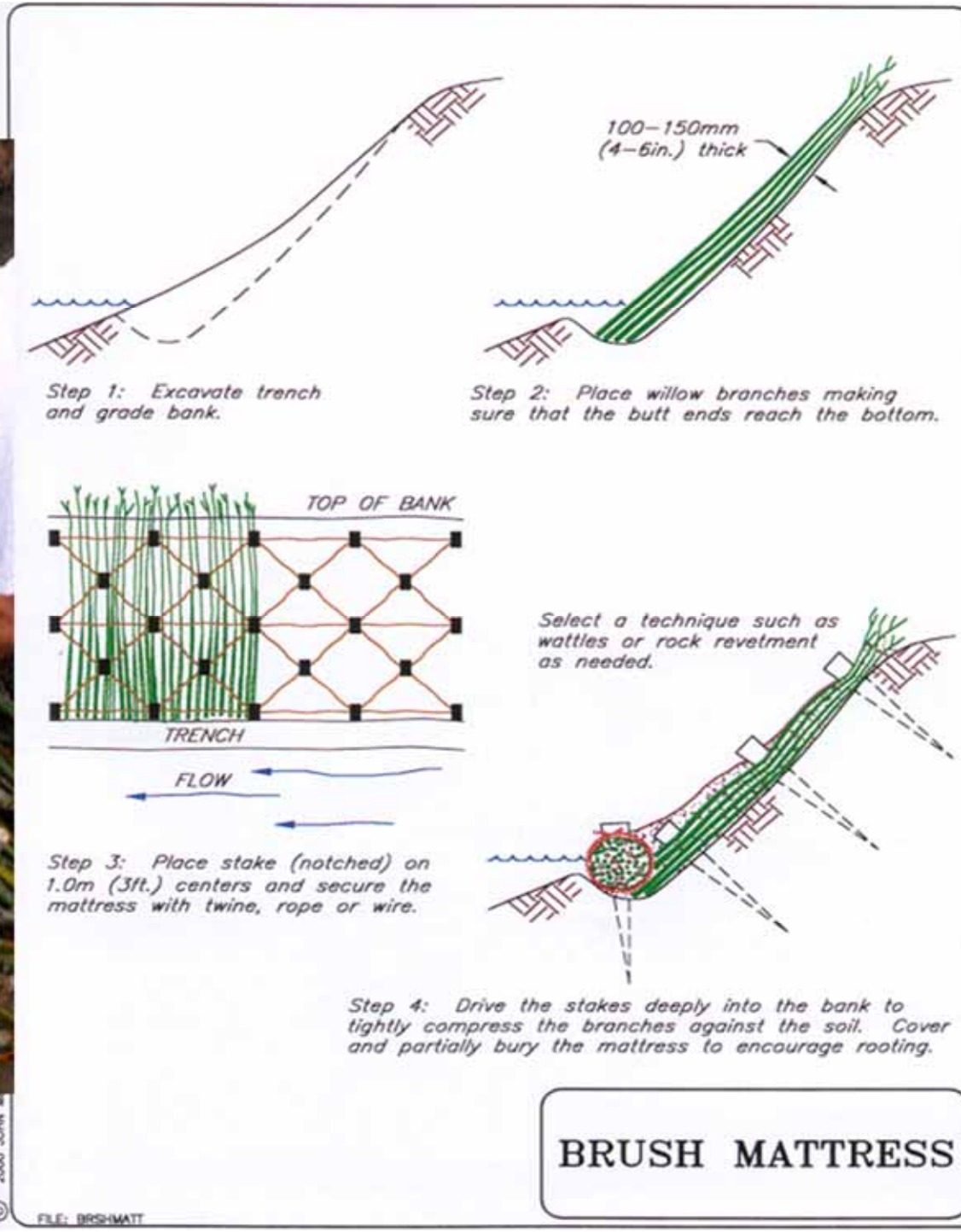
Biological


Place coir rolls parallel to the streambank along a horizontal contour.
16–30in. (47–70cm)
Double stakes required for offshore installation.
Place branches crisscross and dipping at different angles before backfilling behind coir roll.
Place coir roll such that the roll extends 2in. (50mm) above mean water elevation.
MEAN WATER ELEVATION
2in.
ERODING LAKE SHORE
FILL
COIR ROLL W/ BRUSHLAYERING
© 2000 JOHN McCULLAH
FILE: COIRBRLY

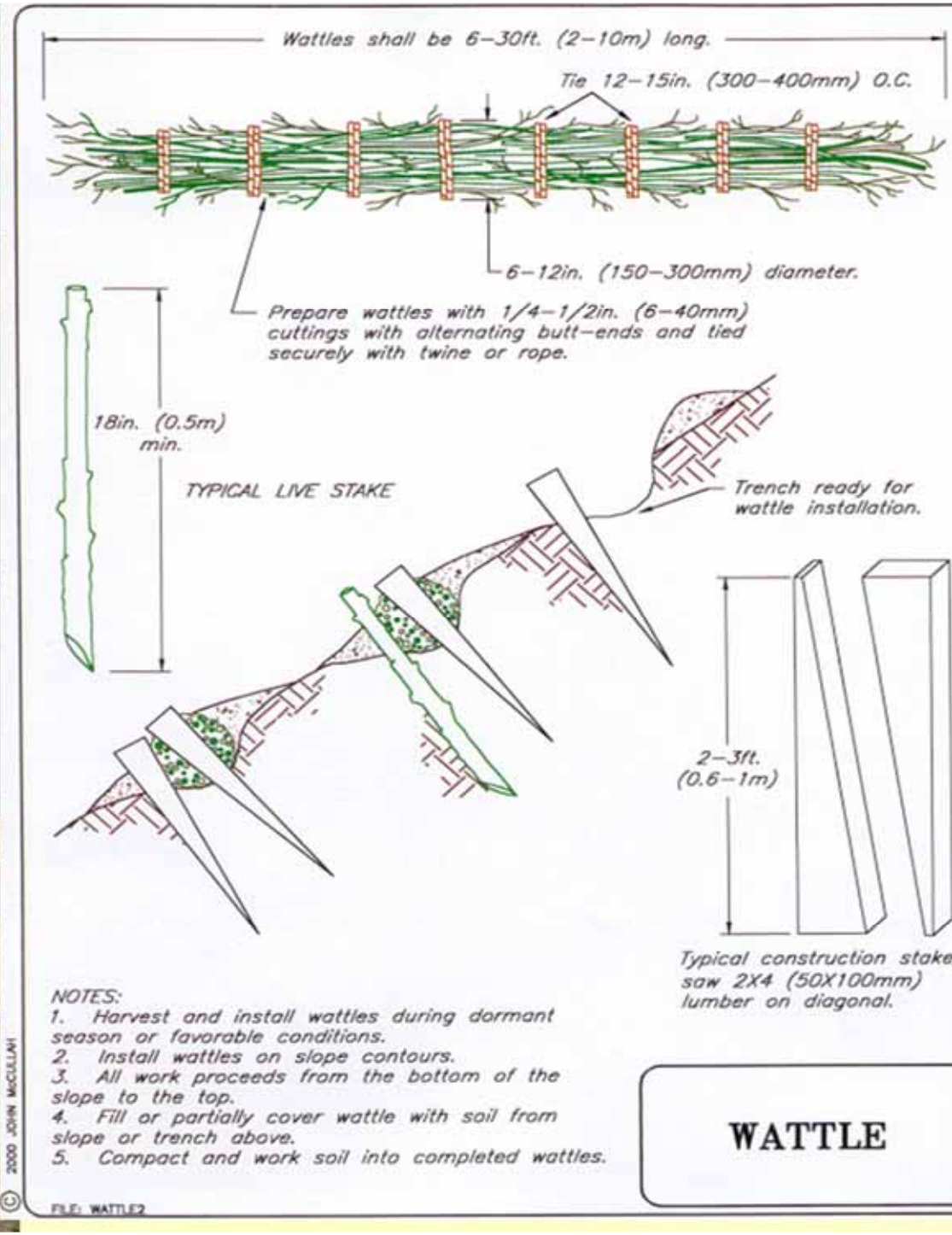
Biological


Typical use of willow stakes to anchor willow wattles, straw rolls, bio mats, or turf reinforcement mats.
VADOSE ZONE
Typical area staking 1–3ft. (0.3–1m) apart.
Typical – drive or plant willow stakes through openings in riprap or gabions.
Cut top of stake square.
2 to 5 buds scars shall be above the ground.
18in. (0.5m) min.
Plant 80% of stake length into the ground.
Trim branches close.
3/4–3in. (20–75mm) diameter.
Make angled cut at butt–end, plant butt–end down.
NOTES:
1. Harvest and plant stakes during the dormant season.
2. Use healthy, straight and live wood at least 1 year old.
3. Make clean cuts and do not damage stakes or split ends during installation, use a pilot bar in firm soils.
4. Soak cuttings for 24 hours (min.) prior to installation.
5. Tamp the soil around the stake.
FILE: LVST-TPL
LIVE STAKING AND JOINT PLANTING

Biological


100–150mm
(4–6in.) thick
Step 1: Excavate trench and grade bank.
Step 2: Place willow branches making sure that the butt ends reach the bottom.
TOP OF BANK
TRENCH
FLOW
Step 3: Place stake (notched) on 1.0m (3ft.) centers and secure the mattress with twine, rope or wire.
Select a technique such as wattles or rock revetment as needed.
Step 4: Drive the stakes deeply into the bank to tightly compress the branches against the soil. Cover and partially bury the mattress to encourage rooting.
BRUSH MATTRESS
FILE: BRSHMATT

iological


Wattles shall be 6–30ft. (2–10m) long.
Tie 12–15in. (300–400mm) O.C.
6–12in. (150–300mm) diameter.
Prepare wattles with 1/4–1/2in. (6–40mm) cuttings with alternating butt–ends and tied securely with twine or rope.
18in. (0.5m) min.
TYPICAL LIVE STAKE
Trench ready for wattle installation.
2–3ft. (0.6–1m)
Typical construction stake saw 2X4 (50X100mm) lumber on diagonal.
NOTES:
1. Harvest and install wattles during dormant season or favorable conditions.
2. Install wattles on slope contours.
3. All work proceeds from the bottom of the slope to the top.
4. Fill or partially cover wattle with soil from slope or trench above.
5. Compact and work soil into completed wattles.
WATTLE
© 2000 JOHN McCULLAH
FILE: WATTLE2

Shore Protection Techniques

Biological

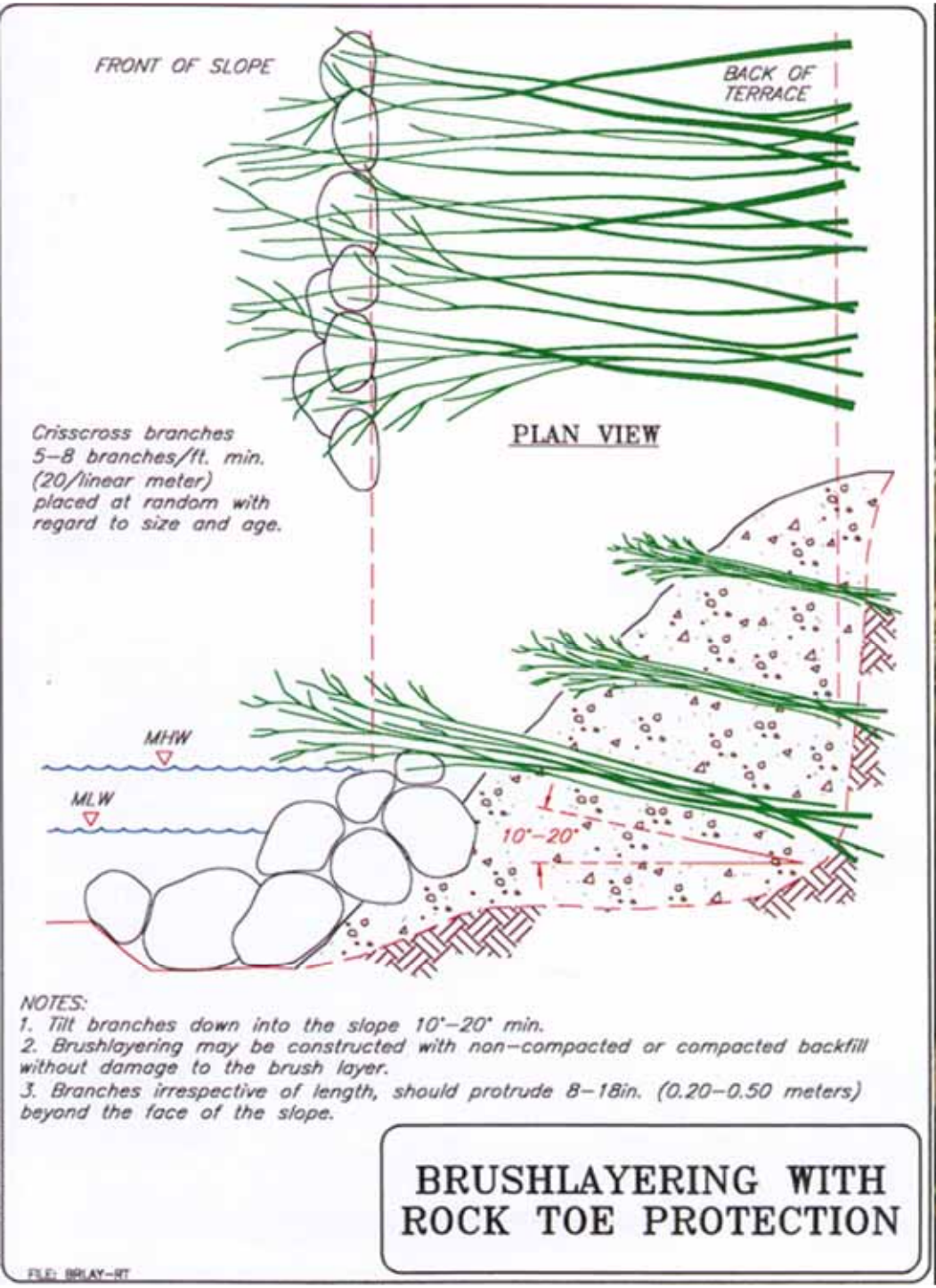
- Live stakes
- Brush mattresses with jute roping
- Coir fiber rolls with jute netting

Biotechnical - “Vegetated Armoring”

- Integrated Toe Protection
- Joint plantings among riprap

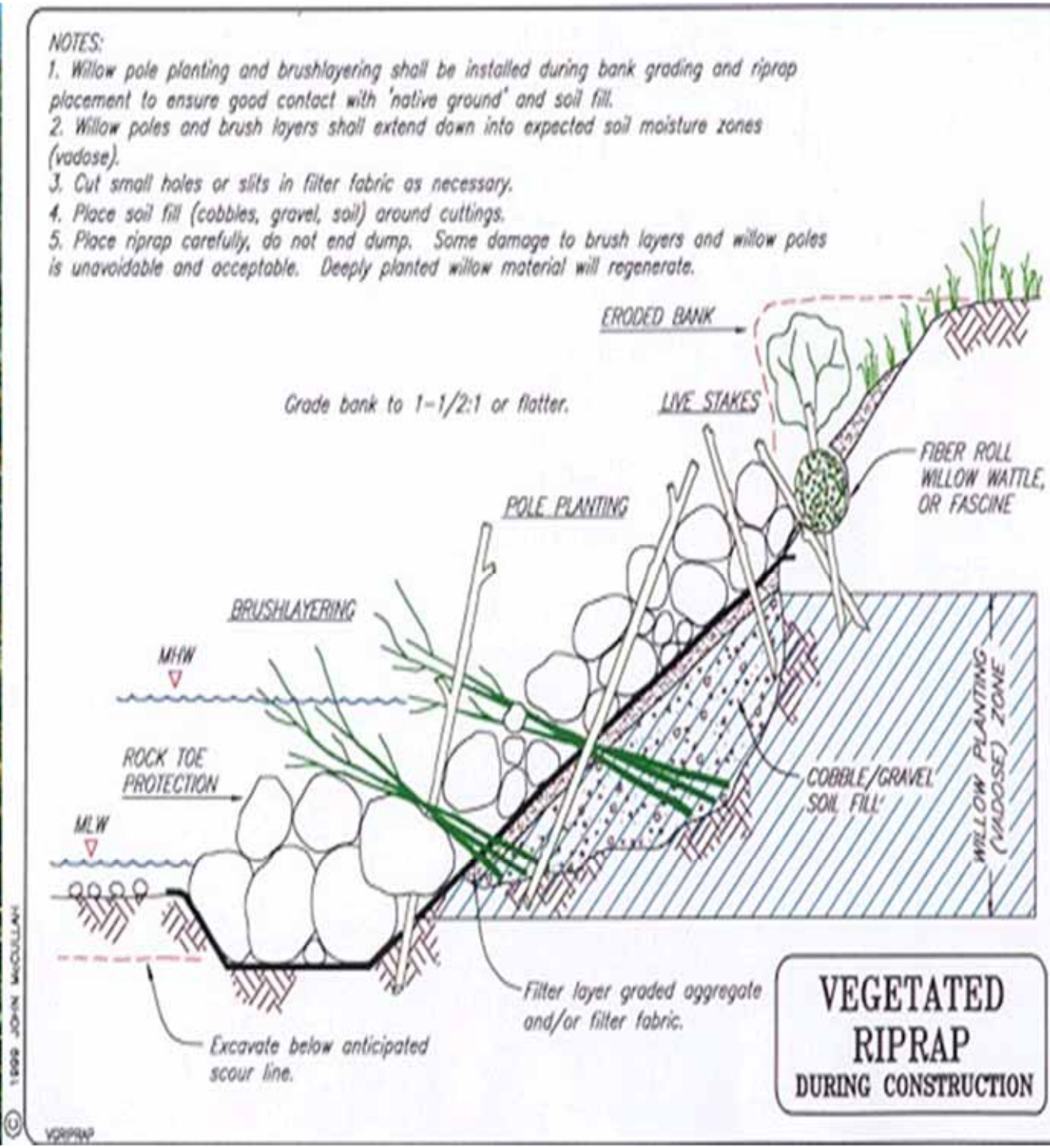
Technical - “Hard Armoring”

- Rock riprap
- Wooden vertical seawalls
- Concrete retaining walls

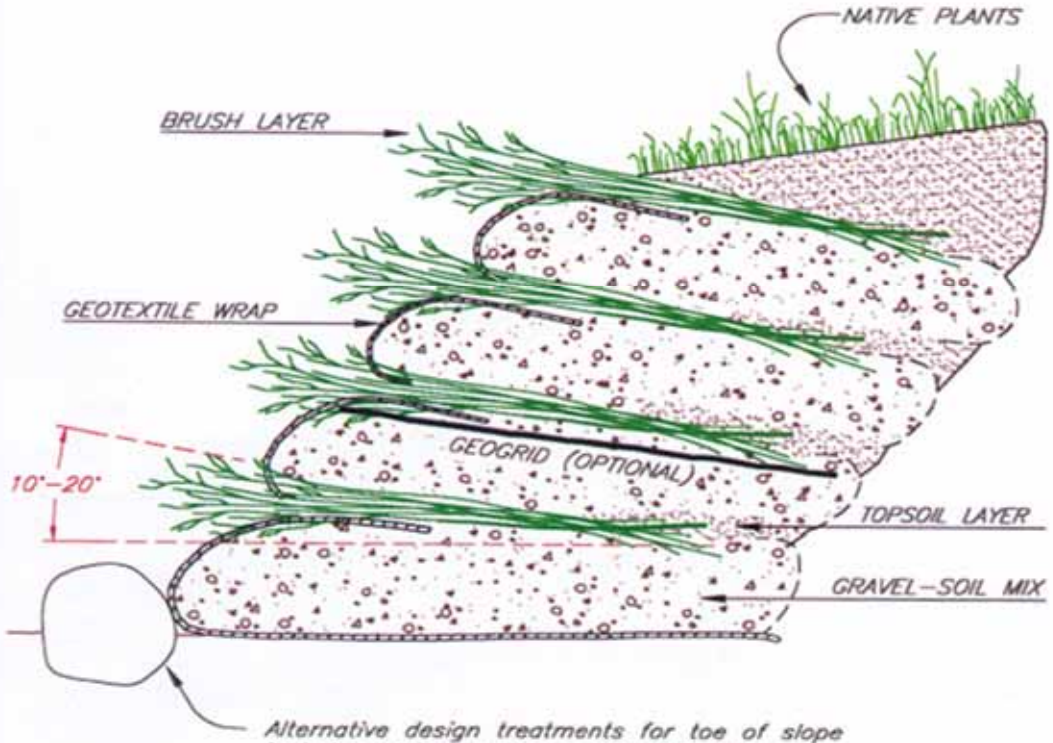

FRONT OF SLOPE
BACK OF TERRACE
PLAN VIEW
Crisscross branches
5–8 branches/ft. min.
(20/linear meter)
placed at random with
regard to size and age.
MHW
MLW
10°–20°
NOTES:
1. Tilt branches down into the slope 10°–20° min.
2. Brushlayering may be constructed with non–compacted or compacted backfill without damage to the brush layer.
3. Branches irrespective of length, should protrude 8–18in. (0.20–0.50 meters) beyond the face of the slope.
BRUSHLAYERING WITH
ROCK TOE PROTECTION
FILE: BRLAY–RT


Biotechnical

Biotechnical



Biotechnical



NOTES:
1. Brush layers, geofabrics and geogrids are tensile inclusions, which modify shear stress.
2. Additionally, once established the root systems bind the entire system together as a coherent mass.
3. Live brush layers act as horizontal drains and improve slope stability by redirecting the flow direction.
4. Cut branches 3' to 12' long from appropriate salix, cornus or populus species.
5. Branches up to 12' long can be used on fillslope installations. Branches for cutslope installation can be 2' to 10' long depending on the bench excavation.
6. Natural geofabrics (coir netting) or geogrids can be wrapped around soil layers to provide additional soil reinforcement.

BRUSHLAYERING WITH GEOTEXTILE SOIL WRAP

FILE: SOILWRAP

General Permit Application Review

- Application Completeness
- Verify data submitted reflects site conditions (desktop approach for both Windwave and EI)
- Assess whether treatment type is GP eligible
- Review adequacy of erosion control plan
- Review if GP conditions are met in the plan.

Windwave Modeling

- For All Apps-Quickly Review all data submitted for Windwave Model.
  - Check Max Fetch on Webview. For that fetch, eyeball a mean depth estimate from a lake map to discern if the applicant's mean depth estimate is reasonable.
  - Run the Windwave Model. Verify agreement with the applicant's energy classification.
  - If disagreement in energy class exists with the applicant, verify that your shoreline location is correct, calculate the mean depth and rerun the model.
  - Note for lakes<400 acres, windwave model output will always be low, nonetheless applicant should calculate a storm wave height estimate.

Desktop Review All Submitted EI's

- **Fetch**
- **Shoreline Geometry**
- **Shoreline Orientation**
- **Boat Wakes**
- **Bank Height**
- **Bank Composition**
- **Influence of Adjacent Structures**
- **Depth at 20 Feet**
- **Depth at 100 Feet**
- **Aquatic Vegetation**
- **Bank Stability**
- **Bank Vegetation**

Red Bold Metrics Can be calculated from Desktop

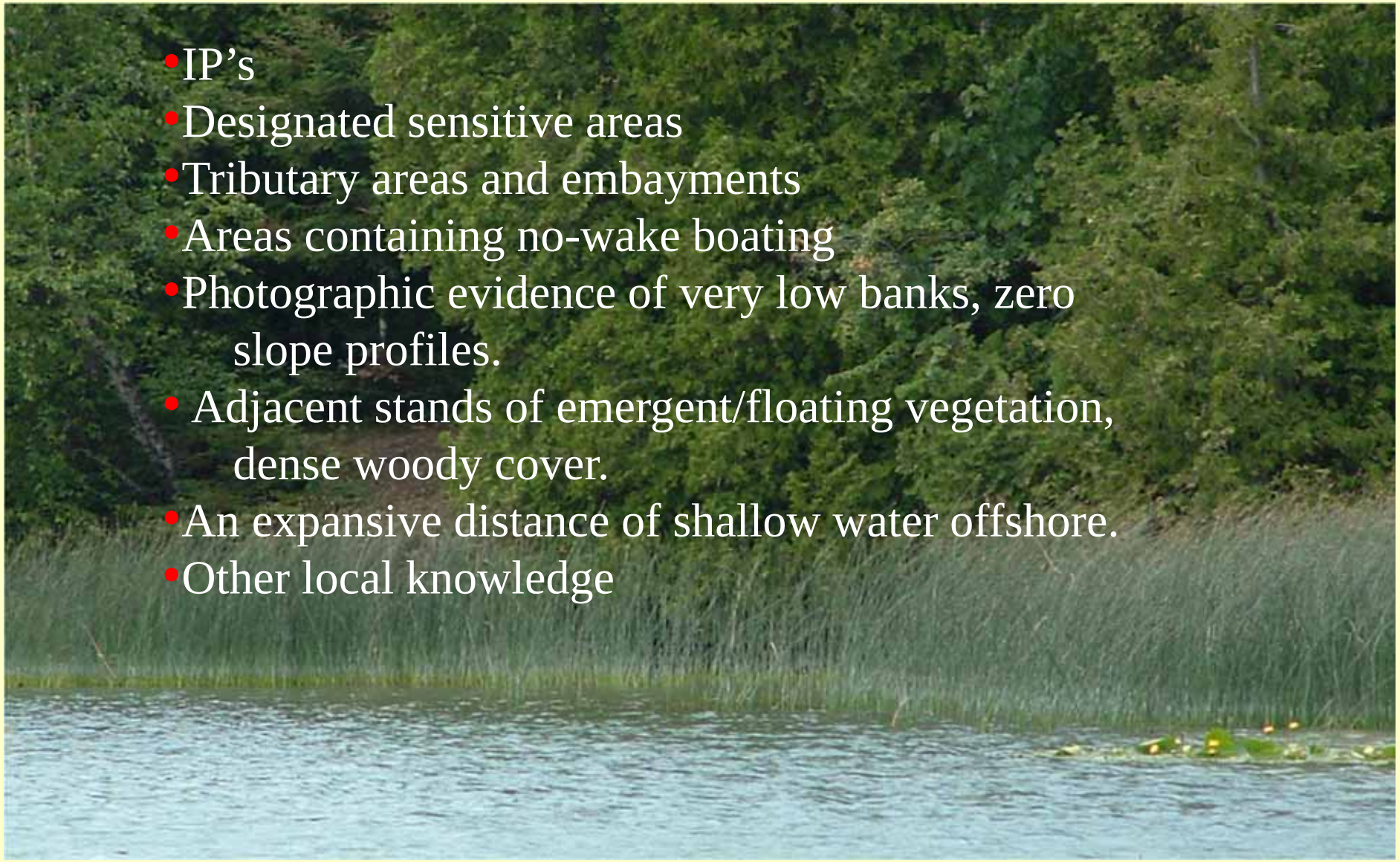
"Estimates" of the other metrics can be made from Photo Interpretation

If your red bolded metrics along with the applicant's other metrics results in a different energy class, then inform the applicant of the energy reclassification and their options.

When to Conduct a Site Review of Applicant's EI?

If **your** Desktop metrics along with **your** "photo-interpreted" metrics results in a different energy class and the difference between the applicants EI and your EI is due to differences in the **"photo-interpreted"** metrics.

Where should a WMS initiate an EI along moderate/high energy shorelines?



- IP’s
- Designated sensitive areas
- Tributary areas and embayments
- Areas containing no-wake boating
- Photographic evidence of very low banks, zero slope profiles.
- Adjacent stands of emergent/floating vegetation, dense woody cover.
- An expansive distance of shallow water offshore.
- Other local knowledge

What Constitutes a Revegetation Plan that meets NR328 Standards?

(b) Willow wattles, willow posts, brush mattresses, brush layering, fiber roll breakwaters, plant carpets, root wads, and other natural materials shall be installed by hand.

(c) Vegetation shall be plant species which are native to the area of Wisconsin where the project is located. Vegetative treatments shall be installed according to Natural Resources Conservation Service Conservation Practice Standard Code 580 (Streambank and Shoreline Protection) or the Natural Resources Conservation Service Engineering Field Handbook (chapter 16).

(j) Riprap or other vegetated armoring along moderate energy sites shall be re-vegetated above the ordinary high water mark by using native shrub plantings, native live stakes or native jointed plantings.

What Constitutes a Revegetation Plan that meets the Rule Standards?

- Plant Species List Including Only Native Plants:Species/type/number
- Diagrams showing planting above the OHWM along the bank face and immediately landward of the bank lip (at least one shrub layer, 5-15’ depending on bank height (low Banks-5 feet, high banks 15’ feet).
- Diagrams showing the upper limit of rock in relation to OHWM and Storm-Wave Height.
- A plan to incorporate plants into the rock design from the OHWM up to the top of the rock (PSWH). Or a plan to limit the rock to below the OHWM and revegetate above.
- Wisconsin Biology Tech Note #1 for Density Standards
- Give Good Advice Based on EI’s--Dormant Cuttings/Woody Shrubs should be encouraged on EI’s above 42. Bushlayering/Brush Mattresses/etc.

Wisconsin Biology Tech Note #1 for Density Standards

Table 1. Shoreland Habitat Planting Densities				
	Woodland		Wetland or Barrens/Dry Prairie/Wet Prairie	
Layer	Minimum Number of Species[1]	Density	Minimum Number of Species[1]	Density
Trees[2]	2	0.5 – 5 per 100 sq. ft.	0	0 - 0.2 per 100 sq. ft.
Shrubs	3	1 - 4 per 100 sq. ft. *If clumped, maintain min. 2 foot spacing*	2	0.2 - 0.5 per 100 sq. ft. *If clumped, maintain min. 2 foot spacing*
Herbaceous Cover[3]				
- Plant plugs	3	25 –75 plants per 100 sq. ft. *Soil must be mulched*	5	50 – 100 plants per 100 sq. ft. *Soil must be mulched*
- Seeding	3	Grass/Sedges: 4-8 oz. per 1000 sq. ft. Forbs: 2-4 oz per 1000 sq. ft.	5[4]	Grass/Sedges: 4-8 oz per 1000 sq. ft. Forbs: 2-4 oz. per 1000 sq. ft.

Additional Informational Resources

- ***Lakescaping for Wildlife and Water Quality*** (180 pages, $19.95, available from the Minnesota Bookstore at 1-800-657-3757). Wisconsin DNR staff recommend this book as a detailed planning guide for shoreland restoration in Wisconsin.

- ***NRCS Engineering Field Handbook***

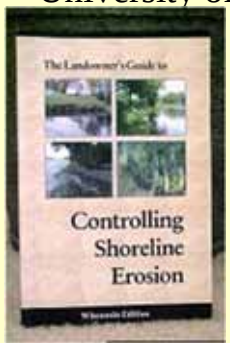
- ***The Living Shore***, a 17-minute video produced by UW-Extension and University of Minnesota Extension showing the importance of leaving a natural 'buffer zone' between the lake and lake owners' dwellings, and providing information about selecting and planting shoreline plants. Call the Wisconsin Association of Lakes (1-800-542-LAKE) to order a copy for $15 plus $2 in shipping, or check your local library for a copy.

- ***A Fresh Look at Shoreland Restoration***, A 4-page pamphlet describing options for restoring shoreland habitat. Available from UW-Extension # GWQ027, or the DNR, publication # DNR-FH-055

- ***What is a shoreland buffer?,*** A brief ecological and legal overview of shoreland buffers. Available from the UW-Extension, publication #GWQ028 or the DNR, publication # DNR FH-233.

- ***The Water's Edge***. A 12- page brochure about what you can do on your lakeshore property to improve habitat for fish and wildlife. Available from your local DNR Service Center.

- ***Life on the Edge... Owning Waterfront Property,*** UW-Extension. Send $3 per copy plus $1.50 for shipping and handling for a total of $4.50 (make checks payable to UW-Extension) to: UWEX-Lakes Program, College of Natural Resources, University of Wisconsin, 1900 Franklin St. Stevens Point, WI 54481



LJ Reas Environmental Consulting Corp.

Specializing in shoreline erosion control and restoration since 1999.

LJ Reas Environmental Consulting Corp.

- Landowner's Guide to Controlling Shoreline Erosion Book
- Project Pictures
- WI Shoreline Regulations
- Bioengineering
- Shoreline Plant Info
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- Home

Landowner's Guide to Controlling Shoreline Erosion Book ©

1 Book $22.95 + 2.30
Shipping and Handling = $25.25

Purchase 1 Book

2 Books $45.90 + $3.50
Shipping and Handling = $49.40

Purchase 2 Books

5 Books $114.75 + $4.95
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Purchase 5 Books

10 Books $229.50 +6.63
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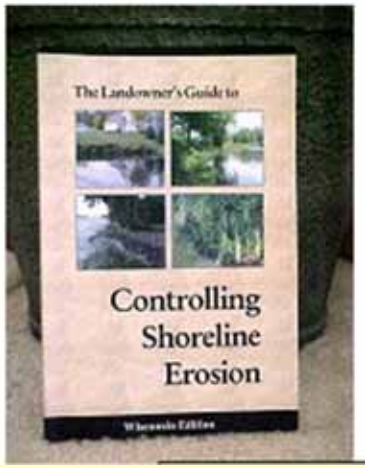
Purchase 10 Books

Please call with any Questions **920 294-3116**

This exciting new book, written by Lisa J. Reas and David Knapp, is now available online. Written in 2004, The Landowner's Guide to Controlling Shoreline Erosion© is a full color book showing actual Wisconsin shoreline photos of before and after stabilization projects. The book's eight chapters and appendix material are designed to guide landowners through the stabilization process. Also included are cross sectional diagrams of eroded and stabilized shorelines. The book is designed to answer basic questions of shoreline landowners including:



NR 328 - Subchapter III

Shore Erosion Control - Rivers and Streams

Why an Emergency?

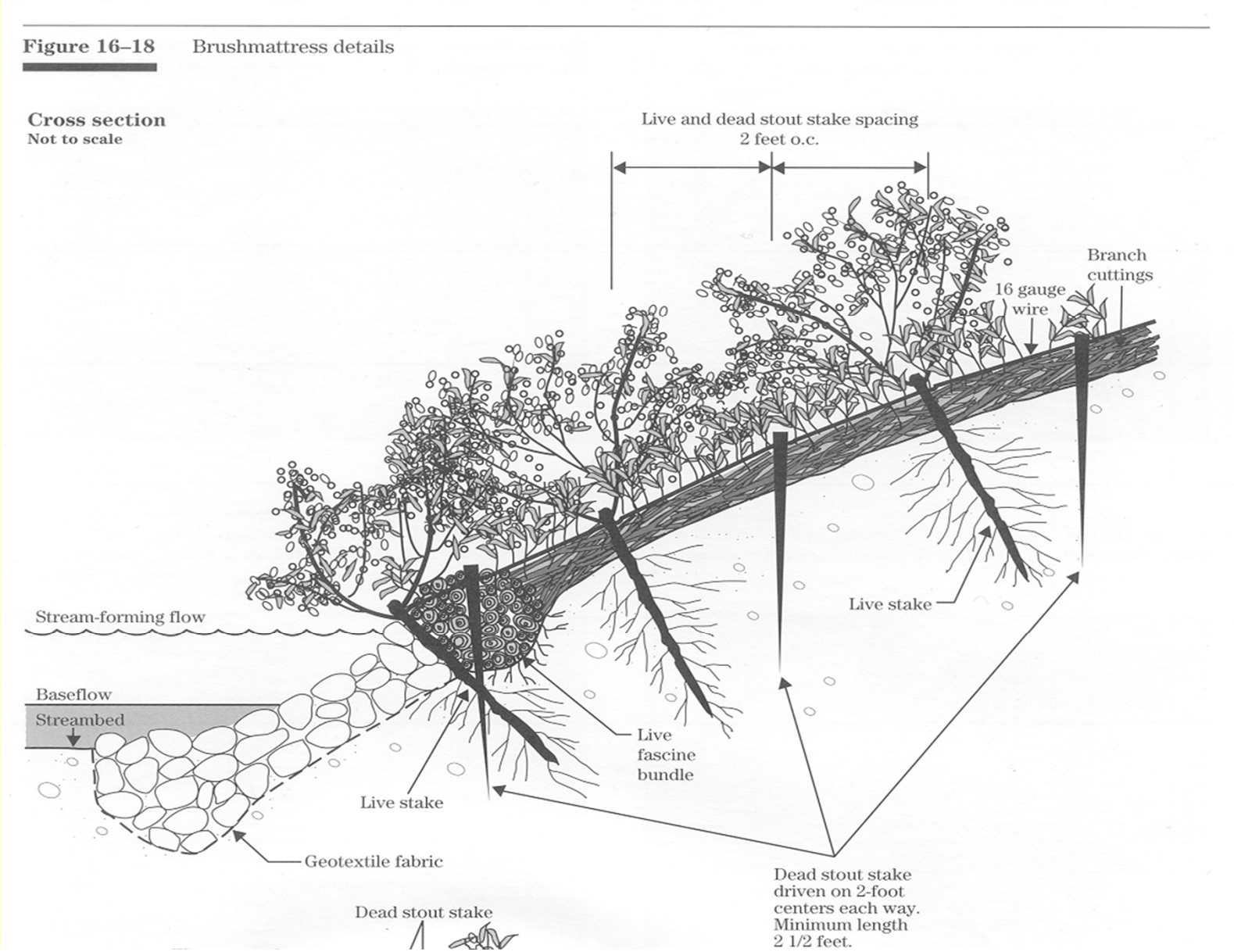
- No statutory exemptions provided for stream/river shoreline protection
- Since Act 118, all projects require IP, including public notice
- General permits will avoid delay for 25-30% of stream/river shoreline projects for 2005

NR 328 Subch. III - Applicability

- Shore erosion control measures placed below the ordinary high water mark require authorization

- Practices involving grading more than 10,000 square feet on the bank require a permit, except on lands used entirely for agriculture.

Integrated Treatment example



NR 328 Subchapter III - General Permits

Conditions:

1. Construction timing to protect spawning
2. Protection of coarse woody cover
3. No impact to Endangered/Threatened species
4. Designated waters - GP not available for:
   - wetlands
   - streams greater than 35 feet wide
   - federal or state wild rivers (Integrated treatment)

NR 328 - General Permits

Conditions, cont'd:

5. Erosion Control and Stormwater Management
6. Maximum length for individual site (one meander) 150 feet; maximum length for project (multiple sites) 500 feet.

Alternate process for large habitat projects not meeting GP standards.

Determining project length