Standard Operating Procedures

Shoreline Re-vegetation

Lost Lake, IL

Prepared for the:

Lost Lake River Conservancy District

Prepared by:

Kaskaskia Engineering Group

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Forward

The following document provides information for guiding a homeowner through the process of how a stabilized vegetated shoreline is created. A vegetated shoreline is an excellent long-term stabilizing solution which adds not only a distinct attractive appearance but also creates a significant ecological benefit to the lake. Areas of dense vegetation along a shoreline provide refuge area for vulnerable young fish and the things that young fish like to eat. They are also important for providing the right kind of habitat for amphibians and fish to lay their eggs. While the benefits of creating a vegetated shoreline are many, installing and maintaining this type of stabilized shoreline is significantly different than the typical act of installing rock armament or seawalls. Part of installing a vegetated shoreline, by definition, involves installing vegetation. Because this type of project involves living plants it can essentially be considered an extension of your landscaping and as such means from time to time plants will need to be replaced, added, or removed. A homeowner should consider this aspect and be sure they are comfortable with the commitment prior to beginning with the planning process as maintaining the plants is an integral component to the stability of the shoreline.

If after this document has been thoroughly reviewed and a homeowner has made a decision that this type of project should be further investigated, the following steps should be taken:

First, the shoreline property should be walked to determine some generalities: which option described in the document would make the most sense for my property; would heavy machinery be able to get to and maneuver around the shoreline; would any excess dirt be able to be used elsewhere on the property or would it all have to be hauled away, what plants from the list provided do I want to use. Starting to identify the answers to these kinds of questions will be helpful once a contractor is contacted and the planning process is fully underway.

Second, a general contractor should be found to assist with completing the planning process. Be sure there is a comfort level reached with them before proceeding beyond the planning process. A suitable contractor should be able to identify past projects where they have conducted similar work and have produced positive results. Prior to hiring a contractor, be sure they include performance standards or something similar to insure the quality of their work. Performance standards simply list the requirements they are held to such as: no more than 10 percent of the live plants shall have perished by the end of the first growing season, any amount beyond 10 percent mortality will be replaced by the contractor at the contractor's expense. A good contractor should be more than happy to guarantee their work as well as be able to help identify any additional construction issues that may be specific to the property.

Third, during the planning process with the contractor the homeowner should decide how much responsibility to take during the establishment period of the plants. Many contractors will provide a maintenance program, for an additional fee of course, over a determined period of time (1-3 years perhaps). This type of service may be beneficial to a homeowner that does not have a comfort level with handling plants.

As a final note, this type of work is currently relatively specialized but quickly becoming more prevalent across the country. The majority of general landscaping contractors deal with hybridized 'yard-plants' and have not worked with the native plants before – especially shoreline plants. In the not too distant future the plants identified in this document will be much more familiar to the general landscaping industry; unfortunately, the number of contractors which specialize in this now is limited. Several companies which have conducted this type of work are listed in the document to provide a potential starting point. Additionally, before planning this type of project, a visit to the Chicago Botanic Gardens is highly recommended (http://www.chicagobotanic.org/visit/map.php#). The Botanic Gardens have restored thousands of linear feet of their shoreline using native plants and while this document describes the process for establishing a stabilized vegetated shoreline, it cannot capture the beauty of one.

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SHORELINE EROSION CONTROL: INSTALLATION OF 'SOFT' MATERIALS

This document is intended to be used as a guideline for shoreline property owners interested in implementing 'soft-stabilization' techniques to establish a vegetated shoreline. The recommendations included are limited for use on shorelines of small reservoirs with relatively stable annual water levels such as Lost Lake.

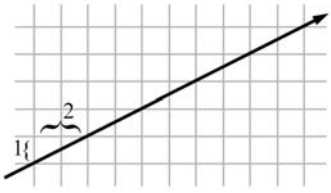
This document will serve to educate the reader as well as provide a range of options for creating an attractive and stable vegetated shoreline.

BACKGROUND

Slope and Substrate

The key to a successful shoreline re-vegetation project is to first understand the basics of shoreline erosion. Grossly oversimplified, shoreline erosion results when the slope of the shoreline exceeds the capacity of the substrate to support itself. The slope (how steep the ground is) and substrate (the ground under your feet) are the main factors in determining the possibilities for how a shoreline can be successfully stabilized.

Unfortunately when speaking about slope, we may need to blow the cobwebs off the mathematics we told ourselves we would never need to use after we got out of school. The slope of the shoreline is given as a ratio; a slope of 2:1 means for every two feet you walk away from a point, you go up or down one foot. The smaller the first number is the steeper the slope of the shoreline is; conversely, the larger the first number is the more gradual the slope is.

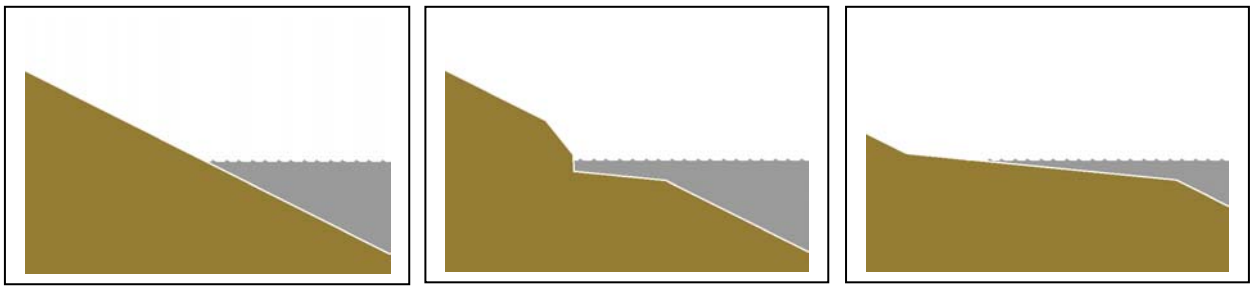


The substrate of a shoreline may be composed of solid rock, loose rock, soil, or any variation/combination of these. A shoreline composed of exposed bedrock (i.e. solid rock) is relatively stable at any slope. This document is designed for use on shoreline areas predominantly composed of soil and not of bedrock. The cohesive strength of soil varies depending on its percentage of clay, sand, or silt. Additionally, those cohesive properties of soil change based on soil moisture. While shoreline erosion is natural, a significant degree of erosion

is an indication that something has changed in the landscape and an imbalance between the slope and substrate has been created.

Lost Lake is a typical Illinois reservoir. It was formed by impounding a stream which in turn flooded a valley. Once the valley was flooded, the shorelines came to rest on the former bluffs. This is the root cause of the majority of the erosion problems experienced by reservoirs. These valley bluffs most often lie at a 2:1 or 3:1 slope (or steeper) and are quite stable on the dry, vegetated valley slope; however, this slope is quite unstable once it becomes saturated and exposed to wave action.

The shoreline erosion going on within the lake is a rebalancing of the slope. The erosion visible above the waterline results primarily from erosion taking place below the waterline. A naturally stable slope below the normal water line most often falls between 10:1 and 20:1. As the water erodes into the bluff to create the reduced slope below the water line, it causes the upper part of the bluff to cave in, which creates a further destabilized slope above the water line. The figure below demonstrates this process.



1 2 3

1 – River valley is flooded and the former bluffs become inundated
2 – The shoreline erodes into the bluff in an attempt to achieve a more stable slope
3 – Over a period of decades or centuries, the banks will erode back to a relatively stable state

Wave Energy and Vegetation

Waves are, at the end of the day, the big bad wolf that blows down the house. Most slopes which are stable when they are dry would still be fairly stable wet; if there were no waves. Damage is done both when a wave comes into contact with the shoreline and when it retreats. First it slams into the shoreline like a hammer hitting a wall which serves to loosen the substrate. Secondly, the residual energy of the wave bounces off the shoreline and is forced under the subsequent waves, which transports material broken loose away from the shoreline like a conveyor belt.

As discussed earlier, a slope between 10:1 and 20:1 is what naturally forms below the water along a shoreline. In older lakes, where erosion has had time to work, this gradual slope will extend out to where the water reaches a depth of two to five feet, then the slope often becomes considerably steeper (in lakes that are not excessively shallow). This change in slope is the point where wave energy begins to lose its influence. Below this point, the water column remains fairly static and the soils can come to rest at a steeper slope where they remain relatively

undisturbed. The depth at which this change occurs is entirely dependent on the size and shape of the lake and the position of the shoreline in relation to the normal wind/weather patterns (all the factors that affect how big the waves can get by the time they impact the shoreline).

Vegetation is a critical factor affecting how wave energy interacts with the shoreline. Plants multi-task as the portion above the soil serves to dampen wave energy and the roots bind the soil in place below. Just as a single bed pillow would do little to stop a person's fall from a rooftop while a large stack of pillows could cushion their landing, quantity is important when considering how vegetation can dissipate wave energy. Plants need to be present for a minimum of 10 feet out from the water's edge to perform any function as wave dissipaters. The physical structure of the plants allows the energy of the waves to be absorbed slowly over a period of space rather than simply reflected back as happens with rip-rap or seawalls.

Aquatic plants can be divided into 'emergents' and 'submergents'. Emergent plants are those species which have their roots in water but the majority (or a significant portion) of the plant grows above the water. Submergent plants are those which grow completely under water. Many of these species are considered nuisances as they can colonize large areas. Additionally they do little to prevent shoreline erosion; Eurasian water milfoil is an example. None of the submergent species are recommended for use in shoreline stabilization.

Emergent species have the necessary combination of form and function to persist at the interface of land and water. Although it may not seem like it, the shoreline is a fairly harsh environment for a plant. In addition to being regularly bombarded by waves, water levels can fluctuate by several feet throughout the year (either leaving a plant high and dry or under extra water), and there is no shortage of wildlife that enjoys disturbing plants. Because of these conditions, emergent plants have segregated themselves into groups that grow in certain zones within the shoreline. The 'driest' group will only grow at or immediately above the normal water level where they can keep their roots wet most all of the time but the upper part of the plant stays dry. The plants can tolerate being submerged for several days as may happen under heavy flooding conditions but not for extended periods. The next zone continues from the waterline to a depth of 3-6 inches and these species can generally tolerate being submerged under a foot of water or exposed for extended periods. The next zone fades to a depth of around a foot and a half. These species typically like to keep their roots wet all of the time. The last zone extends beyond 18 inches and is predominantly composed of species such as lilies and lotus. The depth of water to which these species can grow is limited by the clarity of the water (the importance of water clarity has to do with how deep light can penetrate into the water column). In northern lakes these species may be rooted to depths exceeding 6 feet, but the water in most Illinois lakes is too turbid to allow them to root at depths much beyond 2-3 feet.

The vegetation goes hand-in-hand with a gradual slope. A gradual slope allows for an increase in plant diversity and density with slow, steady transition from driest to wettest. Conversely, the increase in plant area and density allows for the dampening of the wave energy hitting the shoreline and prevents the conveyor belt action removing soil from the shoreline. Note that not all plants are created equal. The native plants recommended for use are specifically adapted to growing in wet and/or dry buffer areas. These plants produce more biomass below ground than above. As a point of reference, the roots of turf grasses will not generally extend below three

inches of the soil. Some of the recommended native species will put roots down over ten feet. The extra biomass makes a significant difference in stabilizing the soil.

Predation

One of the biggest failings of plants for use in shoreline stabilization projects results from them tasting too good to a variety of wildlife. A well developed/established and healthy community of shoreline vegetation can handle periodic predation; however, freshly planted material and/or sparsely planted individuals are not tolerant of grazing. Carp and Canada geese generally cause the biggest problems, but muskrats, bullheads (catfish), and waterfowl other than geese can also impact the vegetation. Carp damage vegetation as they root along the shoreline and completely dislodge plants from the soil. Geese absolutely love to graze on young sprouts and a large flock of geese can graze a significant area in a short period of time. Plants require a few years to fully develop their root systems. Until fully developed, they are unable to quickly resprout after top grazing occurs. Density is important even after the root system is developed as lone plants are uprooted or damaged far more easily than a dense stand of plants with intertwined roots.

CREATING STABLE VEGETATED SHORELINES

The previous section provides an understanding of the erosion processes going on at the shoreline. This section will build upon that information to outline potential methods that can be used to create a vegetated shoreline. Prior to any work being done along the shoreline, all applicable local and federal permits should be obtained.

Slope

An eroding shoreline will not have the proper slope to allow the use of native vegetation for stabilization. Therefore, determining the amount of earthwork is a necessary component of the planning process. Five general options are provided to help the user determine the best fit for their situation. All earthwork activities should be coordinated with the Lost Lake River Conservancy District. In order for the earthwork to be completed, the lake level should be dropped by about two feet, but may be more based on the shoreline conditions present.

Each option involves removing material from the shoreline to achieve a reduction in slope. In some situations, the required excavation will balance the amount of required fill. In most situations, more material will need to be removed than can be used. Calculating the amount of extra material and deciding where to dispose of it is an important part of the planning process as the earthwork is often the most expensive component. Soil that is used for fill within the lake should not be highly erodible (i.e. too high a high percentage of silt, sand, or loam). As a general guideline, fill material should have enough clay content that it can be molded with your hand when moist and not crumble or dissolve. Topsoil that is removed from the bank should be set off to the side until the final grade is achieved and then used as a top dressing not thicker than two

inches. The topsoil does not compact well and will be beneficial to plant growth. Once the final grade is achieved but prior to placing the topsoil, the fill material should be compacted in place (it should not be compacted to the consistency of a brick but enough that a stern kick with your heel doesn't penetrate more than an inch). This compaction will provide some stability while the vegetation is developing.

A few rules-of-thumb are provided and will be repeated within each option. These rules-of-thumb are for slopes composed predominantly of soils, not bedrock. In any situation where these can not be met, additional structural controls should be put in place.

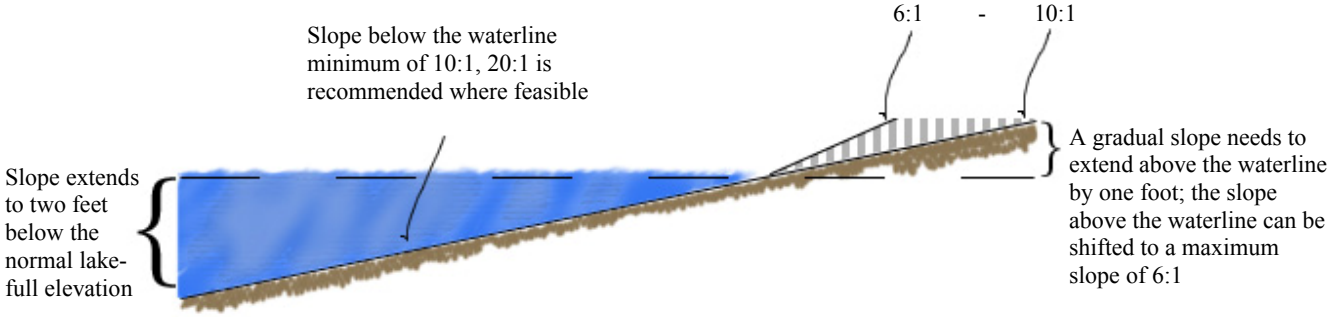
a) Slopes beneath the normal lake-full elevation should not be steeper than 10:1 to a depth of 2 feet,
b) slopes from the normal lake-full elevation to a foot in elevation above that point should not be steeper than 6:1,
c) slopes along the shoreline between a foot above the normal lake-full elevation and three feet above should not be steeper than 3:1.

Temporary erosion controls will be discussed later in this document but one permanent erosion control material will be discussed briefly here. GeoWeb is a honeycomb shaped product that is placed along the shoreline at the water-land interface. The material is sold in segments nine feet wide; when used it should be placed so that a third is below the normal lake-full elevation. The product is sold in various thicknesses and dimensions. An acceptable size would be the GW30V with cells 71 square inches and six inches deep (see photo right). The material must be staked down with reinforcement bar (re-bar) and buried so the top of the GeoWeb is just below the final grade. The product helps stabilize the bank and is designed to allow the roots of the plants to intertwine with the cells, further adding to shoreline stability. Based on the functionality of this product, it is recommended for use on any of the options provided but is only specified in Option 5. While GeoWeb adds an extra layer of protection, the considerable cost both for the material and installation is a consideration for its use.

The line drawings below are shown for demonstration purposes only. They are not drawn to scale.

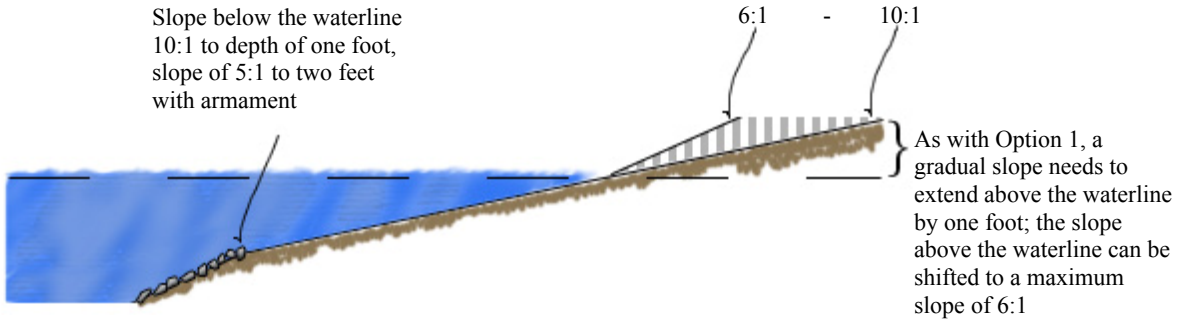
Option 1

This option is the simplest of the 5 and is viable where the eroded banks are not excessively steep, either on the land side or in the lake, and where space is available on the landside. The slope between lake-full and two feet below the lake-full elevation should not exceed 10:1. A slope of 20:1 is preferred as the wider the distance available for plants, the better. From the normal lake-full elevation to a foot above lake-full, the slopes should not be steeper than 6:1. Above this point, the slopes should not be steeper than 3:1.



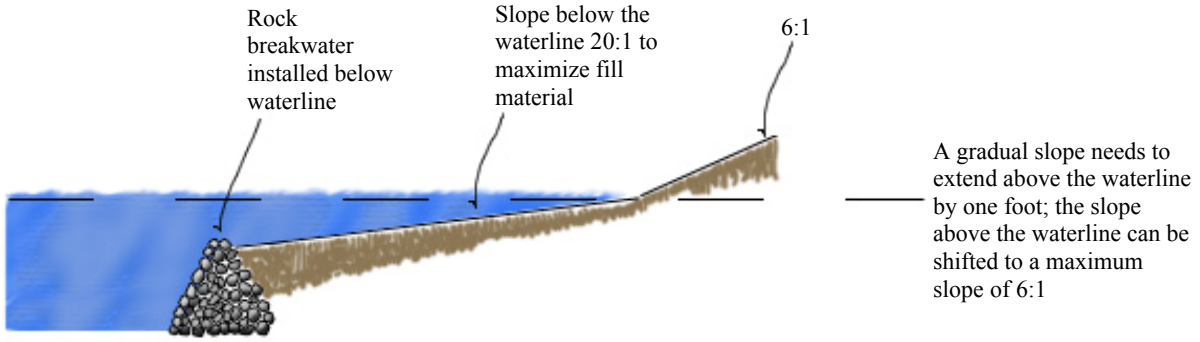
Option 2

This option is for areas where the eroded banks are not excessively steep, but space begins to be an issue. A slope of 10:1 is carried out from the normal lake-full elevation to one foot below lake-full. From the depth of one foot below lake-full to a depth of two feet below lake full, the slope should not be steeper than 5:1 and this portion should be armored with rip-rap. As with Option 1, the slopes should not be steeper than 6:1 between the normal lake-full elevation and one foot above, and the slopes above that point should not be steeper than 3:1.



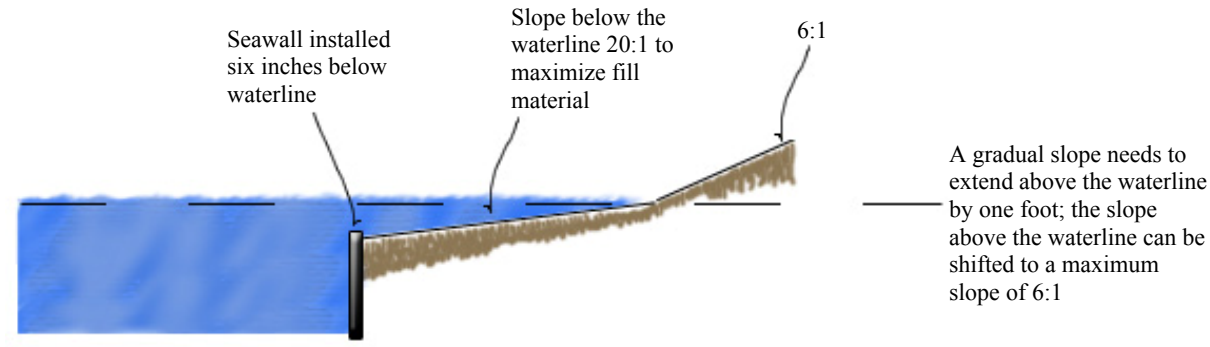
Option 3

This option is useful as the height of the slopes above water increase. This extra slope height requires a fair amount of extra fill material, but there is not enough space to create the proper slope. A rock breakwater is placed a minimum of 12 feet out from the shoreline (if the depth of the water is greater than 3 feet at this point this method is not recommended based on the quantity of rock that would be required). The top of the breakwater should be set six to twelve inches below the normal lake-full elevation depending on the exact distance from shoreline. The fill material is placed behind the breakwater. A slope of 20:1 should be achieved from the breakwater to the lake-full elevation. As with Option 1, the slopes should not be steeper than 6:1 between the normal lake-full elevation and one foot above, and the slopes above that point should not be steeper than 3:1.



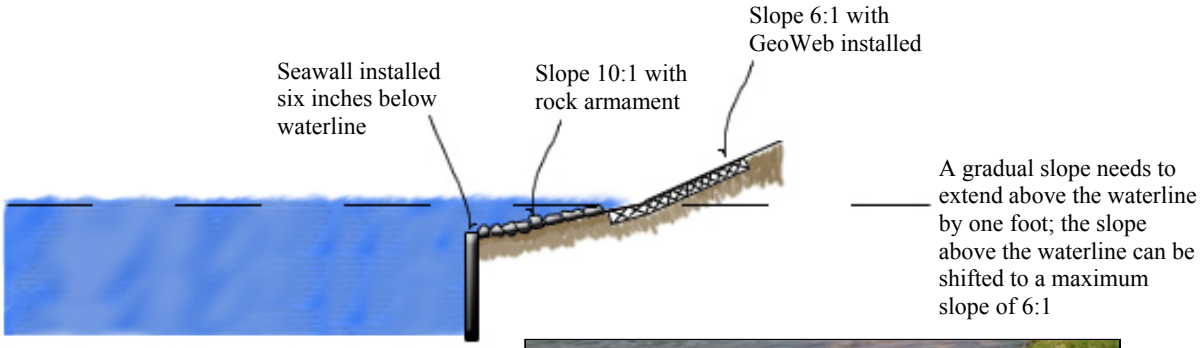
Option 4

This option is necessary when the slopes below the water level are excessively steep and prevent the use of a rock as a breakwater. A seawall (preferably corrugated steel) is placed below the water line so that the top of the seawall is located six inches below the lake-full elevation. The distance from the shoreline is dependent on the steepness of the slope and the quantity of seawall material necessary (the deeper the water, the more material will have to be purchased). A slope of 20:1 should be achieved from the seawall to the lake-full elevation. As with Option 1, the slopes should not be steeper than 6:1 between the normal lake-full elevation and one foot above, and the slopes above that point should not be steeper than 3:1.



Option 5

This option is the only one discussed that does not involve the use of native vegetation. This option is provided for individuals who wish to have part or all of their shoreline with standard turf grass down to the waters edge. Turf grasses will not tolerate constant saturation and will not hold saturated soil in place. Their roots will remain at or near the surface in order to survive. For this reason, this method must use the GeoWeb material (or a similar product) previously discussed. Because this option does not include native vegetation below the water level, armament such as rip-rap and /or a seawall must be used below the stabilizing web. As with Option 1, the slopes should not be steeper than 6:1 between the normal lake-full elevation and one foot above, and the slopes above that point should not be steeper than 3:1. A high level of mortality should be expected for the grass located in the saturation zone near the land-water interface. The expected short lifespan of the grass will require regular reseeding.



Photograph to right provides a visual reference for this sort of treatment. Note the grass will not tolerate any submergence in water and terminates growth at the waterline.

With all options, the final plan needs to incorporate tying back into the shoreline at the edge of the property. 'Capping' the ends with a rip-rap armament or folding seawalls back into the bank is generally the most straight forward approach. All lake ordinances for the application/installation of rip-rap or seawalls must be followed.

Temporary Erosion Control

Properly selected and installed native vegetation will ultimately provide the necessary stability along the shoreline; however, the exposed soils are susceptible during the period of plant establishment. To protect the surface soils, a temporary erosion control blanket should be installed after the earthwork has been completed. The blankets are only necessary for use on the areas where earthwork was conducted. Erosion control blankets are made of a number of different products such as straw, coconut, wood fibers, jute, and plastics. They are made in different combinations and densities in order to order to function properly under various situations; some products will last for only 6 months, while other will last for several years.

The majority of blankets on the market come in one hundred foot roles and are either three-and-a-half or six-and-a-half feet wide: these can typically be ordered in wider rolls, if needed. They are held in place with six to eight inch long round-top or U-shaped staples. Preferred installation methods such as the density of staples, anchoring methods, and amount of necessary overlap between blankets are generally similar and are provided by the manufacturer. There are specialized staple guns that can be purchased; however, the staples can be installed simply by pressing in with your foot. The most important part of installing the blankets is to be sure the ends are secure and that the material is in direct contact with the soil and not being suspended above it. If the material is not in contact with the soil, water is able to flow underneath the blanket.

A 700 grain fully woven coconut blanket is recommended for use in the area below the normal water level. This is a ‘heavy-duty’ blanket which should last for several growing seasons. The woven structure of the blanket also allows for easier installation of live planting material over a non-woven blanket. The heavier weight of this material stands up better to wave action and is resistant to the burrowing or rooting action of fish while the plants are establishing.

A straw or wood fiber product is recommended for use above the normal water level. These are ‘light-duty’ blankets which will only last one growing season. They are essentially loose material stitched to a plastic core to hold them in place. These styles of blankets can be purchased with the material dyed green for those who prefer to have the shoreline have an immediate ‘green’ appearance. The lighter weight material is recommended above the normal water level because the slopes are not exposed to the same level of stress as the portion of the shoreline immediately below the water line. The primary purpose of this material is to prevent rills and gullies from forming as water flows over the land and then down the slopes during a rainstorm. After one growing season, there should be enough vegetative cover that this is no longer a concern.

The two styles of blankets discussed above are temporary products. They are either bio-degradable (break down by bacteria) or photo-degradable (exposure to the sun slowly disintegrates them). All of the manufacturers of erosion control blankets also make permanent blankets which use a non-degradable plastic grid in the core of the blanket. These are designed primarily for use in drainage ditches or on stream banks where a sudden rush of high velocity flowing water is a normal event. A permanent erosion control blanket could be used on the slopes above the normal water level but it is not necessary as the conditions present along the slopes are relatively constant.

The permanent erosion control blankets are often called TRMs (turf reinforcement mats). The plastic grid functions effectively for erosion control once the vegetation grows up through the grid which then becomes locked in place by the vegetation. The TRMs are not recommended below the water line due to the tight grid system which works well for use with turf grasses on dry slopes, but is not as conducive for use with the more 'tuberous' growth of many of the emergent plants. However, a recently-developed product called benthic-mesh is designed specifically for use along shorelines below the water line. The plastic grid openings are approximately a square inch and allow for the thicker stems of wetland plants. The primary function of this product is to create a permanent barrier over the soil to eliminate the potential for damage caused by fish rooting. Once the plants are established, the benthic-mesh prevents uprooting either from grazing or from burrowing action. Benthic-mesh is recommended, especially where carp are known to be present, but it adds considerable cost to the project.

Vegetation

The vegetation has been segregated into the following four planting zones:

Zone 1: Upland Buffer, 1 foot above normal elevation to saturated soils
Zone 2: Saturated soils to 6 inches below the waterline
Zone 3: 6-12 inches below the waterline
Zone 4: 12+ inches below the waterline.

A recommended species list is provided at the end of this section. This is neither a comprehensive list of native species that can be found in Illinois wetland habitats nor is it a comprehensive list of plants that would be acceptable for use in a shoreline planting. This is a generalized list that is both reflective of those species that would naturally occur in this portion of the state and are available for purchase. Property owners should consult with the RCD prior to installing any species that is not on the list to determine if it is appropriate. The American lotus (*Nelumbo lutea*), for example, is a native plant which can be found growing throughout Illinois and the eastern part of the country. This species provides excellent coverage, is extremely hardy, is very attractive, and would be appropriate for Zone 4; however, this plant has not been placed on the recommended list. It is one of the rare natives that *can be* overly aggressive and may easily spread onto adjacent landowners properties.

A list of potential plant suppliers is provided in the Appendix. As with the plants, the list of potential suppliers is not comprehensive. Some of the suppliers listed sell as retailers (individual plants), others as wholesalers (only in bulk), and others will only grow plants contractually (orders must be arranged 6 months to a year in advance). Multiple suppliers may be necessary for a single project as suppliers tend to specialize in certain species. The species in Zone 4 spread primarily through vegetative growth (spreading through their roots, not by seed) so suppliers often sell this in bare-root-stock form or as cuttings rather than as plants started from seed that year. Bare-root stock is simply a piece of the root of the 'parent' plant that has to be planted and then sprout into a new plant. Cuttings are clumps of a fully grown plant that been divided into individual stems for sale. Cuttings are typically more expensive, but are recommended over bare-root stock for shoreline plantings. The species listed for the other zones are typically grown from seed and sold in flats of 38.

Plants should be installed on 1-2 foot centers. Installation should not occur before the second week of May and not after the last week of July. Plantings that occur prior to mid-May run the risk of getting hit by a late frost; those planted after July run the risk of not establishing their roots prior to going dormant in the fall. Plants can be installed 'in-the-wet' after the lake levels have returned to normal from their reduced levels during the earthwork, or they can be installed 'in-the-dry'. Planting 'in-the-dry' is generally easier on the installer but the plants must be watered every day until the water returns to a level high enough to keep the soil saturated (upland plants in the buffer zone should be watered normally as if a regular flowerbed).

If emergent plants are planted 'in-the-wet', the plants must not be totally submerged. Emergent plants need to have a portion of their top-growth above the water in order to absorb carbon-dioxide properly (submergent species do not). An established mature plant will have enough root stock available to propel the plant growth above the water level where it can breathe normally. These plants can live entirely under water for a time, but the young, freshly installed plants are trying to set their roots and do not devote the energy to grow upward. Project planning is important in this respect: either larger plant stock needs to be purchased as depth increases so that the top-growth extends above the waterline when the lake is at full pool or for large projects the RCD should be coordinated with to discuss lake level manipulation. Maintaining a reduction of the lake levels by 4-6 inches for the first growth season is of great benefit. Lake level reduction also mimics the natural cycle of shoreline plant development of Zones 2 and 3 (these plants typically establish themselves and / or expand their coverage area in drier years as water levels drop during the summer months). If lake level is manipulated for planting, be sure to account for the need to water the upper areas of Zone 2. As discussed previously, Zone 4 plants spread primarily through their root systems once established. Live plants in Zone 4 should be concentrated in depths of 12-18 inches. The plants will naturally expand into the remaining area of Zone 4 within a few years.

Zone 1 plants are not emergent plants. They are upland prairie plants. The Zone 1 buffer area is listed as the area from the saturated zone near the waterline to an elevation of 1 foot above the normal water level; however, this buffer zone can be extended farther up the slope if desired. The prairie plants, as with the emergent plants, produce more biomass under the ground than they do above the ground which acts to maintain a more stable slope immediately adjacent to the water's edge.

Protection of Vegetation

Each phase of the restoration process builds upon the previous phase. Unfortunately, the project is not over after the earthwork is completed and the vegetation is in the ground. The first growing season is the most vulnerable for the live plants. The plants have no reserves to fall back on if they are damaged. Additionally, their roots are not set into the substrate which means they can be plucked out entirely if grazed upon at this time. The plants will devote most all of their energy reserves to the production of root material the first year. The second year the plants will produce more top growth, but will still devote a majority of energy to their roots. By the third year, the

plants will assume a relatively full stature. In order to help ensure the plants live to see their second year, it is extremely important to provide adequate protection.

The plants above the water line are at relatively little risk to predation, the plants below the waterline are what all the wildlife disturbs. The entire planting area below the waterline should be quarantined. Metal stakes should be driven in the ground on 8-10 foot centers around the perimeter. The height of the stakes should be 3-4 feet after they are driven in the ground. Netting should be attached to the stakes so that there are no breaks in the barrier. It is helpful to run twine (or the heavy duty nylon string used for masonry or concrete work) along the tops of all the stakes to provide a stringer to attach the netting to. The bottom of the netting should be stapled firmly to the ground approximately every foot where the netting is under the water to prevent fish from getting under the netting. To prevent waterfowl from landing inside the perimeter, string should be run in a criss-cross pattern over the open area within perimeter.

Any type of netting that will prevent fish and waterfowl from entering is acceptable. Snow fencing is commonly used but can be considered an eyesore. Nixalite is a company based in the Quad Cities which specializes in bird control products. They sell a light-weight netting that is very unobtrusive, functional, and cost effective. The PollyNet line is sold in rolls 17 feet wide by various lengths (50-1,500 feet), but the netting can be cut into roughly 4 foot sections so each roll purchased provides 4 rolls. The netting should be maintained for two full growing seasons. The netting can be damaged by ice, so some replacement is usually required the following spring.

Maintenance

Maintenance consists of two main tasks: keep invasive or undesirable plant species from colonizing the shoreline and replace damaged / dead plants. The plants should be developed and well established within three to four growing seasons. Once established, most of the species will become more robust and their densities will begin to increase naturally as long as they are not suffering from heavy grazing pressure. The highest natural mortality will occur within the first year and over the first winter dormancy. Most plants that survive their first winter dormancy period will not fail in their second growing season and beyond, unless otherwise damaged. Because of ice heaving, maintaining the netting completely through the winter is not generally feasible. The foraging of carp over winter typically results in the bulk of the mortality over that period.

The potential for invasive or nuisance species is high when the shoreline has exposed areas. The most aggressive nuisance species are: reed canary grass (*Phalaris arundinacea*), narrow-leaf cattail (*Typha angustifolia*), common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*). The reed canary grass, cattails, and common reed will generally not grow in water deeper than 6 inches so they will not extend too far from the shoreline but they have the potential to work their way down the length of the restored shoreline and displace all the other species in their path. Cattails and common reed can grow to heights exceeding 7 feet which results in a complete visual block of the waterfront. One additional note: cottonwood and willow

trees commonly will migrate in and should be removed while they are seedlings before they can establish their taproots.

Removal of the undesirable species can be achieved either by physical removal (i.e. shovel or pulling) or through treatment with a broad-spectrum herbicide such as glyphosate (the active ingredient in Round-up). When spraying herbicide over standing water, be sure the product is designed for that use. Most herbicides are highly soluble in water which can cause a great deal of havoc to the surrounding plants and other wildlife. Herbicides (such as Rodeo) made for use in wet areas have additives which reduce their solubility in water. Use of aquatic herbicides requires a permit from the IEPA. Procrastination is highly negative when dealing with nuisance species. They are easily disposed of if dealt with early, but can become very difficult to treat if left alone. If allowed to take over an area, they must not only be removed, but plants will need to be purchased to fill in the damaged area.

The area above the waterline that is planted and left in native vegetation can be mown in the fall (October) or spring (April) each year but should not be cut during the growing season. Regular mowing will keep out most tree species. Typical yard weeds will find their way into this planting zone and should be removed in the same fashion as if the area was a flower bed. The shoreline is generally a visual focal point. The plants provide both functional and aesthetic roles. Landowners should be encouraged to manipulate the quantities and species of plants to produce more formal groupings of plants if desired.

The vegetation below about 10 inches of water will typically have the top part of the plants sheared off each winter during ice cover. The vegetated area right at the water line, which is too wet to mow but high enough that the previous year's top-growth remains fairly unscathed after ice-out, can be clipped with a weed-whacker, if desired. Over time, some of the species which were planted can out-compete adjacent plants and may begin to overrun other species. Even though these are desirable species, they should be cut back or thinned to prevent them from increasing beyond their intended area. However, the primary issue is that the shoreline remains covered with native plants. It is up to the landowners' discretion whether to allow one or a few species to dominate the shoreline area.

Table 1: List of appropriate plant species by Zone

Zone 1 (dry buffer)		Zone 2 (saturated-6" below waterline)	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**
Amorpha canescens	Lead plant	*Calamagrostis canadensis*	blue-joint grass*
Asclepias tuberosa	Butterfly weed	*Caltha palustris*	marsh marigold
Aster novae-angliae	New-England aster	*Carex bebbii*	Bebb's sedge
Baptisia alba (lactea or leucantha)	Wild indigo	*Carex cristatella*	round-spikelet sedge†
Baptisia bracteata (leucophaea)	Wild indigo	*Carex emoryi*	Emory's sedge
Boltonia asteroides	False aster	*Carex frankii*	Frank's sedge
Bouteloua curtipendula	Side-oats grama	*Carex grayi*	Gray's sedge
Carex bicknelli	Bicknell's sedge	*Carex hystricina*	porcupine sedge†
Coreopsis palmata	Prairie coreopsis	*Carex lacustris*	Hairy lake sedge
Dalea purpurea	Purple prairie clover	*Carex laeviconica*	slough sedge
Desmanthus illinoensis	Bundle flower	*Carex lupulina*	hop sedge
Dodecatheon meadia	Shooting star	*Carex scoparia*	Sedge
Echinacea pallida	Coneflower	*Carex stricta*	tussock sedge
Echinacea purpurea	Coneflower	*Carex tribuloides*	Sedge†
Eryngium yuccifolium	Rattlesnake master	*Carex vulpinioidea*	foxtail sedge†
Eupatorium perfoliatum	Boneset	*Chelone glabra*	White turtlehead
Hypericum punctatum	St. John's wort	*Echinodorus berteroi*	bur-head
Liatris aspera	Rough blazing star	*Filipendula rubra*	Queen-of-the-Prairie†
Monarda fistulosa	Bergamot	*Helenium autumnale*	Sneezeweed*
Panicum virgatum	Switchgrass	*Hibiscus laevis*	rose mallow
Parthenium integrifolium	Wild Quinine	*Iris shrevei*	wild blue iris
Penstemon digitalis	Beardstongue	*Juncus dudleyi*	Dudley's rush
Phlox pilosa	Phlox	*Juncus effusus*	soft rush
Physostegia virginiana	Obedient plant	*Juncus interior*	inland rush
Pycnanthemum pilosum	Hairy mountain mint	*Juncus tenuis*	path rush
Pycnanthemum virginianum	Mountain mint	*Juncus torreyi*	Torrey's rush†
Ratibida pinnata	Drooping coneflower	*Liatris spicata*	marsh blazing star
Rudbeckia hirta	Black-eyed Susan	*Lobelia cardinalis*	cardinal flower*
Schizachyrium scoparium	Little bluestem	*Lobelia siphilitica*	Great blue lobelia*
Sporobolus heterolepsis	Dropseed	*Mimulus ringens*	monkey flower†
Tradescantia ohiensis	Spiderwort	*Onoclea sensibilis*	sensitive fern*
Verbena hastata	Blue vervain	*Phlox maculata*	sweet William*
Vernonia fasciculata	Ironweed	*Scirpus acutus*	hard-stem bulrush
Veronicastrum virginicum	Culver's root	*Scirpus pungens*	Three-square bulrush
Zizia aurea	Golden alexanders	*Scirpus tabernaemontani*	soft stem bulrush
		Spartina pectinata	cordgrass
		Teucrium canadense	germander*

* - plant at or near waterline but not below 1 inch of water
† - do not plant below 3 inches of water

Table 1: Continued

Zone 3 (6-12")		Zone 4 (12-24")	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**
Acorus calamus	sweetflag	*Nuphar luteum/advena*	cow lily / spatterdock
Alisma subcordatum	water plantain	*Nymphaea tuberosa*	water lily**
Carex lacustris	hairy lake sedge	*Pontederia cordata*	pickerelweed
Carex lurida	lurid sedge	*Sagittaria latifolia*	arrowhead
Iris shrevei	wild blue iris		
Pontederia cordata	pickerelweed		
Sagittaria laitfolia	arrowhead		
Sparganium eurycarpum	bur-weed		

** This is the native water lily. Many nurseries carry non-native lilies that are EXTREMELY INVASIVE and should never be planted in open water.

Appendices:

A – VARIOUS INSTALLATION SUPPLY INFORMATION
B – EXAMPLE PROJECT PLAN / IMPLEMENTATION

VARIOUS INSTALLATION SUPPLY INFORMATION

Erosion Control Materials

American Excelsior Company (http://www.americanexcelsior.com), *Western Excelsior* (http://www.westernexcelsior.com), *North American Green* (http://www.nagreen.com), and *RoLanka* (http://www.rolanka.com) are major manufacturers of erosion control materials. Their websites can be explored to read about the various products they sell. These manufacturers do not typically sell directly, but instead use local distributors for their products. Ero-Tex is a primary distributor in the Chicago / Northern Illinois area (http://www.ero-tex.net). They (or other distributors) are excellent resources for information on available products. The local distributors will also be the resource for staples to use on the blankets.

Benthic-mesh was developed by Wetlands Research Inc. and to the authors' knowledge, is only distributed through Ero-Tex.

GeoWeb is a proprietary product manufactured by Presto GeoSystems (http://www.reynoldspkg.com/alcoa-geo/en/home.asp).

Plant Protection

The metal support stakes and twine can be purchased through any local hardware store. Snow fencing is typically sold in farm supply stores. The light-weight polynet from Nixalite can be ordered directly from the company (http://www.nixalite.com/pollynetbirdnetting.aspx).

Live Plant Material

Possibility Place
7548 W. Monee-Manhattan Rd
Monee, IL 60449
(630) 761-9350

JF New
708 Roosevelt Road
P.O. Box 243
Walkerton, IN 46574
(219) 586-3400

Genesis Nursery
23200 Hurd Road
Tampico, IL 61283
(815) 438-2220

Taylor Creek
17921 Smith Road
Brodhead, WI 53520
(608) 897-8641

Natural Garden
38W443 Highway 64
St. Charles, IL 60175
(630) 584-0432

Spence Nursery
P.O. Box 546
2220 E. Fuson Road
Muncie, IN 47308
(765) 286-7154

Fromm-Huff Farms (*provide contract growing services only*)
10998 Salisbury Road
Pleasant Plains, IL 62677
(217) 626-2232

Prairie Moon (*concentrate on seeds rather than live plants*)
31837 Bur Lane
Winona, MN 55987-4219
1-866-417-8156

Contractors
(known for having experience with native plant restoration)

JF New
6605 Steger Road, Unit A
Monee, Illinois 60449
(708) 534-3450

Applied Ecological Services
17921 Smith Rd (PO Box 256)
Brodhead, WI 53520
(608) 897-8641

Sextons Landscape Concepts
1112 East Culver Avenue
Springfield, IL 62703
(217) 585-8266

Pizzo and Associates
10729 Pine Road
Leland, IL 60531
(815) 495-2300

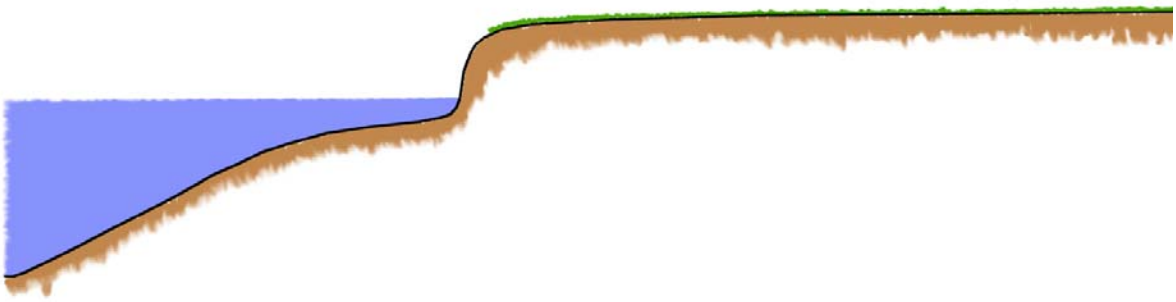
EXAMPLE PROJECT PLAN / IMPLEMENTATION

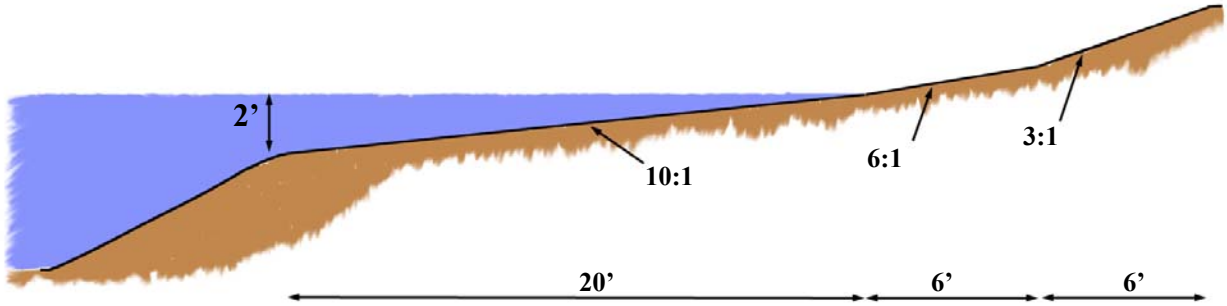
Every shoreline revegetation project will vary based on the complexity of the situation (such as how steep are the slopes coming down to the lake, how steep are the slopes under the water, how much space is available on the property, what to do with the excess fill, how will the earthmoving equipment maneuver around the property, etc.). However, following the concepts outlined in the main body of the report should allow property owners to determine the feasibility of conducting this type of project along their shorelines. A hypothetical situation is provided below to assist with planning a shoreline project.

Before anything is done, the property needs to be characterized to determine a baseline. For this scenario the property owner has approximately 150 of shoreline where:

- There is currently no protection in place (rip-rap or otherwise),
- 1.5 to 2 feet of exposed soil
- The slope below the waterline drops to around 2:1 (5-6 feet out from the edge of the water)
- There are no obstructions for about 75 feet from the shoreline (trees)
- The backslope is gradual

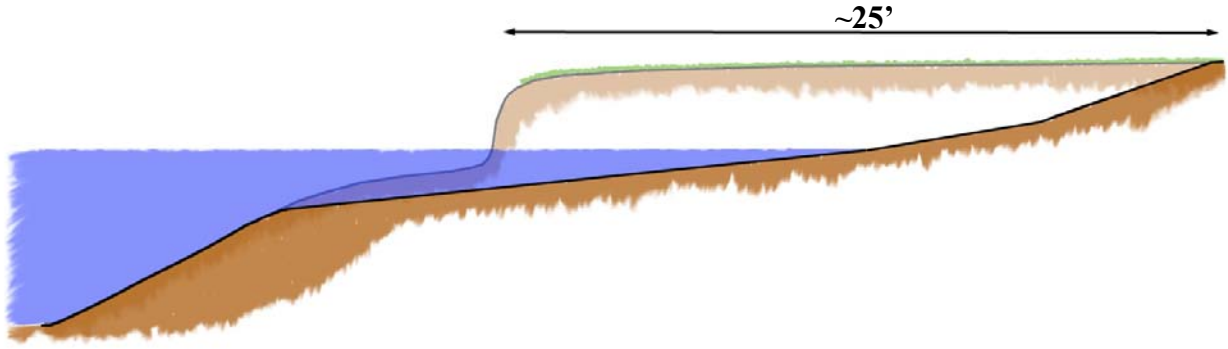
Below: A cross section of the shoreline shows water goes to a depth of 6 feet within about 16-17 feet from the shoreline.



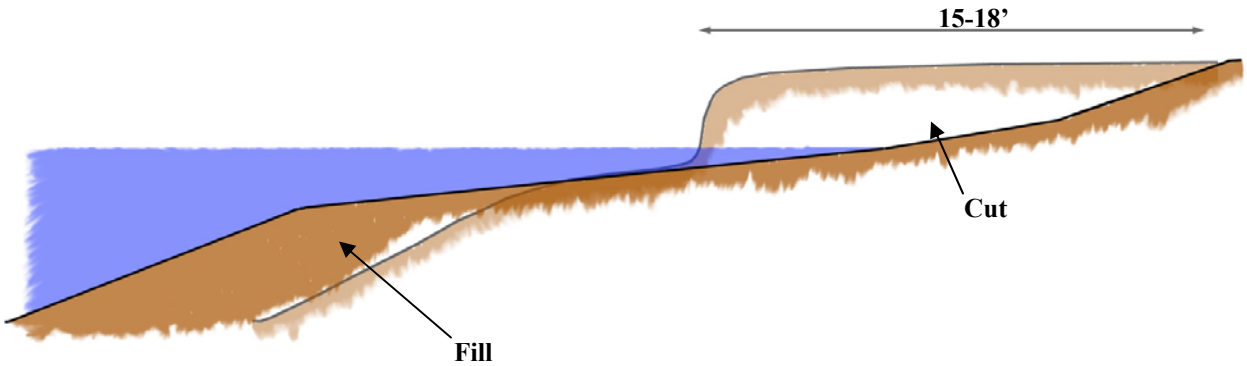


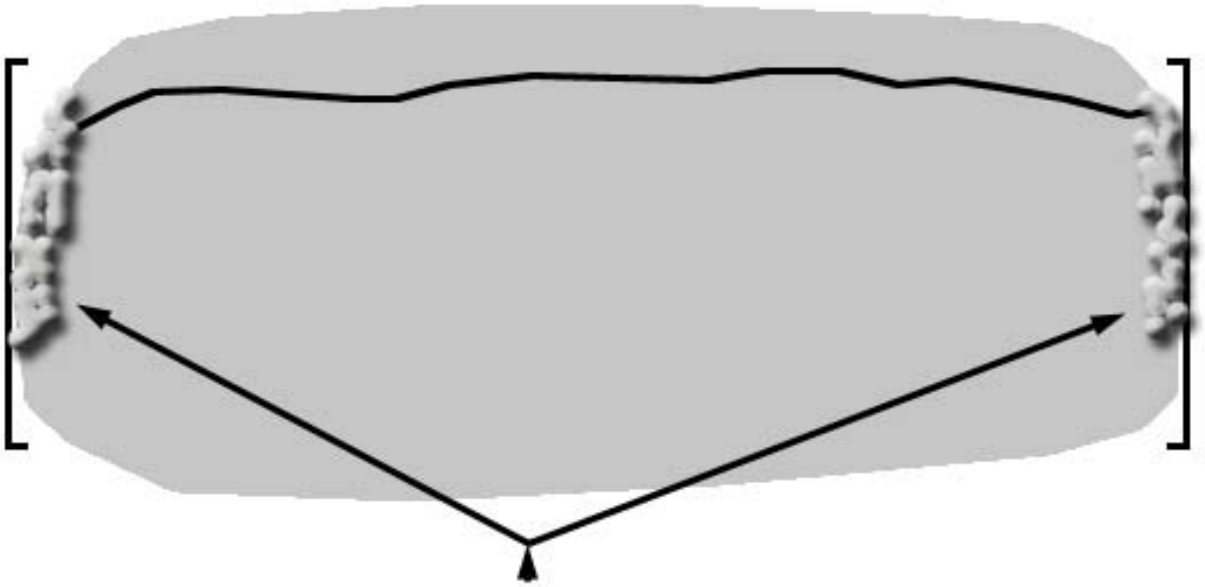
After evaluating the conditions, the decision was made to follow option 1 and use 10:1 slopes. The back-slope in the yard is low, but gradual so the slope was shifted to 6:1 for the first foot elevation, then increased to 3:1 in order to tie back into the hillside.

In this situation, there was abundant space on the side of the property to dispose of the fill. The landowner decided to use it to level out part of the lot; however, a few truck loads were hauled away. To complete the earthwork, the lake level was dropped two feet and a track-hoe was brought in to do the bulk of the soil removal and shaping. A small bulldozer was used to achieve the final grades and spread out the topsoil that had been stored in a pile off to the side. The plan did not involve any fill placement at the shoreline; it was simply ‘pulled-back’ approximately 25 feet (the old grade is shown in the background).



An alternate scenario could occur if the project was timed during major lake renovation where the lake is drawn down significantly lower. At this time, the cut material could be used for fill material on the lower slopes so no material would need to be removed from the site. Also, the distance of the cut area from the edge of the shoreline is reduced since the shoreline is extended inward as well as outward





Armament at property boundaries

The cross section in the previous figure shows the final grades except at the edge of the property. The figure above is looking at the property from above. The black horizontal line would be the original shoreline; the gray would be the area of earthmoving. The earthwork has to account for the adjacent property where the grade is remaining the same. The slopes on the property edges must be protected due to the sudden change. Constructing a shallow retaining wall is an appropriate method but slopes could also be held in place with rock armament.

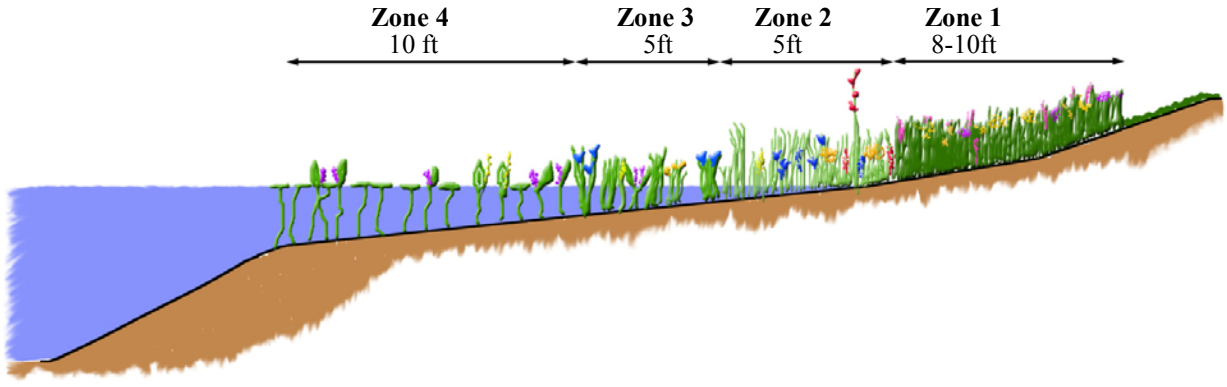
Erosion Control Blanket

Once the slopes have been set, the erosion control blanket needs to be applied. The material is easily handled and can be quickly applied. All seams should be overlapped by approximately six inches and the outside ends should be buried (per individual manufacturer's specifications).

Plant installation

All the plants in Zone 1 and 2 plus some of the plants in Zone 3 will be started from seed and will be grown in special round shaped, open bottomed containers (this encourages downward root growth). Installation is typically via a dibble bar – a device that has the appearance of a simple heavy steel bar. The bar is driven in the ground, removed, and the plant is shoved in the hole. Be sure the installer punches the hole deep enough that the plant sits flush with the top of the ground. The photo on the lower right illustrates the installed plant but would need to be shoved down the last inch before complete. The heavy duty woven material shown in the photos on the right, which is used in the area below the normal water level, is advantageous because the dibble bar will spread the blanket openings without cutting it. If benthic-mesh is chosen, the heavy erosion control blanket is not necessary; however, the going is a little slower as the hard plastic has to be punched through each time. The larger material used in Zones 3 and 4 that are from vegetative cuttings sometimes has to have small holes cut in the fabric or benthic-mesh to be installed. While a simple knife can be used to cut the fabric, using a drill with a 3 or 4 inch hole bit may be the easiest method on the benthic-mesh. The plants should be placed on 1-2 foot centers. Because of the quantities typically involved, having the plants contractually grown is often more economical.

On the slopes for this project, the four zones provide a 30 foot wide buffer on this shoreline



Plant Protection

Once the plants are in the ground, the stakes should be installed and netting applied. Care should be taken to ensure the barrier is maintained and the young plants are not disturbed.

Plant development

The photos on the right are the same spot shown approximately 3 months after planting and then 1 year later. One thing to keep in mind with plant selection: the 'flashier' species are generally grouped in Zone 1 and 2. Some of the Zone 3 and 4 species can produce a splash of color, but not to the same degree.

For a point of reference, below is an example of how the cross section of the modified shoreline might look like if Option 4 was chosen. A seawall was placed approximately 10 feet out from the shoreline where the depth of the water was between 3-4 feet. The top of the seawall was placed about 9 inches below the waterline and the cut material was used for fill. This option only required the shoreline to be cut back about 12 feet to achieve the reduced slopes.