



Texas Agricultural Extension Service

The Texas A&M University System

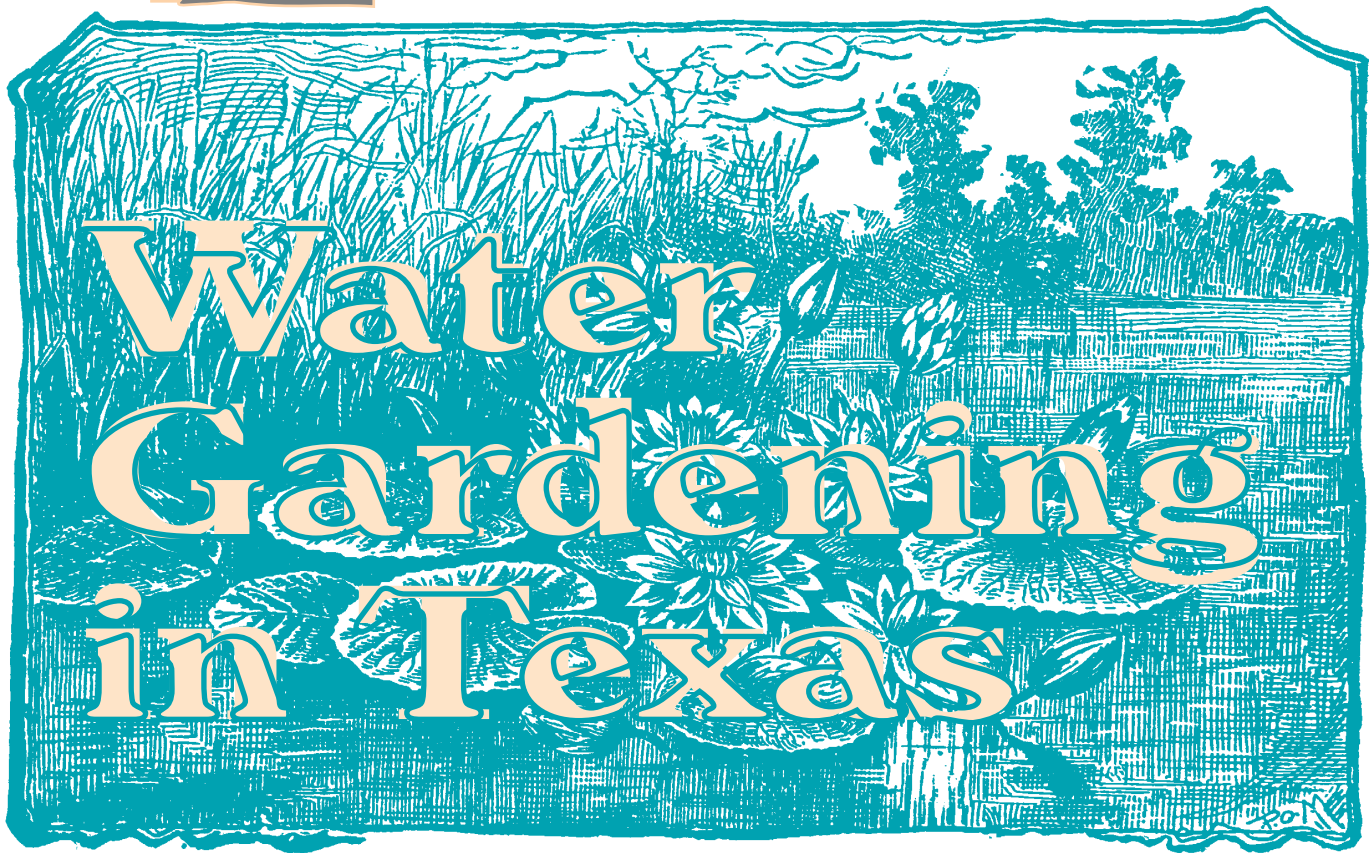


Table of Contents

Introduction	1
Design Consideration	1
Site Selection	2
Construction Methods	3
Construction of the Pond	4
Flexible Liners	4
Fiberglass Pre-formed Ponds	6
Construction of Barrel Water Gardens	7
Construction of Concrete Ponds	8
Construction of Earthen Bottom Ponds	8
Plant Life	8
Planting the Pond	12
Wildlife	12
Maintenance	13
References and Acknowledgments.....	14
Bibliography	14



Water Gardening in Texas

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Introduction

Civilization's first settlements sprang up around rivers due to irrigation and transportation needs. Later these peoples produced such technologies as canals and aqueducts to bring water to lands further removed from the rivers. Water lilies, lotus, iris, arrowheads and cattails, as well as numerous grasses, trees, and other plants found these new oases as inviting as the people who built them.

Water gardens thus had their beginnings in the fabric of both human history and the processes of Mother Nature. As civilizations grew and segregated into classes of the wealthy and the workers, those who could afford to began to have homes built away from the farming areas but wanted to bring with them the beauties of these areas. These gardens, though at first for food and medicinal herbs, soon became elaborate display areas. Eventually the upper classes and royalty built gardens to bring the whole realm of the world to their front door. Gardens like Versailles in France soon stood for the opulence of the elite. This opulence is still a much sought pleasure, but today anyone with the determination and a little money can have a water garden in his or her own backyard.

Thanks to modern plastics, the back breaking, time consuming, labor- and skill-intensive processes of building a beautiful water garden have been reduced to a weekend job with only a minimum of easily learned skills.

There are many considerations before the process can commence including major decisions about design, size of the pond, site selection, materials, and methods of construction.

Design Consideration

The design of the pond is of utmost importance. First, ask yourself, "What role do I want this pond to fulfill in my landscape?" Whatever the answer may be, the design of the pond should take into account:

■ The pool's intended place in your overall landscape design

Designing an entire landscape including a pond would be ideal; however, the majority of the ponds installed are retrofitted to an existing landscape. The relationship, therefore, of the pond to the rest of the landscape should be carefully considered before beginning. A list of questions to consider before starting is given under "Site Selection."

■ Space available

The size of the pond is very important. The smaller the pond, the greater the impact seasonal and diurnal temperature fluctuations have and the less stable the overall pond environment will be. Minimum size for a healthy balanced pond is considered to be about 50 square feet of surface area (a mere 10 foot X 5 foot rectangular pond or an 8 foot circular one).

■ Depth

Another important factor in the overall health of the pond is the depth. Depth of the pond should range from 18 to 24 inches. Greater than 3 feet of depth is not necessary and would prove a

maintenance hazard. In most urban areas, any pond over a depth of 18 inches requires that it be enclosed in or the yard surrounded by a fence 6 feet or taller. If space for adequate surface area is not available, this can be offset to some degree by increasing the depth of the pond.

If you cannot afford much space or the digging is too great a job, all is not lost. Consider a barrel water garden. With proper plant selection and winter maintenance, this can be a viable solution. See construction of a barrel water garden in "Construction Methods."

■ Shape

If the pond is to achieve its potential for your landscape, the shape of the pond should complement the shapes dictated in your landscape. If your landscape is formal in style then the angles, lines, and smooth curves should be repeated in the shape of the pond, preferably in a concentric arrangement. If your landscape is informal, then this freedom of line and form should be reflected by a less geometric design. If the pond is constructed of flexible liners, your options are almost limitless; however, if you elect to use a pre-formed shell liner, your options are more limited.

■ Size

Size of your pond should be a question of proportion and is an important design consideration. If the pond is to occupy a place of prominence, such as the central theme of the landscape, then its size should reflect this by taking a greater proportion of the area allotted to hardscape. If the pond is a nuance or an accent,

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then it should be in proportion to the other accents of the garden.

Also, in deciding on the size of the pond, consider the amount of work to be done. This may help determine whether you will attempt the construction yourself or hire the work done. For one of the minimum sized commercially available pre-formed shell liners of 50- to 65-gallon capacity, approximately 6.7 to 8.7 cubic feet of soil must be removed, or 0.25 to 0.32 cubic yards (only about 2 to 3 wheelbarrows full).

■ Soil removal

What is to be done with the soil removed to make the pond? If need be, arrange for its removal, but better yet, find a project such as a raised bed to build with the soil. After figuring out the gallonage of the pond, use this number to determine the amount of soil that you must remove. For every 1 gallon of water in the pond, there are 0.134 cubic feet of soil to be removed, in addition to soil removed for edging and sand cushioning underneath. Thus, for a 100-gallon pond more than 13.4 cubic feet of soil must be removed, enough for a 5-foot square bed raised 6 inches.

■ Edging

Edging materials help to tie the water feature into the overall scheme of the garden. A coping such as brick, rocks, steel edging, or wood around the pond can be used to accent the pond. Alternatively, inappropriate edging materials can diminish or overstate the pond's importance in the landscape.

Use the colors, textures and form of the individual pieces of edging material to complement or reinforce the position that your pond occupies in the overall hierarchy of your landscape. These materials, in any case, should complement any edging materials already in use. Decide early on in the design phase what type of edging will be used. This decision

substantially impacts the construction phase.

■ Local regulations

Some local governments have no restrictions on pond construction. However, most require fences around the yard of any pond 18 inches or greater in depth. Many municipalities require recirculating pumps and filtration systems. If garden hoses are used to fill the ponds, they must be equipped with an anti-siphon device. Some city and county governments require that all ponds be inspected after construction for these and other sanitation issues. Some municipalities require building permits. Check with dealers in your area carrying water garden construction supplies about specifics for your area or call the local authorities if you are unsure.

■ Construction material selection

Choice of materials should take into account the cost, life expectancy of the material, installation requirements, availability in your area, and how these materials may blend with the existing materials in your landscape. The liner is generally the most important and most expensive component of the water garden. Some examples of liners in order of life expectancy from shortest to longest are:

PVC (fish grade)—7 to 15 years

Butyl or Rubber (fish grade)—30 years

Fiberglass—50 years

Concrete—Lifetime, if done correctly, but very difficult and much skill required.

■ Plants

Plant selection for the pond is, of course, one of the major design considerations. However, as stated earlier, most ponds are retrofitted to an existing landscape, so for best results, the plant material chosen for the pond must be in

concert with existing plants in the landscape. Some design aspects to keep in mind when attempting to match or contrast the pond to your landscape are: overall plant texture, color and length of bloom, foliage type and texture (including the effects of variegation), height, evergreen vs. deciduous, and overall form. If you do have the luxury of designing a landscape to include a water garden, read the section on "Plant Life" before choosing your plants.

Site Selection

In selecting the site for the garden, consider the plants that you intend to grow in the pond, the soils on the site, how level the grade of the site is, surface drainage of the site, the view of the pond site from the house, the overall fit of the pond in the existing landscape, and anticipated maintenance requirements.

General site selection requirements

A water garden should be located:

- In full sun, or as much as is available.
- At the most level site available.
- Within easy access to water and electricity.
- Where it can be appropriately viewed from the house.
- Where the water can reflect the beauty of the surrounding landscape.

A water garden should not be located:

- Where it is in a position to catch leaves falling from trees.
- In a low spot in the yard where heavy rain could flood it.
- Where soils are prone to saturation which could cause the liner to float.

Effect of plant selection on the location of the pond

If you want any flowering aquatic plants such as water lilies in your pond, these dictate the site be in full sun for optimum flowering. Some exceptions are such water lily cultivars as 'Comanche' and 'Graziella', which flower with as little as 3 hours of direct sunlight. For the best growth and establishment of all of your water garden plants, a minimum of 5 to 6 hours of direct sunlight each day is recommended.

If none of these conditions can be met, then consider a quiet, cool bog garden. Far from a dark, dank, mosquito infested swamp, a properly designed and maintained bog garden can be a cool green retreat in a shady summer garden.

Effect of the existing soil and grade

For the best results and ease of construction, a site with a well drained surface and subsoil is best. A sandy-loam textured soil will prevent soil saturation from floating the pond liner. If the area has good surface drainage there will be fewer problems with runoff of chemical pesticides and fertilizers into the pond from the surrounding land. The more level the site the less work in constructing the pond.

View of the pond from the house or decks

When deciding where to place the pond, consider the place from which you will most often view it. If this is a deck or patio, be sure that this view is not obstructed by hedges or other tall landscape features. Remember that the pond is in the ground and even tall grass or ground covers can completely obscure the view.

How the pond fits into the overall landscape

Once the exposure, soils, drainage, and views have been worked out, consider how the pond will fit into your existing landscape. Are there any tree roots nearby from shallow rooted plants such as elms (*Ulmus* spp.) and willows (*Salix* spp.), or trees that do not tolerate root disturbances like post oaks (*Quercus stellata*)? Will there be any trees close enough that leaves, fruit or twigs will present a maintenance problem? Are any of the trees walnuts (*Juglans* spp.)? These trees have a chemical in their roots that inhibits the growth of neighboring plants. Will the reflection of existing plant materials in the pond add to or diminish its overall appearance? Will the surrounding plants eventually grow large enough to shade the pond? Will construction of the pond necessitate construction of a fence? Will the pond cause problems in the overall pattern of surface and/or subsurface drainage?

Maintenance concerns

The site of the pond should facilitate its management. If the pond is sited too close for its size to a wall or other obstructions, this could cause a problem reaching all of the pond's surface for cleaning and removal of dead leaves. If the pond is to contain tropical water lilies or other non-hardy plants, it is helpful to locate it close to the selected storage facility or close to a level hard path leading there. The site should have access to water sources for filling and "topping off" the pond and close electrical outlets if there are to be any lighting or filtration systems included in the design.

Construction Methods

Tasks and tools needed:

- **Digging:** shovels—round point and square point, picks, crow bar.
- **Leveling:** carpenter level, string, stakes, and a long 2X4.
- **Packing:** a tamping tool.
- **Hauling materials:** wheelbarrow, plastic sheets. If the waste soil is to be used on site then remove it in a wheelbarrow as it is dug. If it is to be removed from your residence, store it on a large plastic sheet or an old quilt until it can be removed.
- **Finishing concrete:** wooden float, trowels.

Materials needed:

- **Liners:** order whichever type chosen, well ahead of the proposed construction date.
- **Sand:** a 2-inch layer of sand should be included beneath any flexible liner to cushion it from sharp objects in the subsoil.
- **Chemicals:** Most cities treat their water supply with chlorine. If you use a municipal water supply to fill your pond, call the city water department and ask if they add chlorine dioxide or chloramines. If so, there are compounds on the market that can be used to eliminate these. If chlorine is the only additive, then fill the pond and wait 24 to 48 hours for it to evaporate before stocking.
- **Pumps:** Though a pump for recirculating the water in your pond is not necessary, they are strongly recommended by most professionals and required by health departments in many cities. The size of pump for your pond will



depend on several things, but for the best results and the clearest water the pump should be capable of circulating the entire volume of the pond's water through a filter in 1 to 2 hours. The faster the better. If a water feature such as a waterfall is to be included in the water garden, the pump must be of a size capable of carrying the extra load and fast enough to handle the transit time of the water in the feature. The faster the water falls (the steeper the grade) and the greater the amount of water falling in the feature, the greater the capacity of the pump needed.

- **Pump filters:** These remove particulate matter such as algae, sediments, and fish wastes from the pond's water. There are two main types of filters, mechanical and biological. The mechanical filters are less expensive but require more maintenance. Mechanical filters require the entire volume of water in the pond to circulate through them at least once every hour to be effective. These filters are easy to install and generally lay on the bottom of the pond, but may need cleaning as often as once every few days. The biological filters are more expensive but need less care. Biological filters are more difficult to install but may need attention as seldom as once a month.
- **Edging materials:** If edging materials contain concrete or if blocks used in raising the potted plants contain cement, these materials must be leached with an acidic solution or soaked in several changes of water for one week before being added to the pool. Concrete is basic in nature and will have a detrimental effect on life in the pond.
- **Pots for plants:** Pots for the plants vary in size and increase in direct proportion to the size of the mature plant and the

number of plants to be placed in the pot. Plastic is the best material for pots. Pots for aquatic plants may be pails, buckets, baskets, or pans. Baskets are often the best choice as they allow more surface interface of soil and water for gas exchange. Baskets, however, must be lined with a burlap type material to prevent the soil from clouding the water.

- **Media for plants:** Potting media for all pond plants should be fertile heavy clay loam. This soil should be free from fertilizers, herbicides and other pesticides. These chemicals, if not directly toxic to the plants, can leach out and cause damage to fish and animals living in the pond. Soil should also be free of any fresh organic matter such as peat (fresh organic matter will tend to float out of the soil and cloud the water). All media must be covered with a 1- to 2-inch layer of coarse gravel or rocks (not sand) to prevent the clay from dispersing into the pond water and to prevent the fish from roiling in the soil.
- **Fertilizers:** Fertilizers used should be special aquatic pelletized slow release form pushed in at the base of the plants. You may also use a well balanced fertilizer mixed into the soil and then packed into the middle of the rootball at the bottom of the pot to prevent it from leaching. Caution should be used as any fertilizer leaching out into the water will cause an algae bloom.
- **Maintenance tools:** A long poled dip net is handy for the removal of leaves and other fallen materials. Garden shears facilitate pruning of water plants. A pH meter or testing kit is useful but not necessary as the test can be performed by the larger garden centers or the county agent.

Construction of the Pond

Flexible Liners

■ **Step 1:** Lay out a garden hose or string where the pond is to be located and in the desired shape of the pond. Stand back and view it from the surrounding garden, deck, and house. It is easier to make changes now than once you have started digging.

Once you are satisfied with the position and shape of the pond, remove the turf and any topsoil from the outlined area adding 2 inches to the width for a layer of cushioning sand to be included beneath the liner. If any edging such as rock or brick is to be laid around the pond, remove the turf and soil from this area as well. Then remark the actual area of the pond.

It is easier to level the edge of the pond at this point using the soil as it is removed by raising the lower end. It is extremely important that the edge of the pond be level since the water inside will always be level, thus revealing to the eye and exposing to the sun any liner that is not covered by water or in the shadow of an overhanging edge. Using a carpenter level and as long a 2X4 as needed (Figure 1), lay the board across the pond and the level on top of this. Check the pond in all directions to make sure it is level all the way around the edge. It may be helpful to use short wooden stakes to mark the level spots as you go around. Use these stakes as a reference to level the next one all the way around the pond, removing any soil above the stakes as you go. Once the rim of the pond is level, the rest of the pond's dimensions can be measured using it as reference.

■ **Step 2:** Spread enough polyethylene plastic to hold the soil being removed (Figure 1). Next, begin digging from the center of the pond toward the edge. Remember to allow for shelves if these were included

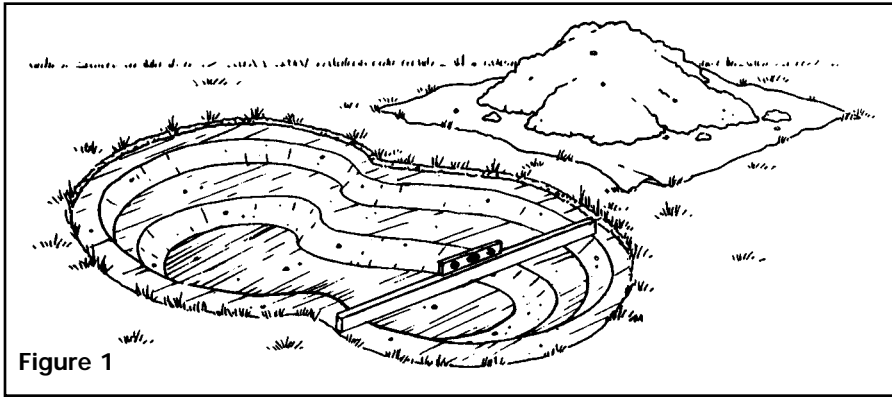


Figure 1

in the design. It is easier to maintain shape and monitor depth if the entire pond is dug out at once to the depth of the shelves first (about 9 to 12 inches). Then start digging out again from the center of the pond, leaving the width of the shelves, 9 to 12 inches. If an edging other than grass is to be used, account for this portion as well. Flexible liners must be lapped under soil to hold them in place and prevent subsurface drainage into the pond (Figure 3). A slight fall of 1 inch per foot away from the pond is all that is necessary and looks best for the edging. The walls of the pond should slope from the shelves to the bottom of the pond at about 20 degrees off vertical, that is, 1

inch toward the center for every 3 inches down. Thus, if the overall depth of the pond is 24 inches plus 2 inches for sand and there is a 9-inch deep shelf plus 2 inches for sand, the wall for the shelf will come in 3.5 inches from top to base. Then, move out the width of the shelf and cut the wall at a slope down another 15 inches to the bottom coming in another 5 inches.

- **Hint:** when digging out the major portion of the soil use a round point shovel. Then, after getting as close as possible, cut the slopes for the walls using a square point shovel. Once you have cut two widths of the shovel to grade, cut the remainder with only half of the shovel

at a time using the other half to follow the grade (Figure 2).

- **Step 3:** Once all of the soil has been removed, all surfaces are as smooth as possible, and the sides are all set to grade, check the walls, base of the pond, and shelves for rocks, sticks, glass, roots, and any other sharp objects that might puncture the pond liner. Next, begin placing the 2-inch layer of sand in the pond. The sand should be moist and packed in as tightly as possible.

- **Step 4:** Roll the liner out on the driveway or any non-turf area; allow time for it to warm enough to become flexible (less time may be needed if it is a particularly hot or sunny day). Once the liner is workable, re-roll it and carry it—DO NOT DRAG IT—to the pond; a wheelbarrow is helpful with large liners. Unroll the liner and position it over the hole so that the lengths and widths match those of the pond. Carefully push the liner into the pond trying not to disturb the sand. It is not necessary to mold the liner exactly to the pond's shape, but it is helpful to approximate it. The water will finish the job as it fills the

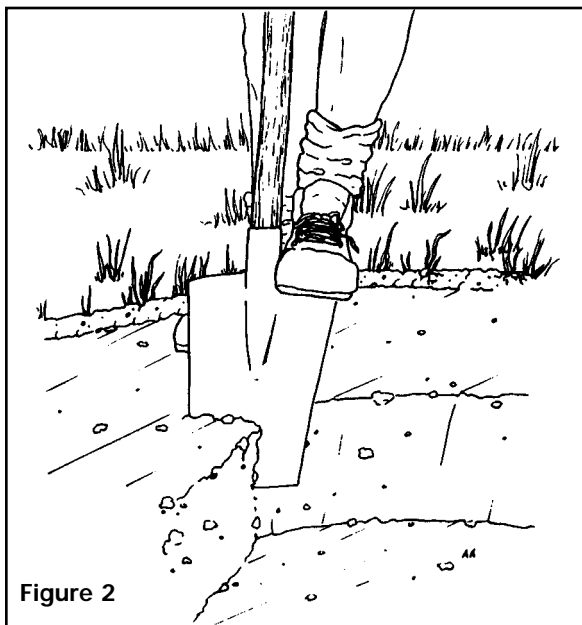


Figure 2

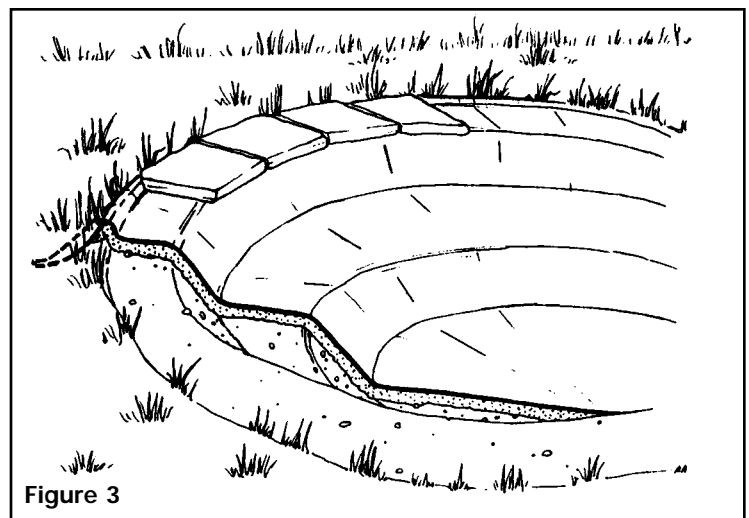


Figure 3



pond. Lay some stones on the ends of the liner to produce some tension as it fills with water (this will prevent unnecessary folds in the liner) (Figure 4).

- **Step 5:** Begin filling the pond with water (Figure 4). This will take some time. As the liner begins to fit the pond, excess liner will begin to gather naturally in certain areas. As the pond fills draw these areas tight and simply fold the material over into as many flaps as needed. Use of more and

is highly alkaline and reaction with water could create a severe pH problem. If enough falls in, it may necessitate draining and washing, before refilling the pond.

If edging the pond with bricks or other rectangular materials, orient them with their length towards the center of the pond. Be sure to allow for at least a 2- to 3-inch overhang to hide and protect any exposed liner (Figure 5). This gives the best appearance and stability to the surface which must be constructed well enough

maintain either an obviously intentionally irregular edge and surface or a perfectly straight and flat one. String lines, carpenter levels, long boards, and pre-cut curved forms are useful here (Figure 1). Allow ample time, 48 hours, for concrete to dry before any foot traffic or potted plants are allowed on the edging.

Fiberglass Pre-formed Ponds

- **Step 1:** Place the pond liner in the spot where you want the pond. Outline this area in the same shape and size as the pond shell with a garden hose or rope. Once you select a fiberglass shell it is too late to change its shape. Remove the pond shell to a safe distance. Add about 2 to 4 inches to the width of the pond outline for room to add and tamp the back fill (Figure 6). Further, add enough distance to the area of turf removed for the addition of edging material if any is to be used. Lay out enough plastic to hold all of the excavated soil (Figure 1). Remove any turf from the enclosed area. At this point use the top soil removed to level the area that is to be the rim of the pond. Use wooden stakes to mark the desired level and then carry that grade around the pond. It is better to add fill

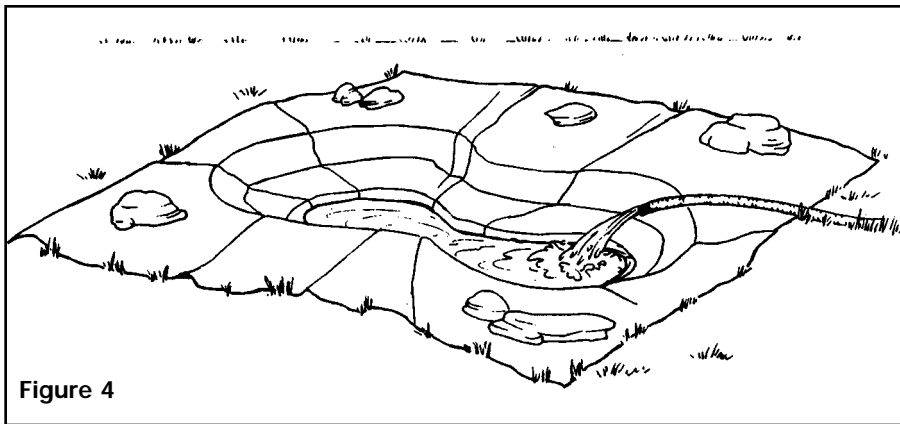


Figure 4

smaller flaps is best. The water will eventually cover these and they will become unnoticeable. As the pond nears full capacity, start to cut the excess liner from the edges. Save these pieces for patches later if the pond needs some repair, or place them under heavy pots and bricks (Figure 5).

- **Step 6:** With the pond full of water, the final step is to install any edging (Figure 3). Edging the pond should wait until it is full so that water pressure will aid the wall in withstanding any weight of material or people. A full pond also keeps the liner in place and well fitted before the edging seals it in place preventing any further changes. If the edging contains mortar, it is most important to avoid spillage into the pond. Cement

to support occasional foot traffic. The material should be laid with approximately 1 inch per foot fall away from the pond, thus preventing surrounding surface runoff from entering the pond. Edging looks best if you can

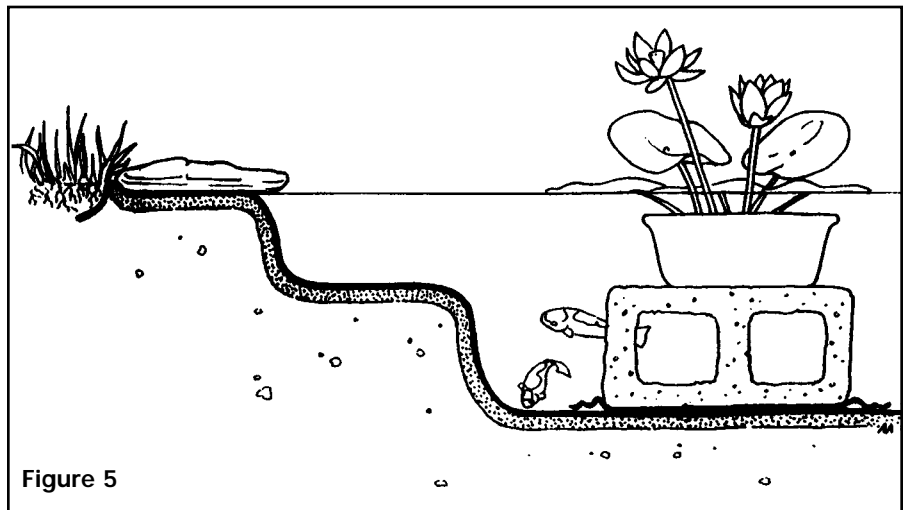


Figure 5

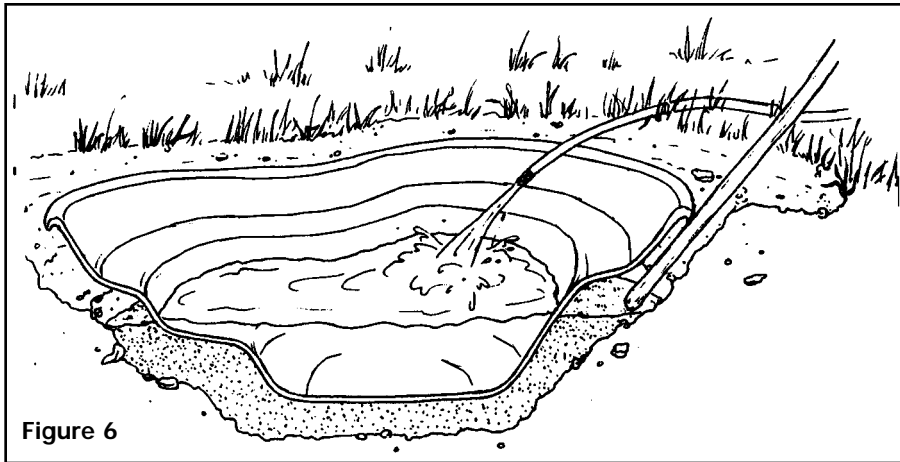


Figure 6

to the low side than to cut the high side.

- **Step 2:** Begin digging soil from the center of the pond outward (Figure 2). Dig down first to the level of the shelves (if any). If edging other than grass is to be used, excavate this area as well. Shelves should be dug 2 inches deeper than the actual shelf to allow for a cushion of sand. Slant the surface where the edging is to be approximately 1 inch per foot away from the pond. Finish digging the soil adding 2 inches to the depth for a cushioning layer of sand. If the pond has a grass edge surrounding it, leave the level of the pond above the surrounding surface at 1 1/2 inches so the lawn drains away from the pond.
- **Step 3:** Level and pack the bottom of the pond and shelves; cover with a 2-inch layer of sand. Pack and level the sand. Set the pond shell in the hole and check the level of the pond itself. Make any adjustments needed to obtain perfect leveling.
- **Step 4:** Once the pond is level make sure that it is centered in the hole; begin filling with water and backfilling. Add water at the same time as the soil. Backfilling should be done 4 inches at a time. Add 4 inches of soil (or sand if your soil is too heavy to work easily) into the area outside the pond shell

(Figure 6). Once the water inside and soil outside are about level (this could take some time depending on your water pressure) start tamping the soil with the handle of your shovel or some other smooth blunt tool. If your water runs slowly there is no need to turn it off while tamping. Do not overcompact the soil which could damage the shell. Repeat this filling and tamping process until the pond is full of water and completely back-filled. Remember to continue to recheck that the pond remains level as you backfill it. So long as you do not backfill too quickly, the liner should remain level.

- **Step 5:** Once the pond is filled, edging may be added. If the edging includes concrete do not drop any in the pond water. If much falls in the pond, it should be drained and washed before refilling. Edging the pond must wait until after filling since edging effectively seals the pond in place and prevents any further adjustments. Refer to Step 6 of "Flexible Liners" for further instructions on edging a pond.

Construction of Barrel Water Gardens

Barrel water gardens are an excellent alternative to in-ground ponds if space or physical constraints are limiting your alternatives (Figure 7). In addition, barrel water gardens are less expensive, quick, moveable, and require no edging. The basics of the barrel water garden are just like those of the in-ground ponds. These can be as simple as putting a flexible PVC liner in a whisky barrel, filling it with 6 inches of a

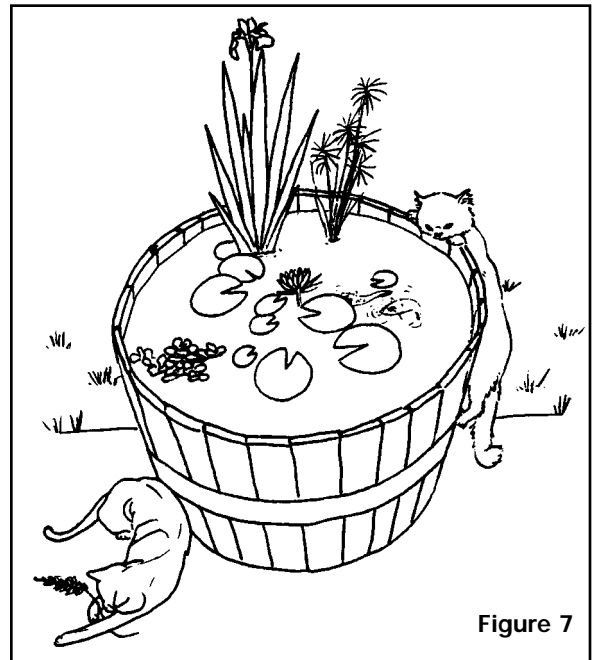


Figure 7

good loam soil and planting lotus. Instead of planting into soil directly, choose some of the dwarf water lilies and put them in the barrel in their pots. Add water and snails and the pond is ready. If you live in the southern half of Texas and use hardy water lilies, they should overwinter successfully in the barrel. However, if you live in areas where the water in a barrel may freeze solid, or if you chose to plant tropical water lilies, you must overwinter the plants in an area that is cool but not freezing.



Construction of Concrete Ponds

Concrete ponds, if properly constructed, can last a lifetime. In addition, they can be constructed with vertical walls to increase the ratio of gallonage to surface area. However, this material is generally expensive and requires much skill to install. If hiring the work done, ask for references and check them. Hire experience! Whether you or someone else builds a concrete pond, a poorly constructed pond will cost more to maintain, repair or replace than it did to install. This is the main reason for the popularity of the new synthetic construction materials.

The basic construction of a concrete pond follows that of the liner ponds. The concrete should be 4 to 6 inches thick. Once the dimensions are established and an outline laid out, dig out the soil for the entire pond. Forms must be built in place to hold the concrete while it dries and cures. Concrete reinforcing bars must be cut to size and fitted into the construction. The pond must usually be poured all in one day and in one piece, or if large, in sections. Start with the bottom, then the sides, shelves, and, lastly, the top and any coping around the edge. Any junctions of ponds poured in sections are critical as the site of future leaks and weakness to the shifting aspects of the soil. An alternative is to pour the pond without forms and simply slope to the walls and pour the concrete thicker to hold the concrete in place. However, this procedure can produce weakness in the concrete itself due to low density and air pockets as well as being a problem to plant and maintain.

Once the pond is built, it must be treated to correct the basic nature of concrete which would affect the pH of the water. The pH of the water may need periodic adjustments for some time after construction. Lastly, the color of concrete must be

changed for the pond to look right. Apply a pool paint or masonry sealant containing a dark pigment. This will conceal the bottom and moderate the pH of the pond.

Construction of Earthen Bottom Ponds

Earthen bottom ponds have several advantages. They are relatively simple to build, inexpensive per unit of surface area, and if well constructed, of low maintenance and usually long lasting. However, there are many drawbacks to these ponds that make them a less advisable choice. Earthen bottom ponds require a great deal of land as small earthen ponds do not maintain themselves well. Small natural ponds never clear properly due to the slow but invariable dissolution of soil into the water and the difficulty of underwater shelf construction with clay soils. In addition, any of the natural occurrences such as moles and insects digging into the pond will have a greater effect on smaller ponds. Most plants in earthen ponds are planted directly into the soil, as plant roots often creep over the edge of pots and escape. Once out of the pot, most aquatic plants become very aggressive with their spread being checked only by water depth. For these reasons, earthen bottom ponds, especially small ones, are not recommended.

If the decision is made to build an earthen pond, the soil must have a relatively high clay content which makes the soil more difficult to work. Due to the required size and land needed, they are more expensive per pond. Plants in them are prone to grow more vegetatively and flower less. Plants, fish, and other wildlife are harder to maintain. Unwanted guests to the pond will be more common and much harder to control. The water may often be muddy in appearance. If fish are included in the pond, they will keep the water muddied as they forage on the bottom.

The basic construction of earthen bottom ponds starts with size and shape designs. Once these factors are determined, remove the soil plus 6 inches for relining. Bring back onto the site enough of the heaviest (highest clay content) soil that you have and line the bottom and sides with a 6-inch layer. This soil must be wetted as it is returned and rolled until all of the structure is broken down and the soil becomes slick. This is called "puddling" the soil and creates a layer almost impervious to water. Then wait for enough rain to fill the pond before planting.

Plant Life

Plants available for use in water gardens are many. Choosing these is a pleasure, but there are certain considerations to be taken into account. Most considerations, such as water depth, amount of sunlight, and how each species relates to its surroundings should have been considered during the design phase. Floating leafed and submerged plants are necessary for a healthy pond and must be included in your selection. The following is a partial list of cultivars of readily available plants by use group. For more information and prices, go to your favorite garden center and look at the stock, or write for catalogs from the many mail order growers found in garden magazines.

Floating leafed plants

Usually water lilies. Plant enough to cover 50 to 75 percent of the surface area of the pond, or approximately one for every 10 square feet of surface area (there are dwarf varieties for barrel gardens). Floating leafed plants will cover the surface of the water to a point that will, if done correctly, limit the amount of light reaching the depths of the pond holding algae growth in check. Thus, Lotus (*Nelumbo spp.*), which hold their leaves above the surface of the pond, do not contribute to this mainte-

nance tool and are considered under Bog or Marginal Plants. Water lilies (*Nymphaea spp.*) are of two types, tropical and hardy. Tropical water lilies in turn are

divided into day and night bloomers. Hardy water lilies are all day bloomers. Some hardy water lily flowers change color shades over the life of the bloom,

adding to the character of these unique plants termed "Changeables." Some available water lilies cultivars include:

Tropical Day Bloomers	
'Albert Greenberg'	Yellow, may be overwintered in southern half of state.
'Blue Beauty'	Deep blue, very fragrant, old stand-by.
'Colorata'	Deep blue, free flowering, African species, overwinters well here.
'Daubeniana'	Light lavender, fragrant, small, does well in barrels.
'Director George T. Moore'	Deep violet blue, with yellow centers, takes shade.
'Evelyn Randig'	Deep magenta, fragrant, variegated foliage, slow to increase.
'Marian Strawn'	White, large flowers.
'Mrs. Martin E. Randig'	Deep violet blue, fragrant, increases well.
'Pink Capensis'	Pink, prolific bloomer, easy to grow, generally seedlings so may vary.
'Robert Strawn'	Lavender flowers held tall above water, overwinters in southern half of state.
'St. Louis'	Light yellow, large flowers.
'Tina'	Purple blue, may overwinter.
'White Delight'	White, very large flowers.
Tropical Night Bloomers	
'Mrs. Emily Grant Hutchings'	Deep pink, takes some shade, prolific bloomer.
'Red Cup'	Red cup shaped flowers, may overwinter.
'Red Flare'	Dark red petals and maroon stamens, foliage tinged red, flowers flat.
'Texas Shell Pink'	Light pink, generally comes true from seed, overwinters southern half state.
Hardy Lilies	
'Charlene Strawn'	Fragrant, yellow, long season, one of most popular.
'Gloriosa'	Red, good for small ponds and barrels.
'Gonnere'	White, double, good cut flower, best in north, maintain good fertility.
'Marliacea Albida'	White, prolific bloomer.
'Red Laydecker' or 'Laydekeri Fulgens'	Red, one of best, good in barrels.
'Red Spider'	Red with narrow petals.
'Sunrise'	Yellow, large, long season.
'Yuh-Ling'	Deep pink, cup shaped, free flowering.
Changeables	
'Aurora'	Yellow to apricot, smallest, good in barrels.
'F.C.N. Forester'	Yellow to golden bronze. one of the best.
'Solfatare'	Small, coppery pink.



Submerged plants

Submerged plants are the oxygenators of the pond—a must if your pond is to be healthy and support fish. Submerged plants may become aggressive if planted in earthen ponds. Especially the first three listed which may take over a pond. The Texas Parks and Wildlife Department and the USDA have listed 12 species and one entire genus of plants on a list of restricted aquatic plants.

These aggressively spreading plants are considered noxious weeds. The import, sale, purchase, propagation, or possession of any plant or its seeds on this restricted list is illegal without proper licensing and permits. In fact, many of these same plants are sold in the water garden catalogs since they are not restricted in states with colder winters. If you are unsure of the plants you are interested in, call the nearest Texas Parks and Wildlife office

and request information. Roots of these plants are not used for nutrient or water uptake, but for anchorage, so oxygenators may be potted in gravel. Submerged plants should be stocked at a rate of one bunch per 2 square feet of surface area, in groups of 6 to 12 per pot depending on the size of the pot. Caging these pots is often advisable if the pond is to contain fish, which tend to forage on submerged plant foliage. Some available cultivars are:

Submerged plants	
<i>Cabomba caroliniana</i> 'Cabomba'	Foliage fine spreading, small white flowers. Too aggressive for earthen ponds.
<i>Elodea canadensis</i> var. <i>gigantea</i> 'Anacharis'	Fern-like, small flowers. Too aggressive for earthen ponds. <i>Egeria densa</i> , also called 'Anacharis', is a RESTRICTED plant.
<i>Myriophyllum</i> spp. 'Water Milfoil'	Foliage very fine texture, covers stems. <i>M. spicatum</i> 'Eurasian Water Milfoil' is a RESTRICTED plant.
<i>Sagittaria subulata</i> 'Dwarf Sagittaria'	Small, grass-like plant for shallow areas like shelves of the pond. Better choice than the species.
<i>Vallisneria americana</i> 'Vallisneria'	Large, grass like plant, takes shade. Better choice than the species.

Extras

Free floating plants

Free floating plants such as duck weed, water lettuce, and water hyacinth, though not necessary, add the finishing touch to a natural appearing water garden. These plants move with the

breeze and produce an ever changing appearance for the pond. Functionally, they add to the oxygenators and produce varying casts of shadow that the pond owner and the fish will appreciate. Though in colder climates these plants are excellent choices, Giant Duck Weed

(*Spirodela oligorhiza*), Water Hyacinth, and Water Lettuce are restricted plants in the state of Texas. Some examples of these interesting plants are described below as well as one commonly available one that is not restricted in the state of Texas:

Free Floating Plants	
<i>Pistia stratiotes</i> Shell Flower or Water Lettuce	Unusual ribbed foliage looks like lettuce. Warning RESTRICTED!
<i>Eichhornia crassipes</i> Water Hyacinth	Pale blue flowers, bulbous foliage bases. Warning RESTRICTED!
<i>Hydrocleys nymphoides</i> Water Poppy	2" deep yellow 3 petaled flowers. This plant may legally be used in Texas.

Though these plants may be available, be aware when ordering from mail order catalogs that they are illegal in Texas even though advertised in many water garden catalogs and usable in other areas of the country. If you are unsure contact your local Agricultural Extension Service.

Bog or marginal plants

Though most are not grown for their flowers, some bog plants offer help for those unable to site their pond in sufficient sunlight for the majority of water lilies. Some plants can tolerate as little as three hours of direct sunlight. Some grow best in constantly moist to soggy soils, while others actually grow in standing water.

There are many different species of bog plants with varying heights, textures and colors to their foliage. Plants for the bog garden or for margins of the pond add height and drama to the water feature; lotus, sagittaria, and dwarf bamboo add unique foliage, where iris, cattails, and sweet flag have unmatched upright linear texture. Some selections of bog plants are:

Plants for Bog and Adjacent Areas

Lotus	<i>Nelumbo nucifera</i> varieties, most are for larger ponds.
'Alba Grandiflora'	White, fragrant.
'Empress'	White with blue edges, fragrant.
'Momo Botan'	Deep pink, double, fragrant; small; useful for striking barrel gardens.
'Mrs. Perry D. Slocum'	Changeable from pink to yellow to cream, very fragrant; hybrid <i>N. nucifera N. lutea</i> ; use in any sized pond, or in small containers.
'Rosea Plena'	Deep rose pink, large flowers, very fragrant.
'Angel Wings'	White, hybrid, great for barrel gardens.
Iris spp.	
<i>Iris fulva</i>	Red iris, coppery red, 8" - 24" tall, a species.
<i>Iris pseudacorus</i>	Yellow flag, yellow, 4 feet tall, a species, can be aggressive.
<i>Iris versicolor</i>	Blue Iris, various colors of blue, 3' tall, a species.
Louisiana Iris selections	Many natural as well as hybrid cultivars.
'Bryce Leigh'	Pale lavender, late bloomer.
'Her Highness'	Hybrid, white flowers, 2' tall, excellent if "true to type."
'Marie Caillet'	Violet blue.
'Roy Davidson'	Golden yellow, striped, pond or garden.
Selected Perennials	There are many perennials that do well in or around water features. Starred names may be grown directly in the pond, others are excellent in moist soils.
<i>Acorus calamus</i> *	Sweet flag, linear foliage, variegated form also.
<i>Adiantum Capillus-Veneris</i>	Southern maidenhair fern, native Texan.
<i>Canna</i> hybrids*	Garden cannas, tropical appearance.
<i>Colocasia esculenta</i> var. <i>fontanesii</i> *	Violet stemmed taro, heart shaped leaves, Z. 9-10.
<i>Crinum americanum</i> *	Bog lily, Texas native, 2', Z. 9-10.
<i>Crinum</i> hybrids	Many pink, white, rose, and striped types.
<i>Cyperus alternifolius</i> *	Umbrella palm, sedge-like foliage.
<i>Cyperus haspans</i> *	Dwarf papyrus, Z. 9-10.
<i>Cyperus papyrus</i> *	Egyptian papyrus, 6' - 10' tall.
<i>Dryopteris normalis</i>	Wood fern, feathery foliage, deciduous.
<i>Dulichium arundinaceum</i> *	Dwarf bamboo, 1'- 3' tall, not true bamboo.
<i>Eupatorium coelestinum</i>	Hardy ageratum, blue flowers in fall, native.
<i>Hibiscus coccineus</i>	Texas star hibiscus, rose mallow, star shaped leaves, red flowers, native.
<i>Hibiscus mosheutos</i>	Many colors, giant flowers, heat tolerant, native to southern U.S.
<i>Hemerocallis</i> spp.	Daylilies, there are many varieties.
<i>Lobelia cardinalis</i>	Cardinal flower, red spikes, native to shade, native to southeastern U.S.
<i>Physostegia virginiana</i>	Obedient plant, lavender and pink spikes in summer and fall.
<i>Pontederia cordata</i> *	Pickerel rush, pretty flowers in purple, blue, or white.
<i>Rosa palustris</i> var. <i>scandens</i>	Swamp rose, spring flowering rose, very thornless!
<i>Sagittaria latifolia</i> *	Arrowhead, interesting leaves and dainty white flowers.
<i>Thalia dealbata</i> *	Thalia, 7' tall flowering spike.
<i>Typha</i> spp.*	Cattails. Dwarf selections available.



Plants to surround the pond

Many of the bog plants can be used in areas surrounding a pond. Other plants for use around the pond should be of a character that their reflection lends drama to the pond. Colorful flowers, attractive bark or fluted trunks, or other winter aspects can add to the seasonal interests of a pond. Avoid plants such as walnuts and willows that have leaves with allelopathic characteristics.

Planting the Pond

Planting the pond is the most exciting time and one of the most crucial. Spring is the best time to complete this task. Plants bought for the pond should be in top condition and installed immediately upon receipt if possible. Therefore, do not purchase the plants until you are ready to plant, or if ordering through the mail, plan their arrival carefully. Many mail order dealers ship their plants at only certain times of the year.

Plants bought from a garden center are often potted and ready to be placed in the pond. If not, or if you purchase your plants from mail order houses, they will come to you bare root, wrapped in plastic containing moist organic media or paper. These plants should be removed from the media, washed, and potted immediately upon receipt. Plan ahead and have your soil, fertilizer tablets, pots, and burlap, if you are using baskets, ready ahead of time.

Lilies (Nymphaea)

Tropical lilies form crowns and should be planted in deeper pots. The crown should be placed in the soil near the top and covered with only as much media as is needed and then 1 inch of gravel leaving the growing point above the soil and gravel.

Hardy lilies grow from rhizomes and should be grown in

wide shallow tubs or baskets.

The rhizome should be placed in the soil at a 45° angle and covered with soil and 1 inch of gravel. Be sure to leave the growing tip above the soil and gravel. Tropical and hardy water lilies should be covered with 6 to 18 inches of water.

Lotus (Nelumbo)

Water lotus should be considered a bog plant, as they do not contribute to covering the surface of the pond as do the floating leafed water lilies. Water lotus grow from large vigorous banana shaped rhizomes and must have at least two nodes (the pinched looking area of the rhizomes) left on them when divided in order to survive. Their roots are brittle and can easily be broken, killing the plant. Lotus should be grown in large tubs or baskets no less than 32 quarts in size. Place the rhizomes shallow in the pot and cover with soil and 1 inch of gravel. It may be necessary to put a rock or brick over the tubers of these plants until rooted to prevent them from floating out of the soil. Lotus should be placed in the pond about 4 inches below the water surface. To place the lotus in deeper portions of the pond, put them up on blocks or bricks to achieve the proper depth. Place scraps of liner under the bricks to guard against punctures (Figure 5).

Oxygenators

These plants often arrive in bundles of cuttings and should be planted as they are into pots and placed on the bottom of the pond. Their roots are merely for anchorage so they can be placed in sand, soil, or gravel.

Bog plants

These plants should be placed in pails or pots on the shelves of the pond where the crowns of the plants are covered by about 1 inch of water.

Floating Plants

These plants should be rinsed well before placing them directly into the pond.

Wildlife

Fish: Fish are not necessary for the balance of the pond, but their presence will greatly increase the speed that it is established. Further, fish eat many of the undesirable visitors to your pond, keep submerged plants pruned, recycle nutrients in the system, and add immeasurably to the beauty of the pond. Fish should be stocked at a rate no more than 1 inch of fish per 3 to 5 gallons of water in the pond. Fish attain a greater size, do less damage to submerged plants, and remain healthier if stocked at rates below the capacity of the pond. Thus a small circular pond 5 feet in diameter and 18 inches deep holding around 160 gallons of water will accommodate from four to five 10-inch fish. When first introducing fish to the pond, put the fish still inside their sealed bag into the pond allowing 15 minutes for the temperature to equalize between the bag and the pond before releasing the fish. If it is a sunny day cover the bag to prevent overheating.

- **Koi:** Japanese koi are carp. These fish are generally expensive, but range in mature size from 2 to 3 feet, come in many colors and live for a very long time. Koi are best suited to ponds larger than 6 feet minimum diameter and at least 18 inches deep.
- **Goldfish:** Are smaller and by far the most popular fish for pond use. They are less expensive, come in many colors, and range from 10 to 12 inches at maturity. Goldfish will breed in your pond thus increasing in numbers over a period of years. This may present a problem for small ponds.

- **Frogs:** Frogs are good for the pond; they supply tadpoles which are efficient scavengers and food for fish and dragonfly larvae. Also, the adults in conjunction with the fish control the mosquitoes and other insect problems.
- **Snails:** There is some controversy over including snails in the pond. The Japanese black snails may not help keep the water cleaner, though they do slowly eat away at the algae. They are, however, fun to watch for and they will not get out of the pool and damage any other plants in your garden.
- **Unwanted guests:** In most instances, if you have stocked your pond properly and maintain the health of your pond inhabitants, there may be the occasional unwanted "Diving Water Beetle" or "Water Boatman," but these and others pests can be kept in check by the predation from larger fish and frogs.

Maintenance

Water

Clear water is usually the primary goal of any water gardener short of the first lily blooms. In a new pond, however, the water is seldom clear for very long. This can be rectified easily if the pond is of the correct depth, has a good filtration system, and correctly chosen plants and wildlife are stocked in sufficient numbers. The only ingredient left to clear the new pond water is patience.

The worst thing to do is change the water. Replacing the water will only delay the developing balance of the new pond's ecosystem. There are algacides on the market and even dyes to artificially color the water, but

these are only temporary solutions to a problem only nature can correct. When fertilizing the lawn, take care not to contaminate the pond. Any new nutrients introduced to the system will only prolong the life of the algae or even start an algae bloom. Algacides are of dubious value as they kill the algae all at once instead of the slow natural death rate that the pond ecosystem can handle. When this happens, the microbial population of the pond begins a massive degradation of the algae and in so doing uses all of the oxygen in the pond. This will weaken the animal life in the pond and possibly result in a fish kill.

What is turning the pond green are innumerable single celled algae. These are present in all water and will create a bloom in any water left in the sun undisturbed. The long filamentous algae that grow on the bottom and sides of the pond are not responsible for the discoloration of the pond. These filamentous algae are actually good for the pond and aid in concealing the liners, shelves, pots, and bricks used to prop up some pots.

In time the balance of the pond will shift away from the green algae, and the plants will cover most of the pond's surface denying light to the algae. The oxygenators and other plants will eventually out-compete the algae for the available CO₂ and soluble nutrients. Sometimes the pond will suddenly clear overnight as the algae succumb and sink to the bottom.

Occasionally throughout the pond's life, this algal bloom may reoccur for a short time. It may happen in the spring when the water in the pond has turned over (undergone a temperature inversion), the temperature of the water is increasing, the nutrient levels are up, and the plants are still dormant. Algal blooms of short duration are to be expected.

Pumps

Pumps should be pulled from the pond and cleaned regularly. The filters may need weekly cleaning. The interval will depend on your particular pond's ecology. The filter should be checked weekly, and the pump inspected at these times and records kept to build a history of your pond. This is the best way to know what your pond needs and when.

Liners

Liners should last without problem for the time specified by the manufacturer if they are properly installed and care is taken not to puncture them while walking in the pond to service the plants, fish, and circulation system.

Edging

Edging, if well designed and constructed, should never need servicing. If the liner is installed and does not allow water in under the edging materials, and the ground underneath is firm, the stone or brick pond edging should give no trouble. If the pond is edged by lawn edging or has no edge, the main concern is to avoid contaminating the pond with lawn fertilizers and pesticides.

Plants

As the leaves and flowers of the aquatic plants die they should be removed. Watch the root balls and leaves for damage by fish and insects. Once a year lotus will need re-potting in the south portion of Texas; in the north, every 2 years.

Fish

Fish should be watched for infections of fungi and other parasites. If any die, remove them as soon as they are found. If any



seem particularly intent on eating your plants, decide which you are most fond of and take appropriate action.

Winter

In winter the pond slowly shuts down. Any tropical species should be stored in the proper manner for each plant. The fish have greatly slowed their intake of food and their actions in the pond. They will need feeding only occasionally in the south and not at all in the north where the ponds freeze over for the winter. In the event that the pond should freeze over, a hole in the ice must be maintained for the survival of the fish. If the hole is not maintained there can be little air/water gas exchange and the fish will die as they continue to respire and use all of the oxygen dissolved in the water of an ice covered pond. A hole in the ice can be maintained using any of the commercially available electric ice melting devices specifically designed for use in pond situations. Never use any device not manufactured specifically for that purpose. Never hit the ice with anything to break it open. The force from the blow will reverberate as shock waves in the pond and kill the fish. This is one of the major causes of winter death of fish in home ponds.

Another source of problems for the plants in winter is the accumulation of fallen leaves that may blow into the pond with every gust of wind. These and any dead fish should be removed immediately.

You do not need to run pumps throughout the winter as the fish need very little aeration and the algae are not growing at this time. However, the algae will have a spring bloom usually as soon as temperatures rise enough to heat the pond to any depth. At this time the pump and filtration system must resume its operation.

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