# the critical role of constructed wetlands

tales from the FIELD

When we first started fooling around with bog filters and constructed wetlands, we had a customer with a large pond who allowed us to test our theories in his backyard paradise. We used a 10,000 gph pump, set the liner in place, shoveled the gravel in, and got the water source all connected. Everything was fine for the first month. Then we received a call from our customer, he said that the pea gravel started to look like it was boiling on a stove … but only in one spot.

The owner didn't know what to think. He suggested the possibility of an underground spring. I told him that the liner was in place, so a spring really wasn't one of the possibilities. As we checked things out further, we found that the underground piping was clogged in all but one place. So these 10,000 gallons per hour were literally being spewed out of a single point under the gravel, and it really looked weird.

Yes, we ended up tearing the entire thing apart, and doing the whole project over again. But on the second "go-round" we were much more careful about keeping the projected openings open, and the water began distributing itself nicely after that.

Now, before we bring a new product to market, we go through these kinds of experiences, so it's really not all that new to us. The good news for you is, we eat the cost of all these experiences and pass on to you what we've learned.

*Ed Beaulieu*
*Vice President of Field Research*

# Wetlands and the Role of Plants in the Ecosystem

To understand the value of wetlands, we must first look at the most basic element of a wetland – plants. While adding aesthetic appeal to water gardens, plants also serve an even more important role. They help maintain the overall health of the pond by aiding in filtration, helping to maintain clear water, and reducing algae. They're an integral part of a balanced pond ecosystem and help create a more natural looking environment. We shouldn't be surprised then, that plants perform the same functions in natural wetlands.

## Nature's Water Filter

For evidence of an aquatic plant's ability to filter water, you need look no further than one of the most efficient filters on planet earth, a natural wetland. Wetlands have the enormous responsibility of filtering the water for rivers, ponds, lakes, and the aquifers found below ground. They help purify the water by reducing nutrients, filtering out sediments and precipitating metals, breaking down toxic compounds, and digesting pathogens.

But it hasn't been until the last 30 years, that we have begun to realize the value of wetlands as we have witnessed first-hand, the chain reaction caused by destroying them for the sake of development. Flooding is more prevalent without wetlands to slow down and hold the excess water after heavy rainfalls. Lakes and rivers have lost their once pristine water quality since they no longer have the wetlands to filter the incoming water. Poor water quality and the lack of wetland habitats have affected the ability of some native flora and fauna to survive.

We are now realizing the damaging chain reaction that occurs when wetlands are removed from the natural setting. Efforts to re-establish wetlands around the borders of polluted rivers and lakes have been quite successful. These "constructed wetlands" have begun to reduce nutrient and sediment loads in the nearby waterways. Slowly, the overall water quality is being restored naturally by re-establishing the filters that were once there … wetlands.

**TIP from TEAM AQUASCAPE**

**Where does a wetland filtration system fit in to your pond design? You could use many BIOFALLS® filters, but it would become cost prohibitive. Fifteen or more Grande BIOFALLS® filter would look impressive, but you'd need lots of pumping power, pipe, and skimmers–not to mention the high electrical cost to operate them.**

## How Are Aquatic Plants Being Used for Filtration?

Environmental scientists, architectural engineers, and yes, pond builders are beginning to realize, more and more, how important wetlands are to the land we live on. We are not only re-establishing wetlands for conservation, but we're beginning to use wetlands' filtration capabilities for other purposes.

Wetlands also demonstrate how efficient plants can be in providing a low-cost, natural approach to treating storm water and waste water. Waste water treatment that once required chemicals and expensive equipment to remove pollutants is now being replaced by constructed wetlands. These wetlands range in size from a typical water garden (175 sq. ft. mini wetlands) that filter the

*Use varying textures and heights for your plant design.*

wastewater from a single residential home, to large mass-acreage wetlands that are the final stage of filtration for small rural communities. Most of these constructed wetlands, no matter how large or small, are built on the same basic principles. They are designed to use the filtration capabilities of plants, bacteria, and enzymes … very similar to the philosophy behind Aquascape's ecosystem.

The fundamentals of constructed wetlands for wastewater, and the properly built backyard pond may not seem to be one in the same, but they do share some very common traits. Let nature do the work! The more efficient the ecosystem is at removing pollutants, the better the water quality. To a pond owner, better water quality results in healthier fish, significantly less maintenance, less nuisance algae, and crystal clear water.

## Types of Plants for Filtration

Scientific studies are continuously finding different species of plants that are good at removing pollutants and can be used in man-made wetlands. Many species of aquatic plants have been found to be more efficient at filtering certain pollutants than others. With this knowledge, landscape architects and wastewater engineers can then pick and choose different species of plants according to the characteristics of the water that needs to be treated. The more commonly used plant families are cattails, sedges, grasses, and rushes. Plants from these families are readily available, and typically are very hardy and prolific growers. Many species within these families have very good ornamental characteristics and can be landscaped nicely into the residential water garden.

## Variety Is Important!

Planting a diversity of species in the pond will ensure balanced filtration. Plants such as cattails have short roots extending only 6 to 12", whereas the roots of bulrushes can extend up to 36", allowing each to grab nutrients from different regions of the substrate. During yearly pond clean-outs you will find a network of roots beneath the gravel that travel throughout the different shelves in the pond. These plants use the nutrients and sediment (fish waste and small debris) that fall to the bottom of the pond.

## The Root Is the Source

Rooted aquatic plants also help promote healthy bacteria populations throughout the gravel substrate. Rooted aquatics, in order to survive beneath the surface of water, have developed pores called lacunae throughout their stems. These allow the transfer of oxygen and other gases to reach deep into the root zone.

*Waterfall aeration is extremely important to pond health.*

The contrast of vertical dwarf cattails and horizontal lilies work well.

The ability of the plant to bring oxygen to the root zone provides an area for both aerobic and anaerobic bacteria to interact around the plants roots. The interaction of bacteria allows for an efficient means of reducing toxic nitrogen in the water. Without beneficial bacteria, nitrogen levels in the pond would become elevated, causing health problems in fish, diminished water quality, and promoting excess algae.

## Water Hyacinth

Certain plants, such as water hyacinth, are more capable than others at removing large amounts of algae-causing nutrients. Some wastewater treatment facilities in warmer climates have been designed to specifically use water hyacinths. The fact that they propagate so rapidly ensures they are using an abundance of these nutrients. But, because of this rapid growth rate, water hyacinths can take over a natural waterway and therefore are illegal in some parts of the South. Water hyacinths can easily be removed, or weeded from the water garden when their numbers become excessive. Simply take out the older plants and dispose of them in a compost pile. The nutrients absorbed by the mature plants will be removed from the pond, indirectly helping to control algae.

*Water clarity is a positive benefit of a balanced ecosystem.*

## Balance the Ecosystem Throughout the Year

A good landscape designer is able to select a diversity of plants that not only compliment one another, but also provide an aesthetic appeal throughout the different times of the year. This same logic holds true, both aesthetically and functionally for a water garden.

It's important to use a variety of plants to ensure that their filtration capabilities are spread throughout the season. Different species of plants develop at different times of the year. Some plants break winter dormancy earlier than others, beginning their use of nutrients early in the spring. For example, irises are said to have enormous filtration capabilities while in bloom. Not only does this plant display its unique showy flowers, but it helps provide good water quality too.

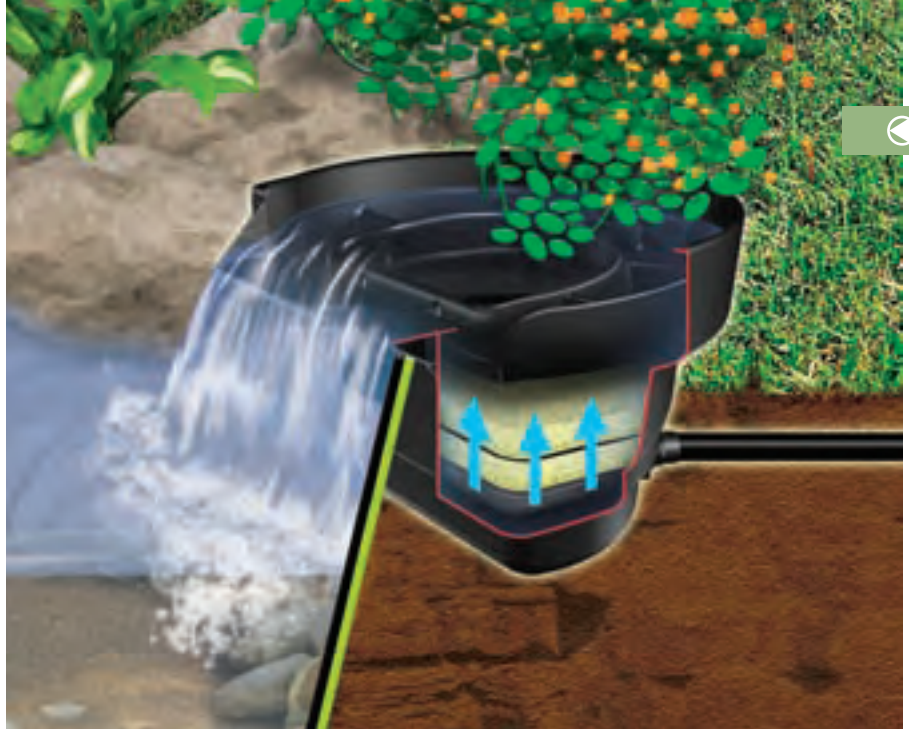
But, what about the times of year when it is not in bloom? This is the reason you want to have other species to pick up where the last one left off. Some plants may not grow at a rapid rate, but instead spread their growth and nutrient uptake throughout the entire season. Tropicals, such as taro, papyrus, and thalia to name only a few, continue to grow into the fall when most plants have reached their peak. These plants can be treated as annuals or brought inside during the winter.

By planting a variety of species, the pond will not only look more appealing, but will ensure that the ecosystem is balanced throughout the season.

## Building a Constructed Wetland

Now that you have some knowledge of wetlands, let's discuss how to build them for large projects, or to add them for aesthetic purposes to any pond system.

Aquascape developed a constructed wetland filtration system that's compatible with all our other products. The new filters are modular in design and they allow builders the flexibility to expand the system to meet their needs. We've been custom building and testing wetland filters for many years, and we've finally settled on a simple system that works. To date there's absolutely nothing else like it on the market.



*The concept of a wetland filter is a very large BIOFALLS® filter.*

## Mechanics Are Exactly the Same

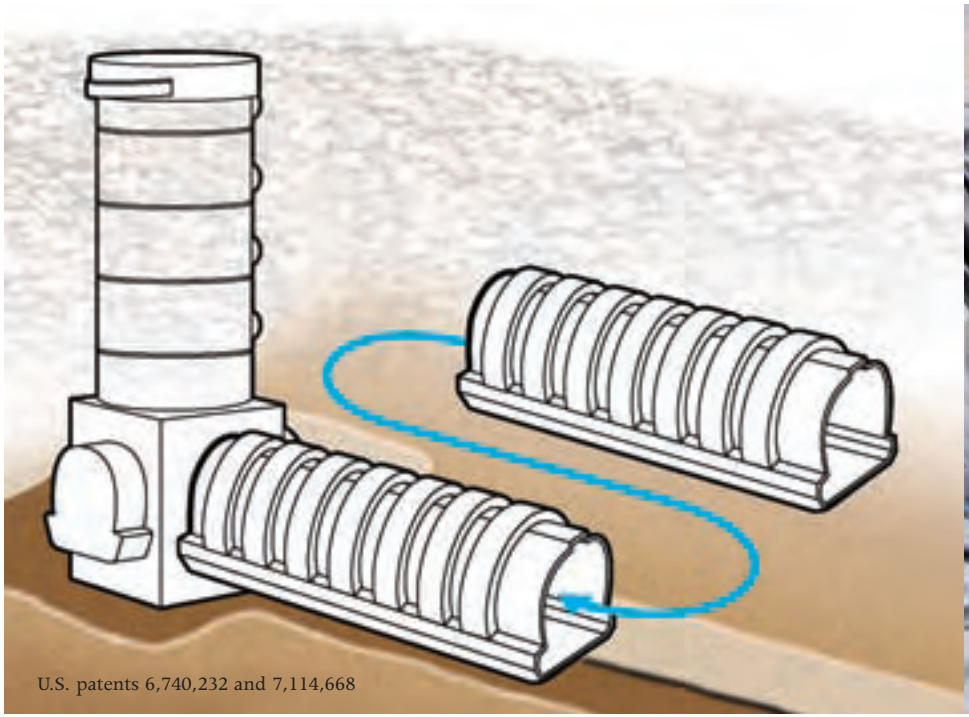
You can understand how the wetland filter works by comparing it to our BIOFALLS® filter, in which the water comes in at the bottom of the filter, and rises up through the filtration media. The water then continues flowing over the waterfall and meanders its way towards the pond.

The main difference between the constructed wetland filter and the BIOFALLS® filter is that the constructed wetland filter media is made up of several grades of gravel, which is contained by EPDM rubber liner that can be custom designed according to your specifications. Other than that, the concepts and philosophies are exactly the same.

## esp La Mecánica es Exactamente Igual

*Ud. puede entender como funciona el filtro de terreno pantanoso comparando nuestro BIOFALLS®, en lo cual el agua entra por debajo del filtro y sube por el sistema de filtración. El agua continúa corriendo sobre la cascada y baja hacía el estanque.*

*La gran diferencia entre el filtro construido a mano y el BIOFALLS® es que el filtro construido a mano es hecho de varios grados de grava, que se mantiene por un EPDM capa protectora de goma que puede ser diseñado de acuerdo a sus especificaciones.*




The filter system that distributes the water is made of heavy-duty polyethylene, and comes in 6' sections which can be snapped together. Each section has over 230 square inches of open area. This allows a flow rate of 1" per second at 3,000 gallons per hour. This slow, steady flow of water is critical for the functioning of a wetland filter. For each pump upgrade, you simply snap on another section of the filter and it will keep the flow rate equal to, or even better (lower) than the specified level.

At the opposite end of the filter (opposite the point where the water feeds into the filter) is the clean-out section. This is a large tubular structure (snorkel) that extends from the bottom of the filter, all the way to the top. It has a cap on top that can be opened for an annual filter cleaning. Each cleanout snorkel has four ports that can be used to connect up to four separate filters or centipedes. With this system, a large pond like the Pond Guy's™ one acre beauty at Aqua Terra can effectively be filtered. Not only is this new design easier to install and more effective, it's much less expensive than custom building each filter.

esp *El sistema de filtración que distribuye el agua es hecho de polio-tileno, y viene en piezas de 6 pies que pueden abrocharse. Cada pieza tiene más de 230 pulgadas cuadradas de espacio abierto. Esto deja que el agua corre a 3,000 galones por hora y a una velocidad de 1 pulgada por segundo. Está velocidad ligera es muy crítica para que funcione bien el fil-tro hecho a mano. Para cada pompa que Ud. instala, simplemente aplica y abrocha otra pieza del filtro y eso hará que la velocidad de la corriente siga equilibrado, o hasta más bajo que al nivel especificado.*

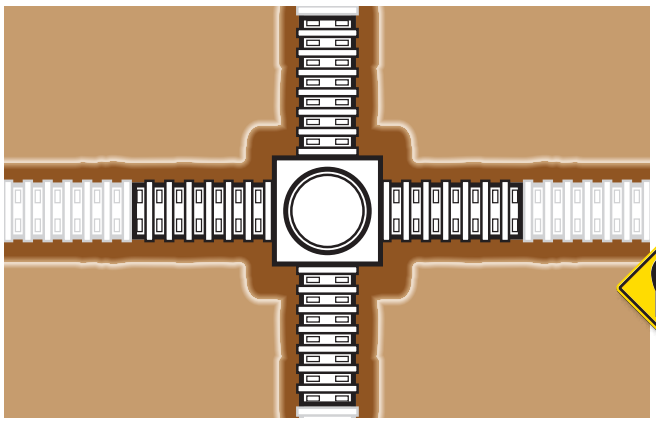
*Al otro lado del filtro (opuesto a donde entra el agua) está la sección de limpieza. Ésta es una estructura (o un tubo) que se extiende desde la parte de abajo del filtro hasta arriba. Tiene una capa encima que se puede abrir para la limpieza anual del filtro. Cada tubo de limpieza tiene cuatro puertas que pueden ser usadas para conectar hasta cuatro filtros diferentes. Con este sistema un estanque bien grande, como de una hectárea del Pond Guy™ llamado Aqua Terra, puede ser filtrado efecti-vamente. No solamente es más fácil y efectivo instalar este nuevo diseño, pero también cuestá menos que construir cada filtro a mano.*

## Putting It All Together

- For each 6′ section, there should be an excavated area of 10′ x 10′.
- If you're building a larger wetland, and are connecting all four centipedes into the snorkel, the excavated area will need to be 20′ x 20′ and increase proportionally from there.
- Four centipedes are the maximum number that can be connected together in a single line.

## esp Construyendo Todo de una Vez

- *Por cada sección de 6 pies, debe haber un área excavada midiendo 10′ x 10′.*
- *Si Ud. está construyendo un estanque más grande y está conectando los cuatro filtros al tubo, el área excavado tiene que medir 20′ x 20′.*
- *Tenga en mente que solo se puede conectar cuatro filtros a un tubo. Es el máximo.*



## It's Designed To Work

Just for perspective, when cleaning an average 11′ x 16′ pond, the BIOFALLS® filter sludge would typically fill a 5 gallon bucket. A large constructed wetland can fill three semi-trucks to the top with sludge and still filter the water effectively. So this system is designed to operate effectively … even when it's half full!

## Our Gravel Research

It's interesting to see that, other than pea gravel, the storage volume for the rocks in our test stayed fairly constant. The reason for this is simple–the smaller pea gravel locks together more tightly, which decreases the spaces present between the individual pieces of gravel. We thought the trend would continue, and we'd have an increasingly greater volume of space as the size of the rocks increased. But this wasn't the case.

This does, however, make the specification process much easier. If a combination of three different rock sizes is used, the storage volume will not change. The main purpose of using three different sizes is to allow for adequate outflow of the filter, and as the gravel gets smaller, it will remove finer particles from the water. The plants will also take hold better in the smaller gravel.

| Type of Stone | Weight in lbs. | $ft^3$ of loose stone | lbs. per $ft^3$ | Water Added in Gallons | Volume $ft^3$ |
|---|---|---|---|---|---|
| Pea Gravel | 2,240 | 21.8 | 102.75 | 47 | 6.28 |
| Small B.C. ½ - ¾" | 2,500 | 24 | 104.7 | 75 | 10.03 |
| Colonial Blend 1½ - 2" | 2,570 | 24 | 107 | 74 | 9.9 |
| 4 - 6" Rock | 2,700 | 24 | 112.5 | 72 | 9.6 |

**Note:** Container was 15" deep, 24 cubic feet = 180 gallons.

$\frac{1.728\ in^3}{ft^3} \times 24 = 41{,}472\ in^3 / 15 = 2{,}764.8 / 144 = 19.2\ ft^2$ avg.

## TIP from TEAM AQUASCAPE

**If you put a snorkel between every fourth centipede, you can have up to 16 centipedes and get a flow rate of 40,000 GPH. This huge constructed wetland would require a 60' x 60' excavated area, and it would take 380 tons of gravel. This monster will filter a 2.5 million gallon pond with capacity to spare. The Pond Guy's™ pond, for example, is only 1 million gallons.**

# CONSTRUCTION GUIDELINES

## Out in the Field

Lets put all this new information to use by installing a basic system with a 4,000 GPH pump.

1. We'll start by digging the 10' x 15' area that will become the constructed wetland. Dig the pond to a depth of 18" around the perimeter, going to 2' in the middle. The purpose of this is to allow solids and sludge to settle towards the middle during cleaning.

## esp En el Campo

*Usaremos está información empezando con la instalación de un sistema básico de una pompa de 4,000 galones por hora.*

1. *Vamos a empezar a excavar un área que mide 10' x 15' que será la base principal del terreno acuático. Excave el estanque a una profundidad de 18 pulgadas alrededor del perímetro, llegando hasta 2 pies de profundidad en el centro. Esto permitirá que sólidos y lodo se acumulen en el medio durante la limpieza.*

2. Slope the bottom 6" towards the middle.

esp 2. *Gradúa 6 pulgadas de abajo hacia el centro.*

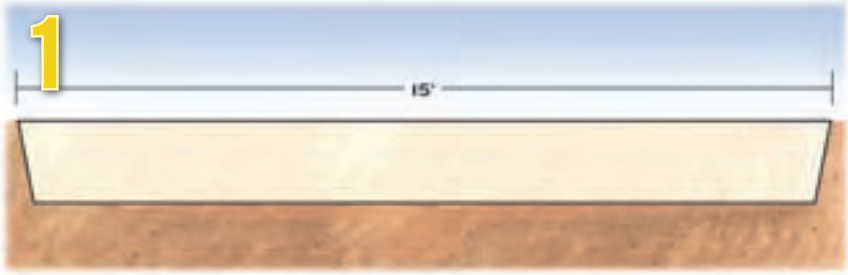
3A. Dig a trough down the center, approximately 18" wide and 18" deep for the centipede.

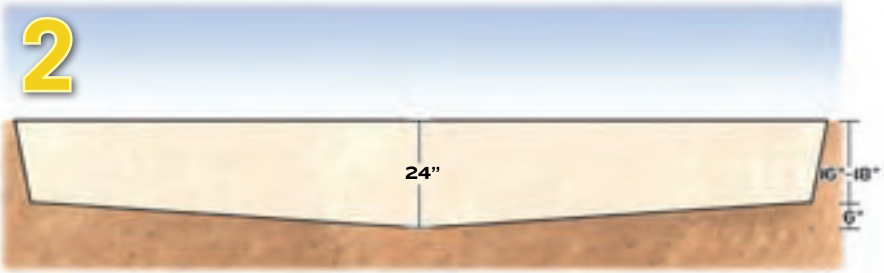
3B. Pitch the trough slightly from the side with the piping to the outside edge where the cleanout snorkel is located.

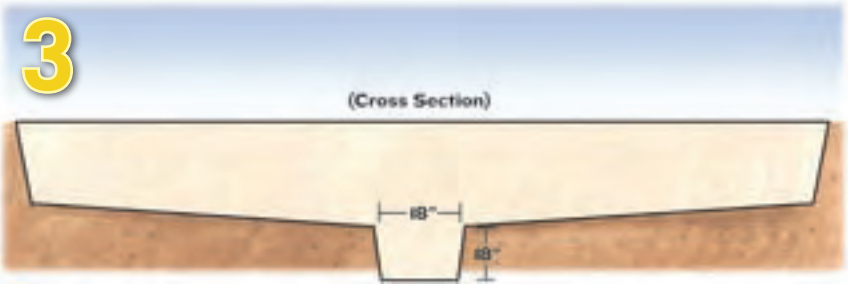
esp 3. *Excave un área a lo largo del centro, aproximadamente 18 pulgadas de anchura y 18 pulgadas de profundidad para el filtro.*

4. Place the underlayment and the liner into the excavation, along with the snorkel and the centipede.

- Connect the piping to the centipede.



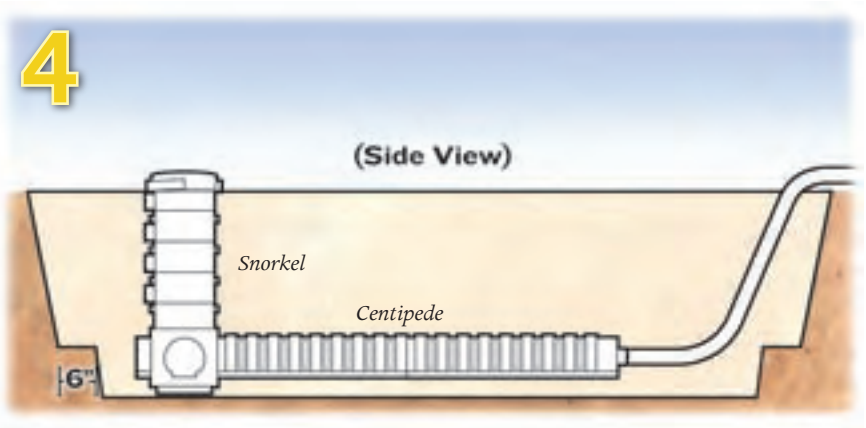




The finished excavation.

- Cover the entire bottom with a layer of 4 to 6" stones.
- The next layer is made up of 1½ to 2" gravel, 6" deep.
- Finish filling with smaller ½" gravel.

esp 4. *Posicione el underlayment y la capa protectora dentro de la parte excavada, como también el tubo (snorkel) y el filtro (centipede).*

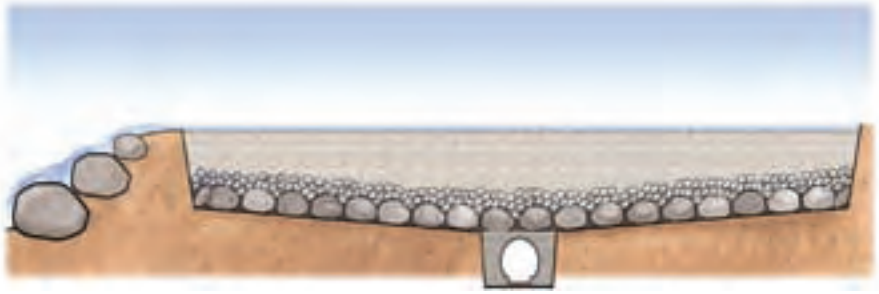
- *Conecte el tubo al filtro.*
- *Cubra el piso entero con una capa de piedras que miden entre 4 a 6 pulgadas.*
- *La próxima capa sera hecha de grava que mide de una pulgada y medio a dos pulgadas, 6 pulgadas de profundidad.*
- *Termine rellenando el lugar con grava que mide media pulgada.*




*Use a bed of gravel to adjust the pitch of the filter. It should slope towards the vertical clean-out (snorkel).*

5. The wetland outlet should be a stream or waterfall going back into the pond.

- This will restore the dissolved oxygen levels which have been lowered due to the heavy biological activity found within the filter.
- Once the wetland filter is running, plant it with a variety of marginal aquatic plants which will remove nutrients from the water.
- Yearly harvesting of the aquatic plants will keep the nutrients from returning to the system.



- Regular bacterial additions are necessary to reduce organic build-up and assure optimal media colonization.

esp 5. *La salida del el agua es hecha por una corriente, o una cascada, que regresa al estanque.*

- *Esto va a restáurar los niveles de oxígeno que han sido disueltos por la actividad pesada que se encuentra dentro del filtro.*
- *Aplicación regular de bacteria es necesario para reducir el aumento de material orgánico y para asegurar colonización óptima de la bacteria.*

This is an exciting new development for us, and all the possibilities and potentials have yet to be discovered. As with all our products, it is designed for builders, and the more creative you are with the raw materials, the better the outcome of your project will be. Any new concept takes a little time and practice to master, but in the end you will find its mastery richly rewarding.