LSU AgCenter
Research & Extension

Aquaculture

Aquaculture Production Best Management Practices (BMPs)

endorsed by

Louisiana Department of Agriculture and Forestry

USDA NRCS

FARM BUREAU LOUISIANA

Table of Contents

Why BMPs Are Important to Louisiana

In Louisiana we are blessed with beautiful and abundant waters to enjoy fishing, hunting, boating or just relaxing on the shore of a lake, river or bayou. Most of the water in Louisiana's rivers and lakes comes from rainfall runoff. As this runoff travels across the soil surface, it carries with it soil particles, organic matter and nutrients, such as nitrogen and phosphorus. Agricultural activities contribute to the amount of these materials entering streams, lakes, estuaries and groundwater. In addition to assuring an abundant, affordable food supply, Louisiana farmers must strive to protect the environment.

Research and educational programs on environmental issues related to the use and management of natural resources have always been an important part of the LSU AgCenter's mission. Working with representatives from the agricultural commodity groups, the Natural Resources Conservation Service (NRCS), the Louisiana Department of Environmental Quality (LDEQ), the Louisiana Farm Bureau Federation (LFBF) and the Louisiana Department of Agriculture and Forestry (LDAF), the LSU AgCenter has taken the lead in assembling a group of Best Management Practices (BMPs) for each agricultural commodity in Louisiana.

BMPs are practices used by agricultural producers to control the generation and delivery of pollutants from agricultural activities to water resources of the state and thereby reduce the amount of agricultural pollutants entering surface and ground waters. Each BMP is a culmination of years of research and demonstrations conducted by agricultural research scientists and soil engineers. BMPs and accompanying standards and specifications are published by the NRCS in its Field Office Technical Guide.

Introduction

The production of seafood from aquaculture businesses involves hundreds of producers in Louisiana and supports many other industries such as transportation, processing, marketing and distribution. The feed and bait industries that support aquaculture production in Louisiana also provide substantial economic benefits to rural communities. Louisiana has one of the most diverse aquaculture industries in the nation. Farm-gate value of farmed crustaceans, molluscs, reptiles and finfish typically exceeds $100 million annually. Catfish, crawfish, soft-shell crawfish, alligators, bait minnows, tilapia, ornamental species, turtle hatchlings, hybrid striped bass, soft-shell crabs, red drum and oysters are all produced in the state. Oyster aquaculture occurs in open waters with no feeding and no discharges. For this reason, oyster production was excluded from this review.

Production technologies vary within each species, as well as among culture systems for different species. Accordingly, this document addresses a number of commercial aquaculture approaches now used in Louisiana. Aquaculture production systems can be specialized businesses or combined with conventional plant and animal agriculture. When combined with conventional agriculture, aquaculture must be managed as part of a complex food production system.

Although Louisiana is a leader in the production of wild caught fish and shellfish, the demand for these products cannot be met solely by natural production. Populations of wild species continue to be affected by fishing pressure, pollution, loss of critical habitat and saltwater intrusion. Part of the demand for seafood must be met by aquaculture if Louisiana is to continue as a national leader in seafood production.

Best Management Practices (BMPs) have been determined to be an effective and practical means of reducing point and nonpoint-source water pollutants at levels compatible with environmental quality goals. The primary purpose for implementation of BMPs is to conserve and protect soil, water and air resources. BMPs for aquaculture operations are a specific set of practices used to reduce the amount of soil, nutrients, pesticides and microbial contaminants entering surface and groundwater while maintaining or improving the productivity of agricultural land. This list of BMPs is a guide for the selection and implementation of those practices that will help producers to conserve soil and protect water and air resources by reducing pollutants from reaching both surface and groundwater.

The BMPs that apply most directly to the aquaculture industry are included in this publication. A brief description, purpose and conditions to which the practice applies are given for each of the BMPs listed.

References are made to specific Natural Resources Conservation Service (NRCS) production codes, which are explained in the text of this document. More detailed information about these practices can be found in the NRCS Field Office Technical Guide (FOTG). The FOTG can be found in all Soil and Water Conservation district offices and all NRCS field offices or on the NRCS web page. Additionally, under voluntary participation by the producer, technical assistance to develop and implement a farm-specific conservation plan is available through the Conservation Districts, NRCS field offices and the LSU AgCenter parish offices.

Aquaculture Production Practices

Finfish Production in Ponds

Introduction and General Considerations

Ponds constructed for commercial production of finfish generally fall into two categories: levee ponds or watershed ponds. Levee ponds are completely enclosed by constructed embankments; watershed ponds usually rely on one embankment constructed across an existing valley to catch and hold runoff from rainfall. Both types of construction are associated with water control structures, irrigation, drainage modifications, access and storage facilities and other conservation practices. Additionally, site selection for both types of pond system should consider prevailing elevations and the need to use natural drainage for management purposes.

While both systems rely on occasional flushing or draining of pond water, fish production converts raw feedstuffs into edible protein more efficiently than traditional animal industries, resulting in comparatively minimal amounts of waste. Also, ponds used for raising catfish, hybrid bass and other species often remain filled for years at a time, using the same natural cycles as wetlands, lakes and oceans to biodegrade uneaten feed and waste products. In terms of best management practices and potential environmental impacts, ponds used to culture turtle broodstock should probably also be included in this category of production systems.

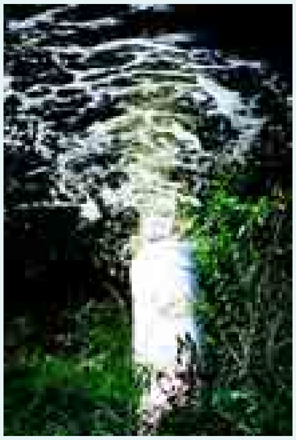
In a typical catfish pond producing 5,000 pounds of fish per acre annually (from 10,000 pounds of feed), 400 pounds of nitrogen, 80 pounds of phosphorus and 3,000 pounds per acre of organic matter are generated in addition to the fish produced. But, because of the natural breakdown and cycling of nutrients within pond systems only 110, 7 and 1,500 pounds of nitrogen, phosphorus and organic matter, respectively, would be discharged even if the pond were drained at the end of each year and no provisions were made to capture rainfall. In contrast, if standard industry BMPs of capturing and storing rainfall and draining ponds only every five years are practiced, per-year discharges drop to only 30, 2 and 400 pounds of nitrogen, phosphorus and organic matter per acre, respectively, equating to waste reductions of 92 percent, 97 percent and 87 percent. Clearly, pond-based aquaculture incorporates efficient production of animal protein while minimizing environmental impacts.

Production System-based BMPs

Operate Production Ponds for Several Years Without Draining

While some production ponds, such as fry and fingerling ponds, require annual draining and re-filling, most commercial ponds in the southeastern United States are operated for as long as possible without draining. While an average figure of 6.5 years between fillings is typical for catfish production, some commercial ponds have been left undrained for as long as 15 years while still maintaining adequate water quality for fish production. This re-use of water for multiple crops reduces both effluent volume from draining and the need for pumped groundwater to refill ponds.

Install Drain Outlets to Draw Overflow From the Pond Surface



Water from the lower layers of a pond is generally of poorer quality than that near the surface. This can be especially true in terms of suspended solids, oxygen demand and nutrients. Pond drains should be constructed to allow water to leave the pond from the surface, not the bottom. Existing drains that draw from the pond bottom and incorporate external structures to regulate pond depth should be modified, during regularly scheduled pond renovations, to draw water from near the pond surface.

Practice Water Detention When Draining Production Ponds

Eventually, most aquaculture ponds must be drained for inventory adjustments or to allow for levee repairs and restoration of depth and slopes. When ponds must be drained, avoid releasing water from the pond while it is being seined or immediately afterward. Holding the last 10 percent to 20 percent of the pond water for two to five days before discharge can significantly reduce nutrient loads in effluents because many nutrients are bound to particles of sediment, which can settle out of the water column before discharge.

Capture and Store Rainfall to Reduce Effluent Volume and Pumping Costs

Allowing the normal pond level to fall at least 4 to 6 inches below the level of the standpipe (or more, depending on the season) without re-filling will greatly reduce the volume of water exiting production ponds during rainfall. In summer and fall, maintain 8 inches of rainfall storage capacity if possible, since effluents will be most concentrated during these months because of heavy feeding and higher temperatures. Standpipes within ponds can be painted a bright color to indicate the target water depth at which pumping is needed. An added benefit of this practice is the reduced need for pumping groundwater to maintain ponds at or near maximum depths.

Use High Quality Feeds and Maximize Conversion of Feed to Fish

Pollutants in catfish pond effluents are generally the result of uneaten feed and waste products from the fish being fed. The use of high quality feeds improves not only feed conversion, but usually feed consumption as well. It is also important to adjust the amount of feed provided each day to match the fish's appetite. Water quality considerations usually limit feeding rates to no more than 125-150 pounds per acre per day. Fish must use their daily ration first and foremost to maintain their weight from one day to the next. Any excess feed provided can be used for growth, which from an economic standpoint is the equivalent of production.

Adopt Moderate Stocking Levels

When excessively high numbers of fish are stocked, most of the daily feed allowance must be used for maintenance and little is available for fish production. This, of course, is an inefficient use of feed, fingerlings and pond space. Lower stocking rates allow more efficient use of feed and ultimately reduce the cost of fish production as well as the amount of waste generated per pound of fish produced. Excessively high stocking and feeding rates result in a deterioration of water quality once the natural processes in a pond can no longer break down waste products as quickly as they are added. This in turn increases disease losses, reduces feed conversion efficiency and can result in fish kills caused by heavy algal blooms. Nutrient levels in any effluents that may leave the pond during these periods will reflect poor water quality within the pond itself. Adhering to moderate stocking and feeding rates can reduce the cost of production through reduced aeration costs, better water quality, higher survival, reduced medication and chemical costs, and improved feed conversions.

Maintain Adequate Aeration and Circulation

Keeping oxygen levels up improves feed consumption and conversion, and it enhances the natural processes responsible for breaking down waste products and cycling nutrients within the pond. Organic matter will be more readily oxidized, the solubility of phosphorus will be reduced and nitrogen losses will be increased, all of which improve fish production and the quality of any effluents the pond may discharge. Aerators should be positioned and operated to minimize erosion of pond levees and bottoms.

Avoid Flushing

The use of pumping well water to flush ponds is becoming increasingly costly, and research suggests this practice is usually of little benefit. Many well water supplies for commercial ponds are unable to add more than 5 percent of a pond's volume on a daily basis, and water exchange at these rates typically has little or no effect on pond water quality. The water leaving the pond, however, represents an unnecessary pollution load in the receiving drainage.

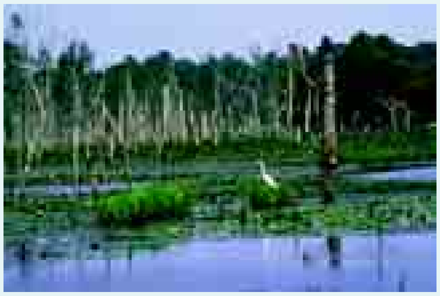
Reuse Pond Water

To save on pumping costs, conserve groundwater and reduce effluents when draining must be accomplished, pond water can be pumped into surrounding adjacent ponds and then reused. Transfer can usually be accomplished with a low-lift pump, and water can be replaced later by siphon. In some circumstances, it may be possible to drain water directly into ponds with lower elevations.

Use Effluents for Irrigation

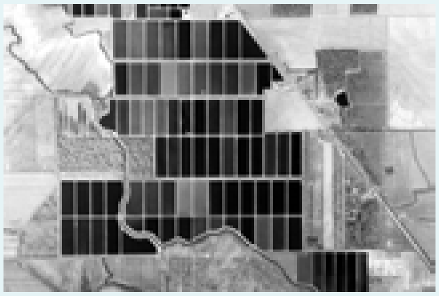
Under some conditions, pond water discharge can be used to irrigate crops. Unfortunately, most pond overflow in Louisiana occurs during periods of high precipitation, when irrigation requirements are low or non-existent. Additionally, the nutrient content of aquaculture pond water is too low to reduce appreciably the fertilizer requirements of terrestrial crops. Under some circumstances, diverting pond discharge can result in excessive erosion, so take care when considering this practice.

Consider the Use of Natural or Constructed Wetlands to Reduce Effluent Nutrients



Natural wetlands are an effective means of treating aquaculture effluents, but care must be taken not to overload these systems. Effective treatment requires retention times of at least two days. Research suggests that constructed wetlands are not cost-effective for treating the entire volume of an aquaculture pond, because of the need to retain water for at least two days, but this option may be appropriate to treat the concentrated effluents typically associated with the final 10 percent to 20 percent of pond volume during draining.

Consider Watershed Issues



Although levee ponds typically collect only that precipitation that falls directly into the pond or on the inner levee slopes, watershed or hillside ponds are subjected to heavy flushing during excessive or prolonged rainfall. Pond design and construction should take into account the overall size and hydrology of the surrounding watershed. Means to divert excessively heavy or turbid runoff should be incorporated during construction or renovation.

Practice Erosion Control in Drained Ponds

When ponds are drained and idle, especially in the winter in Louisiana, substantial erosion of the exposed pond bottom can occur, affecting both the serviceability of the pond and the receiving waters on the outside of the drain pipe. For this reason drains should always be closed when ponds sit empty, and ponds should be partially or completely refilled as quickly as possible.

Minimize Environmental Impacts During Pond Renovation

Use sediment from within the pond to rebuild levees and fill in low areas. Do not remove it from the pond unless absolutely necessary. During renovation, keep drains closed to minimize erosion and discharge of sediment. Pond depth can usually be increased at this time to allow more management flexibility in capturing and storing rainfall or water from surrounding ponds. In this way, effluents will be further reduced.

Crawfish Production in Ponds

Introduction and General Considerations

The development of crawfish culture in the early 1960s was stimulated by the year-round demand for crawfish and by the seasonality of crawfish catches from natural areas. Crawfish culture in Louisiana has developed into a major aquaculture industry, recognized throughout the world. Cultivation and production of crawfish in manmade ponds with controlled water depth, forage management (usually rice cultivation) and water recirculation techniques over the past several decades provided the groundwork for a scientifically managed production system.

Key considerations for crawfish culture are the high volumes of water (70-100 gpm/surface acre) required to maintain acceptable pond water quality, the high expense of harvesting, the length and frequency of the harvesting season, an expanding market and the need for continued product development. Historically, about 100,000 acres of crawfish production in Louisiana have yielded an average of 25 million to 50 million pounds of crawfish a year. The crop has a farm value of $20 million to $35 million annually.

Crawfish ponds do not typically affect the environment negatively, but rather serve as favorable habitat for many species of waterfowl, wading birds and furbearers. Effluents from crawfish ponds have not had serious impacts on receiving waters, especially when compared with other agricultural and industrial activities. Often, marginal agricultural lands are used to produce crawfish. Integration of crawfish production with traditional land uses often provides a practical means of both soil and energy conservation.

Production System-based BMPs

Reduce Pumping Costs and Improve Flushing Efficiency

When flushing crawfish ponds in the fall to improve water quality, avoid pumping and draining at the same time. Fill the pond no more than 12 inches before flushing, then shut off the pump. Open the drain and allow the entire pond to drop to a depth of roughly 4 to 6 inches, then refill with fresh water, again to no more than 12 inches. This type of flushing ensures that stale water will be diluted with fresh water throughout the entire pond, preventing the establishment of ‘dead’ areas where water will not normally flow with conventional flushing. The pond can be filled to an optimum operating depth of 14 to 18 inches during the winter when temperature drops and water quality problems subside.

Alternately, baffle levees can be used to direct water flow through the pond to eliminate hypoxic areas and to allow for the use of paddlewheel circulation or recirculating pumps. In areas where the quality of surface water is occasionally unacceptable or where well water must be pumped from great depths, water recirculation can be a cost-effective alternative.

Fertilize Forage Crops Efficiently

Nutrient application rates will be based on the results of a soil analysis. Select only those materials recommended for use by qualified individuals from the Louisiana Cooperative Extension Service, Louisiana Agricultural Experiment Station, certified crop advisors and certified agricultural consultants or published LSU AgCenter data.

Minimize Discharges and Sediment Loading When Draining

Recent research has shown that the total volume of discharge can be reduced considerably over the course of a season by maintaining a 2 to 6 inch water storage capacity within a crawfish pond whenever possible. This allows for rainwater to be captured rather than be flowing out of the pond and can help reduce pumping costs. Findings also suggest that replacing removable drop pipes with vertically adjustable drainage structures can significantly improve the quality of effluents leaving the pond by allowing water to be drained from the surface rather than the pond bottom.

One aspect of crawfish pond production that is unique to this type of aquaculture is the reliance on natural food chains to support production of the crop. While vegetative forages such as rice are essential to crawfish production, these plants are not directly consumed by the crawfish. Instead, they serve as the basis of a complex, natural food chain supporting microorganisms, protozoans and various invertebrates which in turn serve as the principal food source for the crawfish crop. One consequence of this natural production cycle is the constant bottom foraging behavior of the crawfish, which results in the suspension of clay turbidity in the water column, especially late in the season.

While this condition can be mitigated somewhat in crawfish-only ponds by postponing draining until most of the crawfish present have burrowed in the early summer, it poses problems in ponds where draining must be accomplished much earlier to allow for a commercial rice crop to be planted. In these instances, no specific recommendations have been formulated to reduce suspended sediments in ponds or effluents, but suspending harvest activities for one to two weeks before draining should improve water clarity prior to discharge. The use of filter strips and channel vegetation will also probably be beneficial in reducing this component of crawfish effluents. Other approaches, such as maintaining in-pond buffer zones of natural aquatic vegetation or constructing gravel barriers around pond drains, are being evaluated.

Crawfish Nutrient Management

Introduction

A sound soil fertility program is the foundation upon which a profitable farming business must be built. Agricultural fertilizers are a necessity for producing abundant, high quality food, feed and fiber crops. Using fertilizer nutrients in the proper amounts and applying them correctly are both economically and environmentally important to the long-term profitability and sustainability of crop production. The fertilizer nutrients that have potential to become groundwater or surface water pollutants are nitrogen and phosphorus. In general, other commonly used fertilizer nutrients do not cause concern as pollutants.

Because erosion and runoff are the two major ways nonpoint-source pollutants move into surface water resources, practices that reduce erosion or runoff are considered Best Management Practices (BMPs). Similarly, practices that limit the buildup of nutrients in the soil, which can leach to groundwater or be picked up in runoff, and practices that ensure the safe use of agricultural chemicals also are considered BMPs. In general, soil conservation and water quality protection are mutually beneficial; therefore the BMPs described here are the best means of reducing agricultural nonpoint-source pollution resulting from fertilizer nutrients.

Nitrogen

In aquaculture, conversion of feeds and organic matter results in simpler inorganic nitrogen forms such as ammonium (NH_4^+) and nitrate (NO_3^-). These are soluble in soil water and readily available for plant uptake. The ammonium form is attracted to and held by soil particles, so it does not readily leach through the soil with rainfall or irrigation water. Nitrates, on the other hand, are not attached to soil particles and do move downward with soil water and can be leached into groundwater or run off into surface waters.

Excessive nitrate concentrations in water can accelerate algae and plant growth in streams and lakes, resulting in oxygen depletion. Nitrate concentrations above a certain level in drinking water may injure young animals or human infants.

Phosphorus

Naturally occurring phosphorus (P) exists in a phosphate form either as soluble inorganic phosphate, soluble phosphate, particulate phosphate or mineral phosphate. The mineral forms of phosphorus (calcium, iron and aluminum phosphates) do not dissolve in water very easily. The amount of these elements (calcium, iron and aluminum) present in reactive forms varies with different soils and soil conditions.

Most phosphate is not readily water soluble. Most of the ions are either used by living plants or adsorbed to sediment, so the potential of their leaching to groundwater is low. That portion of phosphate bound to sediment particles is virtually unavailable to living organisms, but becomes available as it detaches from sediment. Only a small part of the phosphate moved with sediment into surface water is immediately available to aquatic organisms. Additional phosphate can slowly become available through biochemical reactions. The slow release of large amounts of phosphate from sediment layers in lakes and streams could cause excessive algae blooms and excessive growth of plants, thereby affecting water quality.

algae bloom

Soil testing is the foundation of a sound nutrient management program.

A soil test is a series of chemical analyses that determine the levels of essential plant nutrients in the soil. When not taken up by a crop, some nutrients, particularly nitrogen, can be lost from the soil by leaching, runoff or mineralization. Others, like phosphorus, react with soil minerals over time to form compounds that are not available for uptake by plants. Soil testing can be used to estimate how much loss has occurred and to predict which nutrient(s) and how much of that nutrient(s) should be added to the soil to produce a particular crop and yield. Take soil tests at least every three years or at the beginning of a different cropping rotation.

Recommended Crawfish Forage Practices

1. Soil test for nutrient status and pH to:

- determine the amounts of additional nutrients needed to produce a forage crop for crawfish and the amount of lime needed to correct soil acidity (ph) problems
- optimize farm income by avoiding excessive fertilization and reducing nutrient losses by leaching and runoff; and identify other yield-limiting factors such as high levels of salts or sodium that may affect soil structure, infiltration rates, surface runoff and, ultimately, groundwater quality

2. Base fertilizer applications on:

- soil test results
- realistic yield goals and moisture prospects
- crop nutrient requirements
- past fertilization practices
- previous cropping history

3. Time nitrogen applications to:

- correspond closely with crop uptake patterns
- increase nutrient use efficiency
- minimize leaching and runoff losses

4. Skillfully handle and apply fertilizer by:

- properly calibrating and maintaining application equipment
- properly cleaning equipment and disposing of excess fertilizers, containers and wash water
- storing fertilizers in a safe place

Intensive Production Systems

Intensive Production With More than 10 Percent Daily Water Exchange

Several examples of high-exchange intensive aquaculture can be found in Louisiana. Production of alligators for hides and meat is accomplished through an intensive production system with daily water exchanges typically exceeding 10 percent by volume. Eggs are gathered under permit from natural nests in marshes and swamps. Eggs are collected in June and July during the early stages of incubation. Eggs hatch in late August. Grow-out technology of hatchlings generally involves intensive indoor growing systems. Alligators are maintained in buildings of rectangular or circular design. About 75 percent of the floor space is flooded. The sloping floor has a water depth of 0 - 12 inches. After flushing, the compartments are reflooded with heated water to reduce thermal stress to the alligators. The building temperature is maintained by circulating warm water in a closed loop system within the concrete floor. There are rigid regulations issued by the Louisiana Department of Wildlife and Fisheries (LDWF) as to growing shed design, water temperature and growing densities.

Alligator culture is somewhat atypical in its discharge of warm, nutrient-rich water. Culture practices involve feeding the animals daily, maintaining water temperature at a minimum of 80 degrees F and changing water daily. The high density of one animal per square foot initially to about 3 square feet per animal at 4 feet long generates relatively concentrated wastewater; however, shallow water depths (12 inches or less) and allowances for dry areas in houses result in a low level of water use. Alligator wastewater includes fecal material and remains of food. Many alligator farmers use oxidation ponds and lagoons to treat effluent. A common alternative is the use of commercially available sewage treatment packages. Depending on holding capacity, excess water from the lagoon is land applied; however, it is rare for wastewater to be disposed of by land application.

Several finfish production systems operating in Louisiana fall into this category. These systems range from outdoor raceways made of concrete or earthen walls to indoor multi-pass tank facilities. Source water can vary, from heated industrial effluent to municipal supplies to surface water from lakes and rivers. As a result, a number of conservation practices must be included to address the multiplicity of possible configurations that fall into this category. Effluent characteristics may vary significantly between similarly configured systems, depending on the species being cultured. Concerns for preventing escape of exotic species may require removal and disposal of all but the smallest solids from effluents, while other types of high-turnover systems may rely solely on dilution to dispose of dissolved and solid wastes in the effluent stream. As this sector of the industry evolves, economically successful configurations will be more easily characterized and BMPs can be more directly applied.

Intensive Production With Less Than 10 Percent Daily Water Exchange

A number of systems operating in Louisiana fall into this category. These systems are typically indoor tank systems that replace less than 10 percent of the system's water volume daily. They have been used to culture soft-shell crawfish and soft-shell crabs, tilapia, red drum broodfish and striped bass broodfish. These species have the high market value needed to cover the relatively high overhead costs. Water sources range from municipal supplies to subsurface wells.

Since the systems are completely enclosed, the effects of the production system on the environment are mainly limited to discharge of effluents. Effluent characteristics may vary significantly based on the size of the system and the species being cultured. Concerns for preventing escape of exotic species, such as tilapia, will require removal and disposal of all but the smallest solids from effluents, while other systems may rely solely on dilution to dispose of dissolved and solid wastes in the effluent stream. Where possible, the producer should be encouraged to connect to municipal sewage systems. When this is not practical, producers must design a waste treatment system based on volume and concentration of the effluent. These treatment systems may range from a simple storage structure for removal to off-site treatment to a series of treatment ponds for removal of solids and nutrients. As this sector of the industry evolves, economically successful configurations will be more easily characterized, and BMPs can be more directly applied.

Soil and Water Management

Sediment is the largest pollutant by volume of surface water in the Nation. Sediment comes from agricultural sources, construction sites and other soil-disturbing activities in urban settings that leave the soil exposed to rainfall. Sediment increases the turbidity of water, thereby reducing light penetration, impairing photosynthesis, altering oxygen relationships and may reduce the available food supply for certain aquatic organisms. It can affect fish populations adversely in areas where sediment deposits cover spawning beds. Increased sediment also fills lakes and reservoirs.

Sediment directly damages water quality and reduces the usefulness of streams and lakes in many ways. These include:

- Damaged fish spawning areas
- Reduced light penetration for aquatic life
- Increased water purification costs
- Lower recreational value
- Clogged channels and increased flooding
- Increased dredging to maintain shipping channels
- Reduced storage capacity for reservoirs

In addition, sediment is often rich in organic matter. Nutrients such as nitrogen and phosphorus and certain pesticides may enter streams with sediment. The detrimental effects of these substances accompanying the sediment may include:

- Rapid algae growth
- Oxygen depletion as organic matter and algae decomposition
- Fish kills from oxygen depletion
- Toxic effects of pesticides on aquatic life
- Unsafe drinking water caused by nitrate or pesticide content

The following are production practices and the NRCS production code associated with each practice that applies to aquaculture production.

Field Borders (NRCS Code 386) and Filter Strips (NRCS Code 393)

These are strips of grasses or other close-growing vegetation planted around fields and along drainageways, streams and other bodies of water. They are designed to reduce sediment, organic material, nutrients and chemicals carried in runoff.

In a properly designed filter strip, water flows evenly through the strip, slowing the runoff velocity and allowing contaminants to settle from the water. In addition, where filter strips are seeded, fertilizers and herbicides no longer need to be applied right next to susceptible water sources. Filter strips also increase wildlife habitat.

Soil particles (sediment) settle from runoff water when flow is slowed by passing through a filter strip. The largest particles (sand and silt) settle within the shortest distance. Finer particles (clay) are carried the farthest before settling from runoff water, and they may remain suspended when runoff velocity is high. Farming practices upslope from filter strips affect the ability of strips to filter sediment. Fields with steep slopes or little crop residue will deliver more sediment to filter strips than more gently sloping fields and those with good residue cover. Large amounts of sediment entering the filter strip may overload the filtering capacity of the vegetation, and some may pass on through.

Filter strip effectiveness depends on five factors:

1. The amount of sediment reaching the filter strip. This is influenced by:

- type and frequency of tillage in cropland above the filter strip. The more aggressive and frequent tillage is above filter strips, the more likely soil is to erode.
- time between tillage and a rain. The sooner it rains after a tillage operation, the more likely soil is to erode.
- rain intensity and duration. The longer it rains, and thus the more sediment deposited, the less effective filter strips become as they fill with soil.
- steepness and the length above the filter strip. Water flows faster down steeper slopes. Filter strips below steep slopes need to be wider in relation to the cropland drained above to slow water and sediment movement adequately.

In general, a wider, uniformly shaped strip is more effective at stopping or slowing pollutants than a narrow strip. As a field's slope or watershed size increases, wider strips are required for effective filtering. The table gives the suggested filter strip width based on slope. For a more accurate determination of the size of filter strip you will need for your individual fields, consult your local NRCS or Soil and Water Conservation District office.

Suggested Vegetated Filter Strip Widths on Percent Slope

Land Slope, %	Strip Width, Feet
0 - 5	20
5 - 6	30
6 - 9	40
9-13	50
13-18	60

*Widths are for grass and legume species only and are not intended for shrub and tree species. Adapted from the NRCS Field Office Technical Guide, 1990.

2. The amount of time that water is retained in the filter strip. This is influenced by:

- width of the filter area. Filter strips will vary in width, depending on the percent slope, length of slope and total drainage area above the strip.
- type of vegetation and quality of stand. Tall, erect grass can trap more sediment than can short flexible grass. The best species for filter strips are tall perennial grasses. Filter strips may include more than one type of plant and may include parallel strips of trees and shrubs, as well as perennial grasses. In addition to potential for improving water quality, these strips increase diversity of wildlife habitat.

3. Infiltration rate of the soil

- Soils with higher infiltration rates will absorb water and the accompanying dissolved nutrients and pesticides faster than soils with low infiltration rates. Parish soil survey reports include a table listing the infiltration rate group for the soils identified in each parish.

4. Uniformity of water flow through the filter strip

- Shallow depressions or rills need to be graded to allow uniform flow of water into the filter strip along its length. Water concentrated in low points or rills will flow at high volume, so little filtering will take place.

5. Maintenance of the filter strip

- When heavy sediment loads are deposited, soil tends to build up across the strip, forming a miniature terrace. If this becomes large enough to impound water, water will eventually break over the top and flow will become concentrated in that area. Strips should be inspected regularly for damage. Maintenance may include minor grading or re-seeding to keep filter strips effective.

In summary:

- *Vegetative filter strips can reduce sediment effectively if water flow is even and shallow.*
- *Filter strips must be properly designed and constructed to be effective.*
- *Filter strips become less effective as sediment accumulates. With slow accumulation, grass regrowth between rains often restores the filtering capacity.*
- *Filter strips remove larger sediment particles of sand and silt first. Smaller clay-sized particles settle more slowly and may be only partially removed, depending on the strip width and water flow rate.*
- *Because soil-bound nutrients and pesticides are largely bound to clay particles, filter strips may be only partially effective in removing them.*
- *Fewer dissolved nutrients and pesticides will be removed than those bound to soil particles.*

Filter strips are a complementary conservation practice that should be used with in-field conservation practices such as conservation tillage, contour buffer strips, strip cropping and waterways.

Grassed Waterways (NRCS Code 412):

These are natural or constructed channels that are shaped or graded to required dimensions and planted in suitable vegetation to carry water runoff. They are designed to carry this runoff without causing erosion or flooding and to improve water quality by filtering out some of the suspended sediment.

Heavy Use Area Protection (NRCS Code 561):

This practice addresses the need to stabilize areas frequently and intensely used by animals or vehicles. Suggested practices include establishing vegetative cover, installing suitable surface materials and constructing needed structures.

Roof Runoff Management (NRCS Code 558):

The practice addresses the collection, control and disposal of runoff water from roofs. It is used to prevent the runoff water from roofs from flowing across animal waste areas and to reduce pollution and erosion, improve water quality, improve drainage and protect the environment. This practice applies where: (1) roof runoff is included in an overall plan for a waste management system and (2) roof runoff water may come in contact with wastes or cause soil erosion.

Sediment Basin (NRCS Code 350):

This is a basin constructed to collect and store manure and sediment. Its purpose is to maintain the capacity of lagoons, to prevent deposition on bottom lands and to trap sediment, agricultural wastes and other debris. This practice helps prevent bedding materials, such as sand, hay or straw, from entering waste disposal systems, and traps manure for hauling to fields.

Waste Treatment Lagoon (NRCS Code 359):

This is an impoundment made by excavation or earthfill for the temporary storage and biological treatment of animal or other agricultural waste. The impoundment stores organic waste, reduces pollution and protects the environment. This standard establishes the minimum acceptable requirements for design, construction and operation of waste treatment lagoons. Embankments are limited to an effective height of 35 feet or less. This practice applies where: (1) an overall waste management system has been planned, (2) waste generated by agricultural production needs treatment, (3) a lagoon can be located near the source of the waste, (4) soils are suitable for retaining the waste or can be sealed and (5) a water supply is adequate to fill the lagoon to about 3 feet before operation and to maintain the design depth when the lagoon becomes fully operational.

Cover and Green Manure Crop (NRCS Code 340):

This is a crop of close-growing grasses, legumes or small grains grown primarily for seasonal soil protection and improvement. It is usually grown for one year or less, except where there is permanent cover. It is designed to control erosion during periods when the major crops do not furnish enough cover. It also adds organic material to the soil and improves infiltration capacity, aeration and tilth.

Critical Area Planting (NRCS Code 342):

This involves the planting of vegetation, such as trees, shrubs, vines, grasses or legumes, on highly erodible or critically eroding areas. This practice does not include planting trees for wood products. The primary purposes are to stabilize the soil, reduce damage from sediment and runoff to downstream areas, and improve wildlife habitat and aesthetics. Examples of applicable areas are dams, dikes, levees, cuts, fills and denuded or gullied areas where vegetation is difficult to establish by usual planting methods.

Regulating Water in Drainage System (NRCS Code 554)

Controlling the removal of surface runoff, primarily through the operation of water control structures. It is designed to conserve surface water by controlling the outflow from drainage systems.

Riparian Forest Buffer (NRCS Code 391):

This is an area of trees, shrubs and other vegetation located adjacent to and uphill from water bodies. This practice may be applied in a conservation management system to supplement one or more of the following:

• To create shade to lower water temperature, which would improve habitat for aquatic organisms.

• To remove, reduce or buffer the effects of nutrients, sediment, organic material and other pollutants before entry into surface water and groundwater recharge systems.

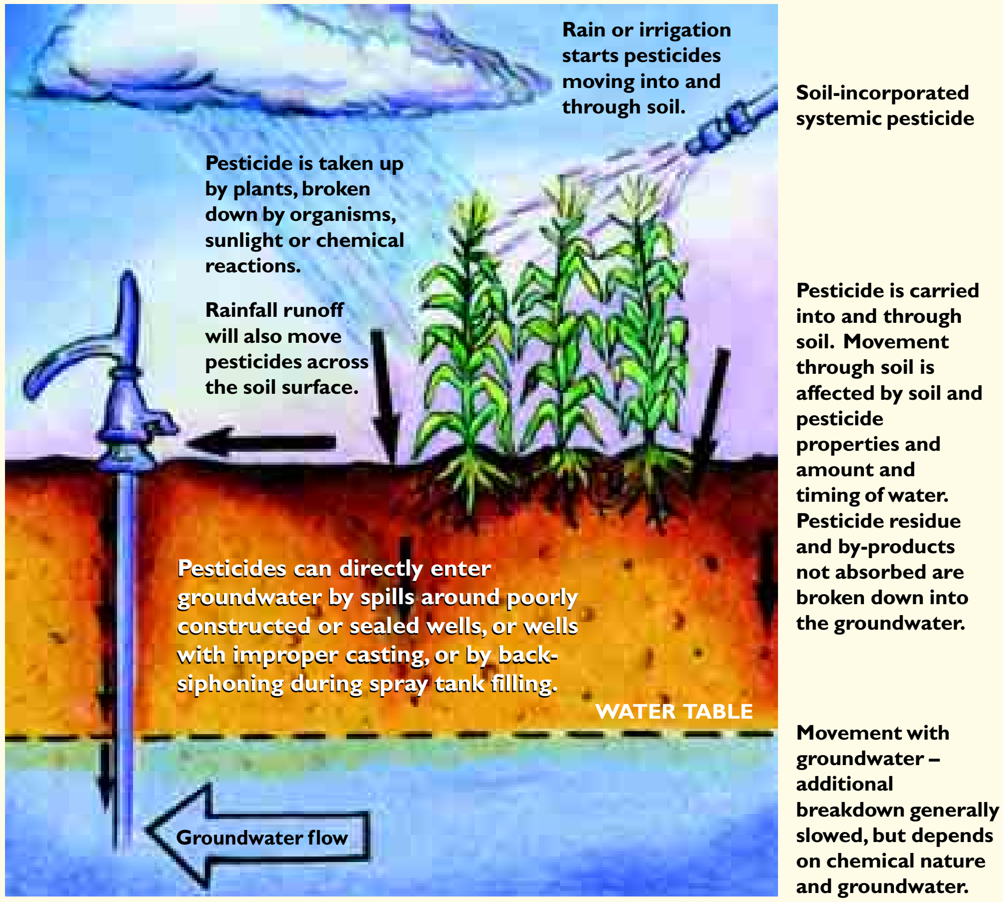
This practice applies on cropland, hayland, rangeland, forestland and pastureland areas adjacent to permanent or intermittent streams, lakes, rivers, ponds, wetlands and areas with groundwater recharge where water quality is impaired or where there is a high potential of water quality impairment.

For more information on these practices and how to implement them, contact your local NRCS or Conservation District office.

Pesticide Management and Pesticides

Introduction

To preserve the availability of clean and environmentally safe water in Louisiana, contamination of surface and groundwater by all agricultural and industrial chemicals must be reduced. Some sources of contamination are easily recognizable from a single, specific location. Other sources are more difficult to pinpoint. Nonpoint-source pollution of water with pesticides is caused by rainfall runoff, particle drift or percolation of water through the soil. Pest management practices will be based on current research and extension recommendations. By using these recommendations, pesticide usage will follow environmentally sound guidelines.



Pest Management Procedures

Pesticides will be applied only when they are necessary to protect the crop. The pesticide will be chosen following guidelines to assure that the one chosen will give the most effective pest control with the least potential adverse effects on the environment.

Water quality, both surface and ground, will be protected by following all label recommendations and guidelines dealing with water quality.

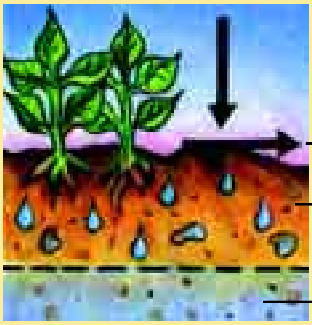
- All label statements and use directions designed specifically to protect groundwater will be followed closely.
- Specific Best Management Practices designed to protect surface water will be followed closely.
- Erosion control practices (such as pipe drops, etc.) will be used to minimize runoff that could carry soil particles with adsorbed pesticides and/or dissolved pesticides into surface waters.

Pesticide Application

Management practices such as the pesticide selected, the application method, the pesticide rate used and the application timing influence pesticide movement. Pesticides should be applied only when needed to prevent economic loss of a crop.

In pesticide application, “the label is the law.” Using chemicals at rates higher than specified by the label is ILLEGAL as well as an environmental hazard because more pesticide is exposed to erosion, runoff or leaching. Poor timing of a pesticide application (application just before rain falls) can result in pesticide movement into water sources, as well as give little control of the targeted pest.

Certain areas on your farm such as streams and rivers, wellheads and lakes or ponds are sensitive to pesticides. You should create buffer zones around these areas where pesticide use will be reduced or eliminated. By buffering these areas, you may reduce water quality problems. Areas such as roads, off-site dwellings and areas of public gatherings should be identified. You may want to limit the use of pesticides near these types of areas, too.



The water table separates the unsaturated zone from the saturated zone (groundwater)

Rainfall runoff

Unsaturated zone

WATERTABLE

Groundwater Saturated zone

These practices will be followed:

- Select the pesticide to give the best results with the least potential environmental impact outside the spray area.
- Select application equipment with care and maintain it carefully.

- Carefully calibrate application equipment at the beginning of the spray season and periodically thereafter. Spray according to recommendations.
- Minimize spray drift by following the label instructions and all rules and regulations developed to minimize spray drift (the physical movement of spray particles at the time of or shortly after application).

- Before applying a pesticide, make an assessment of all of the environmental factors involved in all of the area surrounding the application site.
- Carefully maintain all pesticide applications, not just Restricted Use Pesticides.

Pesticide Selection

When selecting pesticides, consider chemical solubility, adsorption, volatility and degradation characteristics. Chemicals that dissolve in water readily can leach through soil to groundwater or be carried to surface waters in rainfall or irrigation runoff. Some chemicals hold tightly to, or are adsorbed on, soil particles, and these chemicals do not leach as much. But even these chemicals can move with sediment when soil erodes during heavy rainfall. Runoff entering surface waters may ultimately recharge groundwater reserves. Chemicals bound to soil particles and organic matter are subject to the forces of leaching, erosion or runoff for a longer period, thus increasing the potential for water pollution.

These practices will be followed:

- Selection will be based upon recommendations by qualified consultants, crop advisors and upon the published recommendations of the LSU AgCenter, Cooperative Extension Service.
- The selection of the pesticide to be used will be based upon its registered uses and its ability to give the quality of pest control required.
- The selection also will be based upon its impact on beneficials, other non-target organisms and on the general environment.

Pesticide Storage and Safety

Pesticide storage shed

Farmers and commercial pesticide applicators are subject to penalties if they fail to store or dispose of pesticides and pesticide containers properly. Each registered pesticide product, whether general or restricted use, contains instructions for storage and disposal in its labeling. The Louisiana Pesticide Law addresses specific requirements for storage and disposal. The applicator must follow these requirements carefully and ensure that employees follow them as well.

The recommended procedures do not apply to the disposal of single containers of pesticides registered for use in the home and garden. These containers may be disposed of during municipal waste collection if wrapped according to recommendations.

Storage sites should be chosen to minimize the chance of pesticides escaping into the environment. Pesticides should not be stored in an area susceptible to flooding or where the characteristics of the soil at the site would allow escaped chemicals to percolate into groundwater. Storage facilities should be dry, well ventilated and provided with fire protection equipment. All stored pesticides should be carefully labeled and segregated and stored off of the ground. Do not store pesticides in the same area as animal feed. The facility should be kept locked when not in use. Further precautions include appropriate warning signs and regular inspection of containers for corrosion or leakage. Protective clothing should be stored close by but not in the same room as the pesticides because they may become contaminated. Decontamination equipment should be present where highly toxic pesticides are stored.

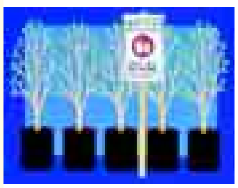
Exceptions for Farmers

Farmers disposing of used pesticide containers for their own use are not required to comply with the requirements of the hazardous waste regulations provided they triple rinse or pressure wash each container and dispose of the residues on their own farms in a manner consistent with the disposal instructions on the pesticide label. Note that disposal of pesticide residues into water or where they are likely to reach surface or groundwater may be considered a source of pollution under the Clean Water Act or the Safe Drinking Water Act and therefore illegal.

After the triple rinse procedure, the containers are then "empty" and the farmer can discard them in a sanitary waste site without further regard to the hazardous waste regulations. The empty containers are still subject to any disposal instructions contained within the labeling of the product, however. Disposal in a manner "inconsistent with the labeling instructions" is a violation of EPA guidelines and could lead to contamination of water, soil or persons and legal liability.

Agricultural Chemicals and Worker Safety

The EPA has general authority to regulate pesticide use to minimize risks to human health and to the environment. This authority extends to the protection of farm workers exposed to pesticides. All employers must comply with ALL instructions of the Worker Protection Standard concerning worker safety or be subject to penalties. Labels may include, for example, instructions requiring the wearing of protective clothing, handling instructions and instructions setting a period of time before workers are allowed to re-enter fields after the application of pesticides (Restricted Entry Interval).



Employers should read the Worker Protection Standard regulations governing the use of and exposure to pesticides. The regulations set forth minimum standards that must be followed to protect farm workers and pesticide handlers. The regulations include standards requiring oral warnings and posting of areas where pesticides have been used, training for all handlers and early re-entry workers, personal protective equipment, emergency transportation and decontamination equipment.

The EPA regulations hold the producer of the agricultural plant on a farm, forest, nursery or greenhouse ultimately responsible for compliance with the worker safety standards. This means the landowner must ensure compliance by all employees and by all independent contractors working on the property. Contractors and employees also may be held responsible for failure to follow the regulations.

The Occupational Safety and Health Act (OSHA)

The federal government also regulates farm employee safety under the Occupational Safety and Health Act (OSHA). OSHA applies to all persons (employers) engaged in business affecting interstate commerce. The federal courts have decided that all farming and ranching operations, regardless of where goods produced are actually sold or consumed, affect interstate commerce in some respect, and thus are subject to OSHA's requirements. In general, every employer has a duty to provide employees with an environment free from hazards that are causing or are likely to cause death or serious injury.

In summary:

■ All label directions will be read, understood and followed.

■ The Louisiana Department of Agriculture and Forestry (LDAF) is responsible for the certification of pesticide applicators. All commercial and private pesticide applicators applying restricted use pesticides must successfully complete a certification test administered by the LDAF. The LSU AgCenter conducts training sessions and publishes study guides in various categories covered by the test. Contact your county agent for dates and times of these sessions.

■ All requirements of the Worker Protection Standard (WPS) will be followed, including, but not limited, to:

■ Notifying workers of a pesticide application (either oral or posting of the field), abiding by the restricted entry interval (REI).

■ Maintaining a central notification area containing the safety poster; the name, address and telephone number of the nearest emergency medical facility; and a list of the pesticide applications made within the last 30 days that have an REI.

■ Maintaining a decontamination site for workers and handlers.

■ Furnishing the appropriate personal protective equipment (PPE) to all handlers and early entry workers, and ensuring that they understand how and why they should use it.

■ Assuring that all employees required to be trained under the Worker Protection Standard have undergone the required training.

■ Pesticides will be stored in a secure, locked enclosure and in a container free of leaks, abiding by any specific recommendations on the label. The storage area must be maintained in good condition, without unnecessary debris. This enclosure will be at least 150 feet away and down slope from any water wells.

■ All uncontained pesticide spills of more than one gallon liquid or four pounds dry weight will be reported to the director of Pesticide and Environmental Programs, Louisiana Department of Agriculture and Forestry within 24 hours by telephone (225-925-3763) and by written notice within three days. Spills on public roadways will be reported to the Louisiana Department of Transportation and Development. Spills into navigable waters will be reported to LDEQ, Coast Guard, USEPA.

■ Empty metal, glass or plastic pesticide containers will be either triple rinsed or pressure washed, and the rinsate will be added to the spray solution to dilute the solution at the time or stored according to the LDAF rules to be used later. Rinsed pesticide containers will be punctured, crushed or otherwise rendered unusable and disposed of in a sanitary landfill. (Plastic containers may be taken to specific pesticide container recycling events. Contact your county agent for dates and locations in your area.)

■ All pesticides will be removed from paper and plastic bags to the fullest extent possible. The sides of the container will be cut and opened fully, without folds or crevices, on a flat surface; any pesticides remaining in the opened container will be transferred into the spray mix. After this procedure, the containers will be disposed of in a sanitary landfill.

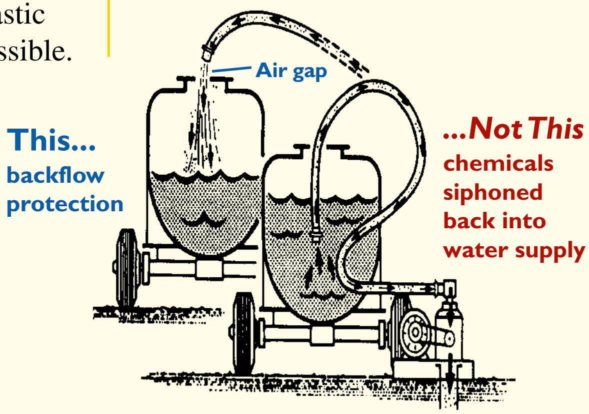
■ Application equipment will be triple rinsed and the rinsate applied to the original application site or stored for later use to dilute a spray solution.

Wash pad with collection pond

■ Mix/load or wash pads (NRCS production code Interim) will be located at least 150 feet away and down slope from any water wells and away from surface water sources such as ponds, streams, etc. The pads will be constructed of an impervious material, and there will be a system for collecting and storing the runoff.

■ Empty containers will not be kept for more than 90 days after the end of the spray season.

■ Air gaps will be maintained while filling the spray tank to prevent back-siphoning.



General Farm BMPs

Water well protection

Farm*A*Syst/ Home*A*Syst should be used every three years to determine potential threats to water wells. Threats identified will be ranked and measured to correct the most serious.

Used engine oil, grease, batteries, tires, etc.

• Used engine oil should be stored in a waste oil container (tank or drum) until recycled.

• Empty paint cans, antifreeze containers, used tires, old batteries, etc., will be stored in a secure area until they can be disposed of properly.

Irrigation water quality

Irrigation water (surface and/or well) should be tested in the spring to determine the salinity (salt) level before irrigating a field or pasture. Take samples to an approved laboratory for analysis.

Fuel storage tanks

Above-ground fuel storage tanks in Louisiana are regulated by the State Fire Marshal and by the EPA if surface water is at risk. Above-ground tanks containing 660 gallons or more require secondary containment. The State Fire Marshal recommends that some sort of secondary containment be used with all fuel storage tanks. This could include the use of double-walled tanks, diking around the tank for impoundment or remote impoundment facilities.

These practices are to be followed:

■ Any existing above-ground fuel storage tank of 660 gallons or more (1,320 gallons if more than one) must have a containment wall surrounding the tank capable of holding 100 percent of the tank's capacity (or the largest tank's capacity if more than one) in case of spillage.

■ The tank and storage area should be located at least 40 feet from any building. Fuel storage tanks should be placed 150 feet and down slope from surface water and water wells.

■ It is recommended that the storage tank be on a concrete slab to prevent any spillage from entering surface and groundwater.

■ The storage area should be kept free of weeds and other combustible materials.

■ The tank should be conspicuously marked with the name of the product that it contains and "FLAMMABLE-KEEP FIRE AND FLAME AWAY."

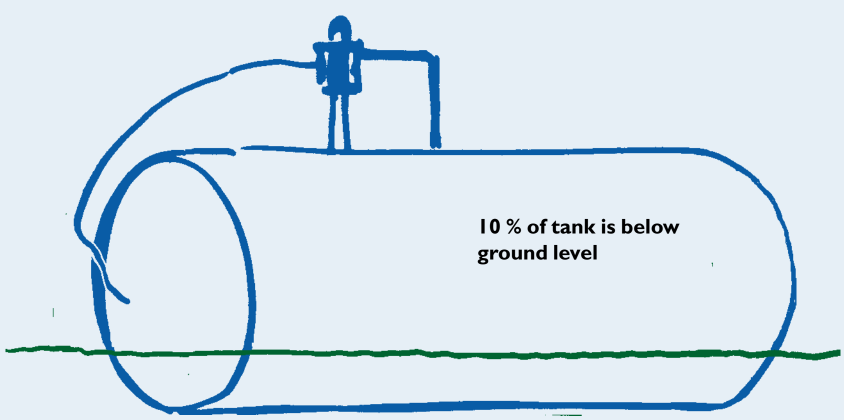
■ The bottom of the tank should be supported by concrete blocks approximately 6 inches above the ground surface to protect the bottom of the tank from corrosion.

■ If a pumping device is used, it should be tightly and permanently attached and meet NFPA approval. Gravity discharge tanks are acceptable, but they must be equipped with a valve that will automatically close in the event of a fire.

■ Plans for the installation of all storage tanks that will contain more than 60 gallons of liquid must be submitted to the State Fire Marshal for approval.

■ All tanks that catch on fire must be reported to the State Fire Marshal within 72 hours of the fire.

■ Underground storage tanks are defined as containing more than 10 percent of their total volume beneath the soil surface. Underground tanks represent more of a problem than above-ground tanks, because leaks can often go for long periods without being detected. This poses a serious threat to groundwater sources in the vicinity of the tank. If you have an underground fuel storage tank, you need to contact the State Fire Marshal's Office for regulations affecting these storage tanks.



This tank would be classified as an underground fuel tank.

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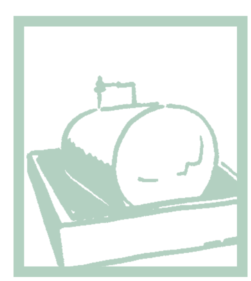

The complex nature of nonpoint pollution means programs designed to reduce its impact on the environment will not be easy to establish or maintain. Controlling these contaminants will require solutions as diverse as the pollutants themselves. Through a multi-agency effort, led by the LSU AgCenter, these BMP manuals are targeted at reducing the impact of agricultural production on Louisiana's environment. Agricultural producers in Louisiana, through voluntary implementation of these BMPs, are taking the lead in efforts to protect the waters of Louisiana. The quality of Louisiana's environment depends on each of us.

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