



# The Woodlands Township

Pond and Lake Management Plan

The Woodlands Township Parks and Recreation Department

RE: Pond and Lake Management Plan for The Woodlands Township

We've enjoyed the opportunity to assist The Woodlands with the development of a Pond and Lake Management Plan. The Woodlands has an incredible system of ponds and lakes that compliment a world-class parks and recreation program. Whether located in prominent parks and commercial areas, or nestled in a quiet neighborhood, the ponds and lakes offer aesthetic beauty, fishing and other recreation opportunities, and ecological services such as pollutant removal and stormwater management, as well as the economic benefits of those ecological services and increased property values within the community.

This document ties together the observations and recommendations based on inspections of each pond and lake, evaluation of current maintenance practices in-house and through outside service providers, and the background tools and information needed to address issues in the future. The plan serves as an extension of the Integrated Forest Management Plan (2000) for operation of these important resources.

We have enjoyed working with The Woodlands on this important project and will be happy to answer any questions you may have regarding the plan.

Respectfully,

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February 2011

### **Transmittal Letter**

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### The Woodlands Township Pond and Lake Management Plan

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# The Woodlands Township

### Pond and Lake Management Plan

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## The Woodlands Township Pond and Lake Management Plan

### **Executive Summary**

The Woodlands Township is responsible for the management of a system of ponds and lakes within the community for the purpose of wildlife, recreation and aesthetics. The Township recognizes the importance of these ponds and lakes as assets that contribute significantly to the character of the community and the guality of life of its residents. Like all small bodies of water, the health and guality of these ponds and lakes requires an investment in time and resources to properly manage them for the benefit of all stakeholders. Since 1997, Parks and Recreation Department staff have engaged the services of Lake Pro, Inc. to carry out the routine maintenance activities needed to keep the ponds in lakes in good health. In the Fall of 2010, the Parks and Recreation Department sought additional services to inspect all ponds and lakes under the Township's control to assess the level of services provided by Lake Pro and to evaluate the overall quality and condition of the water, vegetation, and wildlife habitat; and develop recommendations for long term management, as well as identification of opportunities for enhancement. Burditt Conslutants' resource team joined with Staff to bring perform this assessment and bring the recommendations together into a unified planning document.

Throughout the Fall of 2010, Burditt Consultants conducted general inspections of all 45 ponds and lakes, and a total of 10 ten randomly-selected ponds were sampled to determine current pH levels, nitrate and nitrite levels, hardness, alkalinity, and dissolved oxygen. Water samples were collected for analysis at the Texas A&M Soil, Water and Forage Testing Laboratory. Inspections on site included observations of bank vegetation, water color, water level, presence of wildlife, bank conditions, presence of aquatic vegetation, presence of aeration, potential sources of pollution and general notes regarding overall health of the pond.

Upon completion of the pond and lake inspections past and current management practices were reviewed to determine opportunities for improvement and enhancement of the pond system. Within this plan, a Pond Profile and Management Recommendations sheet has been created for each pond outlining the on-site observation made during inspection and recommended course of action for correcting problems and improving upon existing conditions. A matrix of action items is provided summarizing all recommended maintenance and improvement activities.

Overall, to the credit of Staff and operations procedures, the ponds and lakes of The Woodlands are in excellent condition. Maintaining a pond ecosystem in an urban environment can be one of the most challenging activities, as the influences from the community on water quality and stormwater flows can have a significant impact on daily water chemistry. Current maintenance practices performed by Lake Pro, Inc. were found to be well-executed and consistent with the goals of The Woodlands. Because conditions within any given pond or lake can change rapidly, sometimes overnight, we recommend continuation of these services following the current schedule.

The most common maintenance issues noted were erosion due to pedestrian traffic and duck feeding activity, and water clarity due to siltation and excess deposition of lawn clippings in the water during turf maintenance activities. All of these issues can be remedied, and were considered minor problems. Recommended solutions are offered on each pond profile page.

Remaining sections of this plan offer explanation of the most common problems found in any pond and lake management program. Such items as dealing with water clarity issues, maintaining proper water chemistry and managing fish populations; are discussed within these sections in a technical but user-friendly manner. The aim of these educational sections is to serve as a toolkit for addressing future problems and a reference for explaining complex pond management issues to staff and residents when questions arise. The Pond and Lake Management Plan will become an extension of the existing Integrated Forest Management Plan, developed in 2000. Together these plans address the management of natural resources within The Woodlands.

## Wildlife

## Environment

### **Executive Summary**

### People





## The Woodlands Township Pond and Lake Management Plan

### SUMMARY OF RECOMMENDED ACTIONS AND PROBABLE UNIT COSTS

Pond	Address	Acreage	Monitor Dissolved Oxygen Levels	Desiltation	Topdress Eroded Areas	Overseed/Sod 5 Turfgrass	Depth Study	Control Bank Vegetation	Control Muscovy Ducks	Increase Mowing s Height of Turfgrass	Flocculation Treatment with Gypsum or Agricultural Limestone	Plant Aquatic Vegetation	Control Invasive Plant Species	Bank Stabilization	Repair/Clean Vandalism/Litter Pickup	Repair Plumbing Fixture (Fill Line)	Monitor Vegetation Growth	Monitor Duck Populations	Monitor Water Levels	Comments	
Alden Bridge	725 Alden Bridge Drive	3.17 acres	х	X**																Monitor DO from June to August	
Alden Woods Park	5300 Alden Woods Drive	0.55 acres			Х	Х															
Canstone	5200 Research Forest Drive	0.50 acres			X	X		X		-								1	-		
cupstone		0.05 461 65									1			1			1	1			
Clover Pond	187/207 N. Mill Trace Drive	0.82 acres															х				
Cokeberry	1829 Nursery Road	3.91 acres		X**	Х	Х															
Copper Sage	75 S. Golden Arrow Circle	2.04 acres																			
Creekwood	3383 S. Panther Creek	1.65 acres																Х		Maintain no more than 2 to 4 ducks per surface acre	
Cypress Lake	7250 Alden Bridge Drive	1.89 acres							-	-							, v		-		
Deepdale Deer Rush Rond	7500 Windvale Circle	2.23 acres					v	-	-							-	X		-		
Entry Lake	53 S. Connersage Circle	0.35 acres					^		1	x											
Evergreen	950 Evergreen Circle	0.22 acres								~	1										
Forest Lake	4900 Shadowbend Drive	2.00 acres			х	х															
Hidden Lake	105 S. Mill Trace Drive	0.83 acres				Х			Х	1											
Hidden View Pond	51 S. Hidden View Circle	0.50 acres			Х	Х															
Hullwood Pond	100 1/2 W HULLWOOD DR	5.14 acres				Х					Х										
Kayak Ridge	12 1/2 KAYAK RIDGE DR	4.25 acres						Х			Х										
Kirpatrick Glen	22 E BLACK KNIGHT DR	1.54 acres			_	-		-	+		-							-	-		
Laka Dalama	6535 CREEKSIDE FOREST DR	75.00										Y									
Lake Paloma	145 Feeder and The	75.00 acres							1			*									
Lake Robbins	Woodlands Mall	13 26 acres												X***							
Long Lake	271 Split Rock Road	2.00 acres		X**										~							
Marquis Oaks	1 Marquise Oaks Place	0.60 acres				Х				1									Х		
Mason Pond	1 Mason Pond Place	1.00 acres																			
Meadowlake	9501 N. Panther Creek Drive	0.99 acres																			
Mel Killian	187 N. Tranquil Path	2.11 acres	v	V**		X			-	-									-	Manitas DO faras luna ta August	
Olmstood		0.75 acres	^	X						-						-	-	1	-	Monitor DO from June to August	
Pastoral Pond	105 Red Sable Drive	4 29 acres																			
Pepperdale	17 N. Pentenwell Circle	2.10 acres							1		х										
Player Bend Pond	85 LAKESIDE GREEN	2.00 acres								1											
Reedy Pond	4727 Woodlands Parkway	3.65 acres											Х							Herbicidal control of Chinese Tallow	
	6055 CREEKSIDE FOREST DR																				
Rob Fleming		1.00 acres																			
Shadow Lake Marsh	10 E Shadownoint Drive	2 12 acres		V**	X	X	X			-					X	-	-		-		
Somerset	27 Somerset Pond Place	0.88 acres		A * *			^		1						^						
Somersee	11434 W BRANCH CROSSING	0.00 40103									1						-				
Spindle Tree Ponds	DR	1.54 acres				х											х				
	Stone Croft and Cochran's																				
Stonecroft	Crossing	0.30 acres																			
Summer Cloud	78 N. Summer Cloud Circle	3.00 acres				Х															
Tamarac	1300 N. Millbend Drive	0.85 acres		X**			Х														
Tamarac Mill Pond	13 Forest Steppes Court	0.35 acres													X	Х					
Tupolo Darl	13 Forest Steppes Court	1.70 acres									X **										
Ventures Tech	240 W TOPELO GREEN CIR 8402 New Trails Dr	1.00 acres				Y					Χ*										
ventures rech	UTUL NEW Halls DI.	1.00 acres				^															
Wedgewood	72 Wedgewood Forest Drive	5.54 acres																			
						\$180/1,000			•		•	•		•	•			•			
						sq.ft.(seed) to															

			\$5/1,000	\$400/1,000 sq.ft					\$500 to	\$100/1,000		\$100/1,000	
Probable Unit Cost	N/A	\$4360/acre	sq.ft.	(sod)	\$700/acre	\$150/acre	N/A	N/A	\$700/acre	sq.ft.	\$150/acre	sq.ft. ***	Self Perform

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\* = Flocculation (water clarification) should be postponed until nearby construction activities are complete \*\* = Desiltation was scheduled in May 2010 as component of five-year plan. Action is in agreement with findings from inspections. \*\*\* =Cost based on Maidencane and Spikerush Plantings (cost for bulkhead construction varies greatly)

## **Executive Summary**

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### Summary of Purpose and Methodology



### The Woodlands Township Pond and Lake Management Plan

The Woodlands Township owns and manages a system of fourty five (45) ponds and lakes for benefit of residents and visitors to this vibrant community. The Parks and Recreation Department has identified a need to create a unified management document to outline standards and practices for operation of these ponds. Burditt Consultants, LLC was hired to perform an in-depth assessment of current pond and lake conditions, and to evaluate current efforts of outside pond management services. Maintenance needs and opportunities were to be considered resulting in a plan for addressing current needs as well as those in the future.

A successful pond management program can maximize productivity and provide many hours of recreational enjoyment. Good management of ponds/lakes is critical to maintain value and function as viable ecological units. Proper pond management can reduce water loss, increase wildlife attraction for viewing, improve water quality, increase fishing enjoyment, enhance esthetics, reduce erosion and reduce mosquitos and other nuisance animal problems. Ponds are dynamic systems, but while no two are exactly alike, similar ponds contend with similar problems. Even ponds in the same watershed and built very close to each other can be very different in appearance and differences in watershed and soil characteristics are particular to each pond. Ponds need continual management and maintenance.

The ponds and lakes of The Woodlands are very important, because they address water-quality protection by acting as flood control structures and settling basins, and because they provide open space for recreation, enhance property aesthetics, education oppurtunities, increase property values and serve as wildlife habitat. It is important to remember these ponds are not natural but "man" made and therefore "management" is necessary to maximize these benefits.

Since 1997, Lake Pro, Inc. a professional lake management service company, has been contracted by The Woodlands to ensure the health and well being of the ponds and lakes that they remain a vibrant part of the local ecosystem. Lake Pro, Inc. provides a wide variety of management services including pond and lake maintenance services through four site visits per month to monitor water quality, aquatic vegetation assessments and recommendations, vegetation treatments, water quality analysis, fountain installation and repair, and trash and debris removal. In addition, on an annual basis, they provide fishery surveys, fish stocking recommendations and fish stocking. By monitoring and treating ponds on a weekly basis, they can control unwanted vegetation, keep equipment operating properly and treat potential water quality problems. This program is flexible so that fishing and management operations can be undertaken depending on pond development and the desires and dictates of The Woodlands Township.

The process undertaken for this management plan involved on-site inspections of each pond and lake to evaluate current water quality conditions, bank conditions, vegetation growth and wildlife. Any current and forseeable maintenance concerns were noted, as well as opportunities for enhancement. A total of ten (10) ponds were selected from a stratified list of ponds and lakes based on size and age. These ten ponds were tested on site to determine if water chemistry was within normal range, and water samples were collected for analysis at the Texas A&M University Soil, Water and Forage Laboratory. Results from these tests were evaluated against available data from Lake Pro, Inc. to determine any possible maintenance concerns.

This plan is broken into the following components:

#### Assessment of Current Management Practices

An evaluation of managment practices to date and highlighted results from pond inspections.

**Pond Profiles and Management Recommendations** Site observations and recommendations for each pond and lake.

#### Wildlife

General biology and management tools for fish and wildlife.

#### Environment

Background information and tools for managing water quality, maintaining healthy vegetation populations and ecological services provided by the ponds and lakes.

#### People

Discussion about educational opportunities, accessibility and public participation.



### Assessment of Current Management Practices



### The Woodkinds Township Pond and Lake Management Plan

### Assessment of Current Management Practices

Along with site-specific evaluation of each individual pond and lake, the overall management practices for the pond system were assessed based on site observations, discussions with Township staff and review of data from Lake Pro, Inc. the pond and lake maintenance contractor. Particular areas of interest when evaluating management practices are *water chemistry, water clarity, water levels, bank conditions, and wildlife populations.* Upon review of all available data, water samples, and on-site range testing of water chemistry; we have concluded that overall maintenance of the ponds and lakes is of high quality. Following are general findings and recommendations regarding the current pond and lake management program.

#### Water Chemistry

Managing key parameters of water chemistry in an urban/suburban setting is a challenging task. There are many potential sources of pollution, nutrient overloading, and siltation including surface runoff from residential streets, major thoughfares and commercial parking lots, overuse of fertilizers and pesticides in landscapes and siltation from construction activities. The most frequent observation made during inspection of the ponds was siltation from construction activities. Key parameters tested in the laboratory fell within the normal range with the exception of four ponds having slightly elevated levels of phosphorous. Phosphorous levels are usually elevated by accumulation of phosphates from fertilizers when they are improperly applied at above-normal quantities. Rainwater washes excess fertilizer into surface runoff or storm sewers that in many cases end up being deposited into local ponds. Levels of phosphorous above 0.1 ppm (parts per million) may cause alge blooms in still waters. The ponds found to have elevated phosphorous levels were in the lower range of this spectrum and do not present cause for alarm at present concentrations.

	SAMPLE PONDS WATER ANALYSIS RESULTS													
SOIL, WEATER AND FORAGE TESTING LABORATORY - TEXAS A&M UNIVERSITY														
LABORATORY RESULTS	SAMPLE NUMBER	1	2	3	4 5		6	7	8	9	10			
	UNITS	CAPSTONE	ALDEN BRIDGE	DEEPDALE	DEER RUSH	REEDY	MEL KILLIAN	COPPER SAGE	LAKE PALOMA	TAMARAC	OLMSTEAD			
CALCIUM (CA)	ppm	8	8	8	6	13	6	19	14	7	11			
MAGNESIUM (Mg)	ppm	2	1	2	2	2	2	3	3	1	3			
SODIUM (Na)	ppm	64	22	29	55	23	22	33	32	26	57			
POTASSIUM (K)	ppm	5	5	5	5	4	5	5	7	3	7			
BORON (B)	ppm	0.09	0.05	0.06	0.09	0.05	0.06	0.07	0.08	0.06	0.08			
CARBONATE (CO3)	ppm	0	0	0	0	0	0	0	0	0	0			
BICARBONATE (HCO3)	ppm	155	62	69	152	88	80	113	108	84	168			
SULFATE (SO4-)	ppm	8	7	5	3	1	4	1	7	3	7			
CHLORIDE (CI-)	ppm	46	24	30	28	23	18	32	27	14	25			
NITRATE-N (NO3-N)	ppm	0.01	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01			
PHOSPHOROUS (P)	ppm	0.1	0.15	0.11	0.04	0.01	0.07	0.01	0.01	0.05	0.1			
рН		7.54	6.8	6.8	7.32	7.09	6.74	7.1	7.17	6.93	7.17			
CONDUCTIVITY	umhos/cm	283	126	173	270	164	133	246	226	149	318			
HARDNESS	grains CaCO3/gallon	2	2	2	1	2	1	3	3	1	2			
HARDNESS	ppm CaCO3	28	26	26	23	39	22	58	46	22	39			
ALKALINITY	ppm CaCO3	127	51	57	124	72	66	93	88	69	138			
TOTAL DISSOLVED SALTS (TDS)	ppm	288	130	148	250	154	138	205	198	139	279			
SAR		5.3	1.9	2.4	5	1.6	2.1	1.9	2.1	2.4	4			
			* may cause algae bloc	oms										

\* normal/safe range

Laboratory analysis of water samples from ten ponds indicate normal ranges for all chemistry except phosphorous. It should be noted that these ponds showed only slightly higher levels of phosphorous that pose no immediate threat of algae blooms considering the level of maintenance performed by the contractor.



### Assessment of Current Management Practices



### The Woodlands Township Pond and Lake Management Plan

#### Water Levels

Water levels in most of the ponds and lakes were observed to be normal or slightly lower than normal at the time of inspection. With a particularly dry summer, it is not uncommon for such a pattern. Ponds noted to have particularly low water levels included Tamarac Mill Pond, and Marquis Oaks. Tamarac Mill Pond was low enough to expose storm drainage pipes that supply water to the ponds during heavy rain events. The most likely cause of water loss at these ponds is weather conditions. Marquis Oaks Pond, by the accounts of nearby residents, has regularly had low water levels that may be caused by leakage into the adjacent drainage easement. Monitoring levels at these ponds over time is recommended.

The Woodlands is tasked with maintaining acceptable water levels in the lakes and ponds for multiple objectives including pond biological health, vegetation management and aesthetics. When water levels are too low, shallow areas of the pond (usually less than three feet deep) allow sunlight to reach the bottom, thereby encouraging growth of aquatic vegetation. Excessive vegetation can becomed difficult to control in large quantities. Low water levels also allow for excessive loading of contaminants such as ammonia which are harmful to fish. In addition to pond health and maintenance issues, low water levels are often considered unsightly by residents and visitors.

While maintaining minimum water levels in the lakes and ponds is important, water conservation is an important concern. The Woodlands currently pumps water into 28 ponds from The Woodlands water supply and 9 ponds from water wells. The Lone Star Ground Water Conservation District has agreements with The Woodlands to allow for use of 9.0 million gallons of water per year from the wells to maintain the levels of the ponds. Conservation of ground water is one of the most important issues in the region and throughout the State, and is a key concern to The Woodlands with regards to the management of the lake and pond system. Given the need to conserve use of ground water, it may be prudent to adopt a policy of allowing ponds to draw down to an acceptable level without refilling from the water source, with the understanding that they will be naturally recharged within a two to three months during normal weather conditions. Ponds that would be able to handle such drops in water level without suffering serious impacts are those that do not have shallow shelves near the banks. These shelves are typically only a few feet deep during normal conditions and would be exposed with any significant loss of depth. A policy of allowing pond levels to drop to as low as 75% of their normal levels should be tolerable provided they are monitored for any signs of excessive vegetation growth or fish die-offs. Such a policy should be reviewed annually to determine if adjustments are needed.

#### **Bank Conditions**

The ponds and lakes of The Woodlands display regularly maintained banks primarily consisting of turfgrass and trees with occasional patches of emergent aquatic vegetation. No significant overgrowth of vegetation was noted, in most cases the emergent plants offer many benefits to the pond ecosystem and community at large. In should be noted however that bank vegetation such as Cattails, though often beneficial to the pond ecosystem, can rapidly spread along the banks and become problematic. Routine monitoring of bank vegetation is recommended. The most frequent observation of bank conditions was the erosion of turfgrass in areas where ducks tend to congregate and feed on the grass, and in areas of high foot traffic or steeper slopes. Submerged and floating aquatic vegetation were adequately being controlled through regularl treatments of herbicides and algacides with no significant growth noted.

#### Wildlife Populations

Wildlife populations are an important component of a pond or lake ecosystem. They provide numerous benefits in terms of balancing the food chain, controlling vegetation, and providing recreational opportunities for visitors. Fish and bird species are the most common topics of discussion about wildlife, and they are the most visible members of the pond or lake community. However, a well-balanced fish population is also a great indicator of overall pond health. The Woodlands has a fish study conducted annually to monitor the population size and health and to determine prescripted treatments needed such as stocking and relocation.

Migratory and domestic ducks are found periodically if not daily at most of the ponds and lakes in the community. Waterfowl perform a service to pond and lake ecosystems by controlling vegetation grown. Additionally, these birds add to the overall aesthetics of a pond and are a popular object of observation and enjoyment by visitors. In almost all cases during inspection, the ducks seemed oblivous to human presence and spent their time swimming and feeding around the pond. Problems can arrive when visitors feed the ducks, because they become dependent on people and in some cases become a nuisance. Observations at Hidden Lake Pond indicated that excessive feeding of ducks had occurred, resulting in a needy population that followed visitors everywhere they went. This can be a source of conflict for some people, therefore feeding is to be discouraged. It was noted that park signage at the ponds clearly requests that ducks not be fed, in order to allow them to feed naturally as a member of the pond ecosystem and to prevent overpopulation. As a general rule, human foods such as breads, crackers, and other refined foods are not health for waterfowl and can create weight problems and disease.









### The Woodlands Township Pond and Lake Management Plan

### Each pond and lake managed by The Woodlands was inspected to identify current water quality, bank conditions, wildlife populations, maintenance needs and opportunities for enhancement. The following pond profiles detail the observations made during the inspection and recommendations for addressing current and long-term maintenance needs. These pond profiles serve as a "snapshot" of current conditions and a baseline for reference in future management. Ten ponds and lakes were randomly selected from a stratified list based on size and age for on-site range testing of water chemistry and collection of water samples for laboratory analysis. Sample ponds are identified on their profile page with a microscope icon labeled "Sampled Pond". Profiles are arranged in alphabetical order by







# The Woodkinds Township

### Pond and Lake Management Plan

### Alden Bridge Pond

Location: 7525 Alden Bridge Drive Size: 3.17 acres

Conveyance Date: 8/4/1995

Water Source: Stream

#### **General Observations**

The pond was inspected on a 09/22/10, a sunny to partly cloudy day with hot, humid weather. The water color was brown to clear, with moderate turbidity. Water level was normal for the lower pond and slightly low ( a few inches) in the upper pond. Observed wildlife included minnows and clams. A fish kill occurred on the morning of the inspection, requiring Parks Department staff to remove a few hundred dead fish. Reports from a nearby resident indicated that the fish were sucking air at the surface of the water in the early morning hours. On-site testing of dissolved oxygen levels indicated that the cause of the fish kill was low oxygen levels, a common occurrence in hot, still summer mornings when no photosynthesis is occurring throughout the night while fish and invertebrates continue to respire. The fish kill occurred only in the lower pond, where it was noted that very little water was trickling over the dam. The water flowing over the dam acts as a source of aeration during normal and wetter months. Bank conditions are maintained turfgrass, low slopes and occasional forested edges. Aquatic vegetation growth was determined to be at healthy levels, providing good structure for fish species and maintaining water clarity.

#### Management Recommendations

The overall condition of Alden Bridge Pond is healthy. With normal to slightly low water levels in the upper pond, there is still a very shallow area near the bulkhead of the swimming pool complex. This indicates that siltation from the creek has reduced the depth of the pond to some degree. It is recommended that this pond be de-silted in the near future to improve depth, water quality, fish habitat and control potential aquatic vegetation overgrowth. Parks Department staff have indicated that the pond is currently scheduled for de-siltation pending funding in the future. To prevent fish kills in the lower pond, a recirculation pump could be installed to carry water from the lower to upper pond, thereby allowing for aeration as the water falls over the dam. The upper pond appears to receive adequate aeration from aquatic vegeation and creek flow.



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Sampled Pond

#### **Noted Bank and Aquatic Vegetation**

St. Augustine Grass

Pennywort

Drummond Rattlebox

Southern Waxmyrtle

Filamentous Algae

Planktonic Algae

Loblolly Pine

Little Bluestem

Alligator Weed

Creeping Water-Primrose

Coastal Water Hyssop

Spikerush

Smartweed

Baldcypress

Maidencane

Sedges

Common Reed

**Noted Wildlife** 

Fish species



Fish kill in lower pond likely caused by low dissolved oxygen levels in the early morning hours.



View of upper pond near the bridge.



View of lower pond.



## The Woodlands Township Pond and Lake Management Plan



∃Feet 0 50 100 200

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# The Woodlands Township

### Pond and Lake Management Plan

### Alden Woods Pond

Location: 5300 Alden Woods Drive Size: 0.55 acres

Conveyance Date: 3/24/1994

Water Source: Meter

#### **General Observations**

The pond was inspected on a 09/15/10, on a sunny, clear, hot, humid day. Water color was clear to dark brown with low turbidity. Water level was found to be normal to slightly low (approx. 8 inches). Bank conditions were generally good with maintained turfgrass and small patches of eroded turfgrass near the treeline due to compacted soils (possibly foot traffic).

#### Management Recommendations

Alden Woods Pond is in healthy condition with an apparently balanced population of fish species in several size ranges, along with turtles, invertebrates and aquatic vegetation. Overall water quality indicates little need for improvement. The eroded turfgrass areas can be remedied by topdressing the soil with sand to provide as substrate for the St. Augustine grass to re-establish itself through stoloniferous growth.



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#### **Noted Bank and Aquatic Vegetation**

Coastal Water Hyssop Pennywort St. Augustine Grass Loblolly Pine Filamentous Algae Planktonic Algae **River Birch** 

**Noted Wildlife** Minnows Bluegill Perch Largemouth Bass Turtles



Mild erosion of turfgrass possibly due to compacted soils from foot traffic.



Coastal Water Hyssop and Pennywort provide for better water quality while filtering storm runoff.



Several Red-ear Turtles observed on site



## The Woodlands Township Pond and Lake Management Plan



27, 1, (F) - (T) - (T) - (F)

Alden Woods Pond 5300 Alden Woods Drive



\_| Feet 100 50 0

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# The Woodlands Township

### Pond and Lake Management Plan

### **Bear Branch Pond**

Location: 5200 Research Forest Drive

Size: 0.50 acres

Conveyance Date: 12/22/1992

Water Source:

#### General Observations

Meter

The pond was inspected on a 09/14/10, on a sunny to partly cloudy, hot, humid day. The water color was found to be clear to dark green with moderate turbidity. Water level was at normal levels. Significant growth of watermeal on the surface was noted. Bank vegetation covers all edges providing good structure and shade, though may inhibit recreational uses of the pond to some degree. No aeration is present, and installation may prove impractical due to location of the pond. Some moderate erosion of the bank was noted near the disc-golf basket due to heavy foot traffic.

#### Management Recommendations

Bear Branch Pond is in overall healthy condition and well-established. Control of bank and aquatic vegetation is recommended to encourage recreational use and prevent overgrowth of Smartweed and Alligatorweed in some areas. Lake Pro has been regularly controlling aquatic vegetation with copper sulfate crystals, but additional treatments may be necessary. Topdressing the turfgrass near the disc-golf basket will encourage regrowth of bermudagrass to control erosion. Bermudagrass can be overseeded in the spring to improve density and establishment. A broken willow tree was noted along the bank that should be removed to improve aesthetics.

### **Noted Bank and Aquatic Vegetation**

Coastal Water Hyssop Smartweed **Black Willow** Watermeal Planktonic Algae Bermudagrass Southern Waxmyrtle Chinese Privet Baldcypress Chinese Tallow Alligatorweed Drummond Rattlebox

### Noted Wildlife

Freshwater Clams Minnows Frogs Turtles





Control of bank vegetation would open up the pond to more recreational opportunities.



Moderate to heavy watermeal growth on the water surface.



Heavy growth of smartweed at one end of pond. Mechanical or herbicidal control is recommended

Moderate bank erosion due to disc-golf foot traffic.



## The Woodkinds Township Pond and Lake Management Plan



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Bear Branch Pond 5200 Research Forest Drive



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February 2011





# The Woodlands Township

Pond and Lake Management Plan

### **Capstone** Pond

Location: 159 Capstone Circle

#### General Observations

The pond was inspected on a 09/22/10, on a partly cloudy, hot, humid day. Water color was clear and dark with a slightly brown tint due to tannic acids from the nearby pine trees. Water level was slightly low (6 inches). Water samples were collected for analysis per random pond selection. On-site range water analysis indicates nitrate levels were low (safe), nitrite levels were normal, hardness level was considered soft and alkalinity levels were ideal. Dissolved oxygen levels were considered healthy and pH levels normal. Lab tests indicated that the phosphate levels were slightly elevated and could result in increased algae growth. Bottom conditions were sandy with a layer of pine needles. Overall the pond is considered well-established and healthy.

#### Management Recommendations

Overall conditions at Capstone Pond are good. Water levels are typical of this year's drought conditions and warrant no concern. Water quality and vegetation patterns are healthy and normal. The pond is frequented regularly for recreational purposes and is well-maintained. No recommendations are offered at this time.



### **Noted Bank and Aquatic Vegetation**

Coastal Water Hyssop Widgeon Grass Loblolly Pine Sweetgum Southern Waxmyrtle St. Augustine Grass Bermudagrass **Black Willow** 

**Noted Wildlife** Minnows Frogs

Size: 0.83 acres

Conveyance Date: 5/25/1994

Water Source: Meter



Sampled Pond



Slightly low water levels (6 inches) at the end of summer typical of a dry summer.



Healthy population of Widgeon Grass provides excellent fish structure and a food source for waterfowl



Stormwater outfall manages excess water during high rain events.



## The Woodlands Township Pond and Lake Management Plan



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Capstone Pond 155 Capstone Circle



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February 2011





# The Woodlands Township

### Pond and Lake Management Plan

**Clover Pond** 

Location: 187/207 N. Mill Trace Size: 0.82 acres

Conveyance Date: 3/7/1991

Water Source: Meter

#### General Observations

The pond was inspected on a 09/15/10, on a sunny to partly cloudy, hot, humid day. Water color was clear to dark brown with low to moderate turbidity. Water levels were normal. Bank conditions are a mixture of maintained turfgrass and mixed aquatic and terrestrial vegetation. Bottom conditions were sandy with minor accumulation of detritus. Some invasive plant species were noted, however no significant population of any species warrants control at this time. Overhanging tree branches and submerged logs and cypress knees offer good structure for fish species. A mild algae bloom had accumulated on approximately 1/8th of the pond surface.

#### Management Recommendations

Overall conditions at Clover Pond are good. Bank vegetation is healthy and not overgrown, thereby providing benefits to the pond ecosystem. Scattered invasive species such as Chinese Tallow, Common Privet, and Alligatorweed were noted, but they are considered trace occurrences that do not warrant control measures. Other plants such as Cattails can become a nuisance if they are not controlled as well. Monitoring of significant expansion of any plant species is recommended. The algae bloom occuring at the time of inspection was temporary and kept under control by Lake Pros' monthly treatment of copper sulfate (when needed). No further maintenance considerations exist at this time.



### **Noted Bank and Aquatic Vegetation**

Coastal Water Hyssop Primrose Willow-Baccharis Goldenrod Baldcypress Yellow Sedge St. Augustine Grass Filamentous Algae Planktonic Algae Southern Waxmyrtle Peppervine Vasey Grass Chinese Tallow **Common Privet** Red Mulberry Yaupon Cattail Alligatorweed Smartweed Spikerush

**Noted Wildlife** 

Largemouth Bass Minnows Turtles



Algae accumulation on the water surface. This bloom is mild and can be controlled with copper sulfate treatment.



Stormwater outlet maintains water level by preventing overflow during heavy rain events.



Diverse bank vegetation providing structure, bank stabilization, and stormwater quality.



## The Woodlands Township Pond and Lake Management Plan



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February 2011

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# The Woodlands Township

Pond and Lake Management Plan

### **Cokeberry Pond**

Location: 1829 Nursery Road

#### General Observations

The pond was inspected on a 09/16/10, on a sunny to partly cloudy, hot, humid day. Water color was clear and dark with low to moderate turbidity. Water levels appeared to be 1 to 2 ft. lower than normal. Bank conditions were good, with well-maintained turfgrass lawns comprising the majority of bankline. Public-access is limited to to park entrances, one of which has a viewing platform and benches. Some minor erosion was noted on one park area due to foot traffic. Overall health of the pond is good. Filamentous algae were noted in light accumulation along the banks and suspended within the water column in a healthy population.

#### Management Recommendations

Overall conditions at Cokeberry Pond are good. Resident complaints of unsightly cypress knees are largely aesthetic in nature. Baldcypress trees naturally produce 'knees' in moist to inundated soil conditions in order to adequately absorb oxygen into their root systems through the use of specialized root cells called aerynchyma, which act somewhat like snorkels. Remedies for this problem include topdressing the knees with sand to lessen their visibility and removal via cutting or grinding. Removal of knees causes some minor damage to the root system of the tree, however studies and experience generally show that the effects are insignificant to overall tree health. Soil erosion along the bank should be addressed via topdressing the affected area with sand to provide a substrate for turf establishement and sodding or overseeding with turfgrass.



**Noted Bank and Aquatic Vegetation** 

Coastal Water Hyssop Baldcypress Filamentous Algae Live Oak St. Augustine Grass Iris Loblolly Pine Yaupon Cattail Planktonic Algae

**Noted Wildlife** 

Ducks Minnows Frogs Perch

Size: 3.91 acres

Conveyance Date: 5/19/1992

Water Source: Well

February 2011



Cypress knees growing along the bank have resulted in complaints from some residents due to their unsightly nature.



Minor erosion in the park area due to foot traffic. The affected area should be topdressed with sand and sodde or overseeded with turfgrass.



Banks along the pond are primarily wellmaintained private residential landscapes.



## The Woodlands Township Pond and Lake Management Plan



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February 2011

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# The Woodlands Township

Pond and Lake Management Plan

### **Copper Sage Pond**

Location: 75 S. Golden Sage Circle

#### General Observations

The pond was inspected on a 09/24/10, on a cloudy, hot, humid day. Water color was a clear to green with low turbidity. Water level was normal. Water samples were collected for lab analysis, and on-site range sampling indicated that nitrate and nitrite levels were in the safe range, hardness levels were characterized as soft, alkalinity was ideal, pH levels within range and ideal dissolved oxygen levels. The majority of the banks were composed of maintained turfgrass with occasional trees and emergent aquatic plants. Access to the property was excellent with walking paths along one side.

#### Management Recommendations

Overall conditions at Copper Sage Pond are excellent. No aeration exists, yet dissolved oxygen levels are ideal, indicating a healthy pond ecosystem when all other factors are considered. Aquatic and bank vegetation exist in small populations with no present need for additional control measures beyond those provided by Lake Pro. Detritus (decaying organic matter) has accumulated to a minor degree on the pond bottom. A substantial portion of the detritus is likely due to lawn clippings blowing into the water during routine maintenance operations, as was noted during the inspection. Solutions to this problem include bagging the clippings or using mulching-mowers, however neither is likely practical due to excessive costs.



### **Noted Bank and Aquatic Vegetation**

Pickerelweed Filamentous Algae Coastal Water Hyssop Cattail Loblolly Pine Sweetgum Chinese Tallow Pennywort St. Augustine Grass Sedges Yaupon Smartweed

#### Noted Wildlife

Ducks Snowy Egret Frogs Minnows Turtles

Size: 2.04 acres

Conveyance Date: 3/14/1991

Water Source: Well



Sampled Pond



The Snowy Egret is a common visitor to ponds within The Woodlands.



Domestic ducks are a common sight at Copper Sage Pond.



Cattails along the bank near the road provide excellent filtration of stormwater runoff during heavy rain events.



## The Woodlands Township Pond and Lake Management Plan



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February 2011

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# The Woodlands Township

Pond and Lake Management Plan

### **Creekwood Pond**

Location: 3383 S. Panther Creek

#### General Observations

The pond was inspected on a 09/16/10, on a sunny to partly cloudy, hot, humid day. Water color was clear to green with low turbidity. The water level was a few inches below normal, a common condition for this time of the year. Bank conditions were good, with maintained turfgrass comprising the majority of edges. Submerged vegetation populations were healthy.

#### Management Recommendations

Overall conditions at Creekwood Pond are good. Aquatic and bank vegetation populations are currently under control, and evidence of recent treatment was noted. Fish populations seem to be balanced. Lawn clippings from string trimmers have been collecting in the water and creating excessive buildup of detritus on the bottom. Long-term accumulation of detritus would require desiltation efforts to remedy.



**Noted Bank and Aquatic Vegetation** 

Planktonic Algae St. Augustine Grass Baldcypress Filamentous Algae Cattail Coastal Water Hyssop American Beautyberry Maidencane Nutsedge Southern Naiad

### **Noted Wildlife** Frogs Minnows Ducks Snowy Egret Perch Largemouth Bass Turtles Catfish

Size: 1.65 acres

Conveyance Date: 5/10/1977

Water Source: Meter



Cattails along the bank of the pond provide excellent habitat for amphibians and invertebrates and filter contaminants from the water, though they must be kept under control to prevent excess growth.



Muscovy ducks, native to S. America, have migrated into Texas waters. Some Muscovies take up permanent residence in local ponds.



Grass clippings from lawn maintenance operations can create excessive accumulation of organic matter. Planting additional emergent aquatic vegetation can aid in the prevention of lawn clippings entering the water.



## The Woodlands Township Pond and Lake Management Plan



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Creekwood Pond 3383 S. Panther Creek Drive



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February 2011





# The Woodlands Township

Pond and Lake Management Plan

### **Cypress** Lake

Location: 7250 Alden Bridge Drive

#### General Observations

The pond was inspected on a 09/14/10, on a sunny, clear, warm day. Water color was clear to green with low turbidity. Water levels were normal and bank conditions were good. Bank and aquatic vegetation are providing for excellent water clarity and structure. Mantaining some quantities of algae and other aquatics several feet out into the water is encourage to sustain ecosystem quality.

#### Management Recommendations

Cypress Lake is a healthy ecosystem with a proper balance of plant and animal species and water quality. Current management practices to maintain bank and aquatic vegetation appear to be successful. No further recommendations are warranted at this time.



**Noted Bank and Aquatic Vegetation** Southern Waxmyrtle

**Black Willow** Chinese Tallow Filamentous Algae Planktonic Algae Baldcypress Cattail Smartweed Southern Naiad Sweetgum Loblolly Pine Blackberry Common Persimmon Sedges Spikerush St. Augustine Grass Jasmine Coastal Water Hyssop

#### **Noted Wildlife**

Largemouth Bass Ducks Minnows

Size: 1.89 acres

Conveyance Date: 6/12/1997

Water Source: Meter

February 2011



Healthy levels of aquatic vegetation growth provide excellent duck forage and structure for fish specis.



Overhanging Baldcypress and Willow branches give fish shade during the summer months and structure for feeding and protection.



Cypress Lake has a well-established population of sumerged plants such as Southern Naiad and watermilfoil that help maintain water clarity and provide forage and cover for fish and wildlife.



## The Woodkinds Township Pond and Lake Management Plan



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February 2011

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# The Woodlands Township

Pond and Lake Management Plan

### **Deer Rush Pond**

Location: 4601 Rush Haven Drive

#### **General Observations**

The pond was inspected on a 09/24/10, on a sunny to partly cloudy, hot, humid day. Water color was as clear green with moderate to high turbidity. Water level was normal. A fountain provides adequate aeration to support fish populations. Wilflife observed includes minnows, turtles and a water snake. The banks are primarily composed of maintained turfgrass. Onsite range tests of nitrates, nitrite, hardness and alkalinity were at normal levels. Dissolved oxygen levels were ideal.

#### Management Recommendations

Deer Rush Pond is a healthy pond ecosystem. Current maintenance practices are succesfully controlling vegetation growth and providing good fish habitat. This pond is well established. Due to the age of the pond, it is recommended that a depth study be performed to determine the level of sedimentation that has occurred over the years.



Noted Wildlife None



Size: 0.53 acres

Conveyance Date: 4/15/1986

Water Source: Meter



Sampled Pond

February 2011

**Noted Bank and Aquatic Vegetation** 



Amenities such as a viewing platform, benches and a picnic table provide excellent recreational opportunities at Deer Rush Pond.



Coastal Water Hyssop growing along the water's edge helps filter stormwater and prevent erosion.



Umbrella sedge, a common wetland plant, can rapidly take over the banks of a small water body. Monitoring the growth of this plant is recommended.



## The Woodlands Township Pond and Lake Management Plan



Deer Rush Pond 4601 Rush Haven Drive

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February 2011

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# The Woodlands Township

Pond and Lake Management Plan

### **Deepdale Pond**

Location: 7500 Windvale Circle

#### General Observations

The pond was inspected on a 09/22/10, on a sunny to partly cloudy, hot summer day. The water color was dark brown with moderate to low turbidity. Water level was normal to slighly high due to recent rain. Bank conditions were good with no sign of erosion or related problems. Most banks are forested edges with aquatic vegetation with some maintained park areas. Range tests of water chemistry were within normal levels. Dissolved oxygen was at ideal levels without supplemental aeration. This pond is fed by storm drainage which can create problems with water quality due to sedimentation and pollution, however no signs of such problems were observed.

#### Management Recommendations

Deepdale Pond is in healthy condition with active populations of fish and other wildlife species. Water conditions appear to be normal and balanced. Aquatic vegetation along maintained areas of the pond should be controlled to prevent excessive growth.



**Noted Bank and Aquatic Vegetation** 

St. Augustine Grass Coastal Water Hyssop Pennywort Baldcypress **River Birch** Willow Baccharis Filamentous Algae Loblolly Pine Drummond Rattlebox Maidencane Flatsedge Goldenrod Smartweed

#### **Noted Wildlife**

Ducks Minnows Perch Turtles Snowy Egret

Size: 2.23 acres

Conveyance Date: 1/17/2001

Water Source: Storm drainage



Sampled Pond



Forested edges with aquatic vegetation attract wetland birds such as this Snowy Egret.



Aquatic vegetation growing along maintained areas of the pond may need to be controlled to improve aesthetics.



Standpipe allowing excess water to outfall to nearby bayou.



## The Woodkinds Township Pond and Lake Management Plan



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Deepdale Pond 7500 Windvale Circle



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February 2011





# The Woodlands Township

Pond and Lake Management Plan

### Entry Lake

Location: 53 S. Coppersage Circle

#### General Observations

The pond was inspected on a 09/17/10, on a sunny, hot summer day. Water color was green with moderate turbidity. Water level was normal with a storm sewer outfall to drain overflows. Bank conditions were good, with wet soil conditions due to recent rain. The pond has significant wetland vegetation growing within the water and along the banks.

#### Management Recommendations

Entry Lake hosts abundant wetland vegetation along its banks. Maintaining the vegetation at current levels is recommended in order to improve water quality. Overall condition of the pond is good, however reports indicate that the water frequently becomes cloudy after rain events, likely due to less presence of vegetation on the south side of the pond near Woodlands Parkway.



**Noted Bank and Aquatic Vegetation** 

Drummond Rattlebox Baldcypress Spikerush Sedges Smartweed Southern Waxmyrtle Water Lily Filamentous Algae Planktonic Algae Pickerelweed Pennywort Coastal Water Hyssop Dewberry Cattail Little Bluestem Alligatorweed American Lotus Waterleaf Goldenrod

**Noted Wildlife** Frogs

Size: 0.25 acres

Conveyance Date: 8/24/1990

Water Source: Meter

February 2011



Entry Lake has a rich diversity of wetland vegetation providing ideal habitat for resident and migratory waterfowl.



The south bank of Entry Lake is immediatly adjacent to Woodlands Parkway and reportedly receives significant sediment during rainfall events.



Emergent wetland plants such as Waterleaf are welcome additions to the landscape that assist in improving water quality through removal of pollutants.



## The Woodlands Township Pond and Lake Management Plan



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Entry Lake 53 S. Coppersage Circle



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February 2011





# The Woodlands Township

Pond and Lake Management Plan

### **Evergreen Pond**

Location: 950 Evergreen Circle

#### General Observations

The pond was inspected on a 09/15/10, on a sunny to partly cloudy, hot summer day. Water color was clear to dark brown with low turbidity. Water level was normal. Bank conditions were good with a majority of the edges in maintained turfgrass. The pond has excellent recreational opportunities with good access and a pavilion/picnic area available. It was noted that this pond has a liner installed, however it could not be located, and is likely buried under sand, silt and debris.

#### Management Recommendations

Evergreen Pond is one of the older, well-established ponds within The Woodlands. Current conditions are good with no additional maintenance needs. As with most of the ponds in the community, lawn maintenance operations routinely result in an accumulation of grass clippings on the surface of the water. These clippings eventually lead to a buildup of detritus (dead organic matter) on the bottom that may require desiltation in the future. The pond liner was not located during inspection, however, no signs of leakage were visible. Each brand of pond liner has its own stated life expectancy, but if no leaks occur, they can remain in place for many years without issue. Most pond liner problems are the result of mechanical damage or exposure to ultraviolet light. With a layer of sand covering this liner, no UV degradation is expected.



St. Augustine Grass Sycamore Live Oak Loblolly Pine Iris Coastal Water Hyssop Southern Naiad Crepemyrtle Pennywort Filamentous Algae

#### **Noted Wildlife**

Perch Minnows Frogs Striped Water Snake



Size: 0.22 acres

Conveyance Date: 10/29/1984

Water Source: Meter



Shallow banks allow overflow from rain events to drain into the storm sewer through this weir.



Lawn clippings from recent maintenance can create excessive detritus buildup over time.



Evergreen pond hosts a substantial population of perch and minnows in all sizes.


# The Woodlands Township Pond and Lake Management Plan



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February 2011

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# The Woodlands Township

Pond and Lake Management Plan

### **Forest Lake**

Location: 4900 Shadowbend Drive

### General Observations

The pond was inspected on a 09/17/10, on a sunny, warm summer day. Water color was green and moderately turbid. Water levels were 6 to 8 inches lower than normal. Bank conditions were relatively good with the exception of some erosion due to pedestrian traffic and duck feeding. Most banks are composed of maintained turfgrass with some tree cover. The majority of the banks are residential backyards.

### Management Recommendations

Forest Lake is in good overall condition. This lake is well-established and receiving good aeration from the fountain. Algae levels are normal and provide good habitat for fish and waterfowl. Current maintenance needs are limited to re-establishment of turfgrass in the park area.



### **Noted Bank and Aquatic Vegetation**

St. Augustine Grass Common Bermudagrass Baldcypress Crepemyrtle Loblolly Pine Coastal Water Hyssop Black Willow Southern Waxmyrtle Planktonic Algae Smartweed

### Noted Wildlife

**Domestic Ducks** Muscovy Ducks Mallard Ducks Minnows

Size: 2.00 acres

Conveyance Date: 6/16/1988

Water Source: Well

February 2011



pedestrian and waterfowl foot traffic. Reestablishment of turfgrass is needed



This weir directs stormwater overflows to the storm sewer system.



Resident population of waterfowl including domestic, black, mottled, mallard and muscovy ducks.



# The Woodlands Township Pond and Lake Management Plan



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Forest Lake 4900 Shadowbend Drive



Feet 0 50 100

February 2011





# The Woodlands Township

Pond and Lake Management Plan

### Hidden Lake

Location: 105 S. Mill Trace Drive

### General Observations

The pond was inspected on a 09/15/10 on a partly cloudy warm summer day. Water color wwas clear to brown with moderate to high turbidity. Water level was normal to slightly low (6 inches). Bank conditions were good with a few areas lacking turfgrass due to shade from nearby trees. Current turbidity and algae growth favor fish production in a lake such as this, fed by supplemental aeration. A population of ducks has taken up residence at Hidden Lake. It appears that people have been feeding the ducks, as they act needy and will follow park visitors. Some parties in the neighborhood have expressed concerns regarding the number of ducks.

### Management Recommendations

Hidden Lake is in good overall condition. Maintenance needs are limited to re-establishment of turfgrass in small areas, though pruning of tree may be necessary to facilitate this. The recommended maximum duck population is no more than two to four ducks per surface acre to prevent water quality problems and damage to bank vegetation. Relocation of domestic and Mallard ducks is the usual solution for overcrowding, however these are Muscovy ducks which cannot be relocated due to a Federal Control Order under the Migratory Bird Treaty. Under the Control Order, Muscovy ducks can only be destroyed or delivered to a duck producer for food purposes.



St. Augustine Grass Watermeal Flatsedge Pennywort Baldcypress Planktonic Algae Peppervine Coastal Water Hyssop Iris Maidencane

**Noted Wildlife** Muscovy Ducks



Size: 0.83 acres

Conveyance Date: 3/7/1991

Water Source: Meter

February 2011



Baldcypress along the banks provide good structure for young largemouth bass.



Muscovy ducks, native to S. America, have naturally migrated into Texas waters. This species is becoming increasingly more common in The Woodlands.



Watermeal, a floating plant, is a choice food source for resident duck populations.



# The Woodlands Township Pond and Lake Management Plan



With the summer line

Hidden Lake 105 S. Mill Trace Drive



Feet 0 50 100

February 2011





# The Woodlands Township

## Pond and Lake Management Plan

### Hidden View Pond

Location: 51 S. Hidden View Circle

### General Observations

The pond was inspected on a 09/17/10 on a sunny to partly cloudy, hot, humid day. Water color was clear to green with moderate turbidity. Water level was normal. Bank conditions were good with most of the shoreline comprised of residential backyards.

### Management Recommendations

Hidden View Pond is in good health. Water quality is ideal for fish populations, and good structure is available for cover. There is some erosion of turfgrass near the park bench due to shade intolerance and foot traffic. Re-establishment of the grass will require top dressing the area with sand to provide viable rooting area over the compacted soil. There are no other current maintenance needs for this pond.



**Noted Bank and Aquatic Vegetation** 

St. Augustine Grass Baldcypress Planktonic Algae Watermeal Southern Waxmyrtle Water Lily

Noted Wildlife Domestic Ducks Minnows Freshwater Clams Perch

Size: 0.50 acres

Conveyance Date: 1/23/1992

Water Source: Meter

February 2011



Residential backyards comprise the majority of the shoreline.



Baldcypress trees line much of the banks providing excellent structure for fish.



Water lilies provide important cover for fish species and aid in oxygen production for the water, however care must be taken to prevent excessive growth on small ponds where they can rapidly take over in a few weeks.



# The Woodlands Township Pond and Lake Management Plan



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Hidden View Pond 51 S. Hidden View Circle



Feet 0 50 100

February 2011





# The Woodlands Township

Pond and Lake Management Plan

### Hullwood Pond

Location: 100 1/2 W. Hullwood

### General Observations

The pond was inspected on a 09/22/10 on a partly cloudy, warm summer day. Water color was brown and cloudy with high turbidity due to sedimentation. This is a newly established neighborhood and pond with recent construction contributing to the sediment problem. Turf establishment along the banks is poor in some areas and experiencing moderate erosion. Lawn maintenance crews have trimmed some of the desirable emergent wetland vegetation along the banks.

### Management Recommendations

Hullwood Pond is a young, newly-established pond in a neighborhood actively under development. Current water conditions are cloudy due to sedimentation that will be reduced over time with the growth of submerged and emergent aquatic vegetation. More immediate results can be achieved using a treatment of gypsum slurry or hydrated limestone. With a slightly alkaline pH such as with this pond, gypsum will be the most effective. Areas of poor turf establishment should be overseeded with ryegrass in the fall-spring or bermudagrass in spring-summer. Lawn maintenance crews should be advised to allow emergent wetland plants such as rushes to grow along the banks where established. Treatment methods for water clarity are provided in the Water Quality Management section of this plan.



**Noted Bank and Aquatic Vegetation** 

St. Augustine Grass Common Bermudagrass Pickerelweed Pampas Grass Baldcypress Spikerush Filamentous Algae

**Noted Wildlife** Snowy Egret

Size: 5.14 acres

Conveyance Date: 10/22/2009

Water Source: Meter

February 2011



Moderate erosion and poor turf establishment has occurred in some areas along the banks.



Lawn maintenance crews have trimmed the spikerush growing along the banks. Communication with maintenance crews may be needed to retain desirable vegetation.



Banks along Hullwood Pond are primarily fenced residential backyards. With substantial open space between yards and the water, a great opportunity exists for creation of a walking path around the pond.



# The Woodlands Township Pond and Lake Management Plan



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Hullwood Pond 100 1/2 W. Hullwood Drive



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February 2011





# The Woodlands Township

Pond and Lake Management Plan

### Kayak Ridge Pond

Location: 12 1/2 Kayak Ridge Drive

### General Observations

The pond was inspected on a 09/22/10 on a sunny to partly cloudy, warm day. Water color was brown and cloudy. Water level was normal to slightly high due to recent rains. Banks are almost entirely composed of maintained turfgrass with sporadic emergent wetland vegetation. Live and dead algae were found on all edges indicating recent herbicide/algacide treatments. Recent construction in the area, combined with a few areas of poor turf establishment are the cause of cloudy water.

### Management Recommendations

Kayak Ridge Pond is a young, newly established pond with moderately cloudy water. Water clarity can be achieved over time with further establishment of submerged and emergent vegetation. Short term solutions for water clarity can be achieved using a treatment of gypsum slurry or agricultural limestone. Treatment methods for water clarity are provided in the Water Quality Management section of this plan.

### **Noted Bank and Aquatic Vegetation**

St. Augustine Grass Cattail Baldcypress Filamentous Algae Planktonic Algae Watermeal Coastal Water Hyssop **Black Willow** Pickerelweed Sedges Coastal Bermudagrass Switchcane



Size: 4.25 acres

Conveyance Date: 10/22/2009

Water Source: Meter

February 2011



Moderate erosion and poor turf establishment has occurred in some areas along the banks.



Cloudy water at Kayak Ridge Pond is primarily due to recent construction in the area.



Cattails near the fishing pier may need to be controlled to allow use of the pier.



# The Woodkinds Township Pond and Lake Management Plan



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Kayak Ridge Pond 12 1/2 Kayak Ridge Drive



Feet 0 50100 200

February 2011





# The Woodlands Township

Pond and Lake Management Plan

### **Kirpatrick Glen Pond**

Location: 22 E. Black Knight Drive

### **General Observations**

The pond was inspected on a 09/14/10, on a partly cloudy, warm, humid day. Water color was clear to brown with moderate to low turbidity. Water level was a few inches below normal. Banks were composed of 50% natural forest edges and 50% maintained turfgrass. The pond appears to be very shallow in most areas, with the bottom visible. Recent construction of a bulkhead/retaining wall on a residential property may have may contribute to minor sedimentation of the pond, however vegetation will likely be planted soon.

### Management Recommendations

Kirpatrick Glen Pond is a newly-established pond with aquatic vegetation beginning to grow. The pond appears to be too shallow to support largemouth bass or catfish populations, however it could support bluegill perch. No management recommendations are offered at this time.

### **Noted Bank and Aquatic Vegetation**

Bermudagrass Chinese Tallow Loblolly Pine Sweetgum Creeping Water Primrose Filamentous Algae Longleaf Uniola Little Bluestem

Noted Wildlife Minnows



Size: 1.54 acres

Conveyance Date: 3/13/2007

Water Source: Meter

February 2011



Forested island in middle of pond with natural vegetation.



Recent construction of a bulkhead may contribute to minor sedimentation.



Water levels at Kirpatrick Glen Pond were a few inches low, a common occurrence within The Woodlands during late summer.



# The Woodlands Township Pond and Lake Management Plan



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Kirpatrick Glen Pond 22 E. Black Knight Drive



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February 2011





# The Woodlands Township

Pond and Lake Management Plan

### Long Lake

Location: 271 Split Rock Road

### **General Observations**

The pond was inspected on a 09/15/10 on a sunny, hot, humid day. Water color was clear and dark with low turbidity. Banks were primarily composed of residential backyards with maintained turfgrass and trees. Trees and shrubs along the banks are providing excellent structure and cover for wildlife. The water depth near the fishing pier is shallow and would require dredging to remedy the situation.

### Management Recommendations

Long Lake is in overall good condition. Water clarity and color indicate sufficient depth to support a healthy fish population. The banks and park area are well-maintained. No recommendations are made for the pond at this time.



**Noted Bank and Aquatic Vegetation** 

St. Augustine Grass Weeping Willow Filamentous Algae Planktonic Algae Baldcypress Southern Waxmyrtle Loblolly Pine Yucca

### **Noted Wildlife**

Minnows Perch Largemouth Bass Ducks

Size: 2.00 acres

Conveyance Date: 8/24/1990

Water Source: Meter

February 2011



Resident population of Muscovy and domestic ducks are actively breeding.



The majority of the bank is comprised of residential backyards, thereby limiting access to only the park areas.



Long Lake is a well-established pond with good water color and an active wildlife component.



# The Woodkinds Township Pond and Lake Management Plan



27 (1.47) average +

Long Lake 271 Split Rock Road



□\_\_\_\_ Feet 0 50 100

February 2011





# The Woodlands Township

Pond and Lake Management Plan

### Marquis Oaks Pond

Location: 1 Marquis Oaks Place

### **General Observations**

The pond was inspected on a 09/14/10, on a hot humid sunny day. Water color was brown to green with high turbidity. Water level was unusually low with exposed electrical conduit usually found underwater. Banks were primarily comprised of maintained turfgrass and occasional trees and wetland plants at the edge of the normal water line. One end of the pond is experiencing erosion due to nearby construction activities along a drainage easement. Vandalism has been reported at the viewing platform where decorative finials have been removed.

### Management Recommendations

Marquis Oaks Pond is experiencing significant sedimentation due to construction activities that will likely recede with the establishment of turgrass in affected areas. Loss of water levels appears to be the result of the hot weather conditions combined with a high-spraying fountain that loses water rapidly to evaporation. When compared to relative water levels at other ponds in The Woodlands, some suspicion arises that water losses could also be related to the construction activities at the adjacent drainage easement. Monitoring of water levels over time is recommended. Treatment for water clarity is not recommended until water levels return to normal and are stable.



### **Noted Bank and Aquatic Vegetation**

St. Augustine Grass Baldcypress Sedges Coastal Water Hyssop Willow Baccharis Eastern Redcedar Loblolly Pine Southern Waxmyrtle Water Oak Yaupon Sweetgum Creeping Water Primrose

Size: 0.60 acres

Conveyance Date: 6/28/2006

Water Source: Meter

February 2011



Water levels at this pond are unusually low. This conduit should be underwater.



Recent construction at the adjacent drainage easement has resulted in sedimentation of the pond.



Reports from local residents indicate that vandals have repeatedly removed the finials from the viewing platform at this pond.



# The Woodkinds Township Pond and Lake Management Plan



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Marquis Oaks Pond 1 Marquis Oaks Place



Feet 0 50 100

February 2011





# The Woodkinds Township

## Pond and Lake Management Plan

### Mason Pond

Location: 1 Mason Pond Place

### **General Observations**

The pond was inspected on a 09/15/10, on a sunny, clear, warm day. Water color was clear to bluegreen with low turbidity. Water level was normal to slightly low (few inches). Bank conditions were good with a mixture of aquatic vegetation, trees and maintained turfgrass.

### Management Recommendations

Mason Pond is in excellent condition. Water quality is ideal with a well-established population of aquatic vegetation that does not inhibit fish health or recreational uses. Current management activities are successful, and no further recommendations are offered at this time.

**Noted Wildlife** Frogs Largemouth Bass

St. Augustine Grass

Filamentous Algae

Planktonic Algae

Willow Baccharis

Coastal Water Hyssop

Cattail

Baldcypress Pickerelweed

Pennywort

Iris

Sedges

Maidencane



Size: 1.00 acres

Conveyance Date: 9/1/2006

Water Source: Meter

February 2011

**Noted Bank and Aquatic Vegetation** 



Cattails near the stormwater outfall help filter contaminants from rainwater prior to deposition in the storm sewer.



A trail follows on bank of the pond.



Submerged and emergent aquatic vegetation are well-established and provide improved water quality, fish habitat and bank stabilization.



# The Woodlands Township Pond and Lake Management Plan



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February 2011

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# The Woodlands Township

Pond and Lake Management Plan

### **Meadow Lake**

Location: 9501 N. Panther Creek Drive

### **General Observations**

The pond was inspected on a 09/15/10, on a sunny, clear, warm day. Water color was clear to dark green with moderate turbidity. Water level was normal. Banks were primarily maintained turfgrass with scattered aquatic vegetation. A significant algae bloom was noted covering approximately 60% of the water surface.

### Management Recommendations

Meadow Lake is in generally good condition. Bank conditions are well-maintained. The algae bloom was significant in size, but did not cause harm to fish populations. Algae blooms can be caused by any situation where sufficient nitrogen and phosphorous are available to support growth. In many residential ponds, blooms occur when excess fertilizer from lawn maintenance operations enters the pond via rainwater runoff. Current practices by the pond maintenance contractor suppress this growth using a variety of herbicides and algacides. Occasionally blooms develop so rapidly that they are not addressed until the next maintenance cycle. A key tool to limiting the occurrence of algae blooms is educating the public on the proper use of fertilizers and pesticides in the landscape. An educational ad campaign can be an effective method using mailers or flyers that are sent with the monthly water bill.



St. Augustine Grass Coastal Water Hyssop Filamentous Algae Planktonic Algae Red Maple Loblolly Pine Southern Naiad Peppervine Chinese Tallow Coastal Bermudagrass Smartweed Water Oak

### Noted Wildlife Frogs Minnows



Size: 0.99 acres

Conveyance Date: 1/25/1990

Water Source: Meter

February 2011



Large passive open areas such as this could be enhanced to provide more a park-like recreational setting such as a picnic area and/or pavilion



An algae bloom covered approximately 60% of the pond surface. This growth can be caused by excess nitrogen and phosphorous from runoff stimulating the algae.



The majority of the bank at Meadow Lake is composed of low slopes with maintained turfgrass.



# The Woodlands Township Pond and Lake Management Plan



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Meadowlake Pond 9501 N. Panther Creek Drive



Feet 0 50 100

February 2011





# The Woodlands Township

Pond and Lake Management Plan

### **Mel Killian Pond**

Location: 187 N. Tranquil Path

### **General Observations**

The pond was inspected on a 09/24/10 on a partly cloudy, hot summer day. Water color was brown with moderate to high turbidity. Water level was normal. Bank conditions were good with the exception of one area of erosion due to foot traffic and/or poor turf establishment. Banks are comprised of maintained turfgrass and forest edges. Recent nutrea activity has destroyed several young tree plantings, which have since been replaced. On-site range testing of water chemistry indicate normal levels of nitrate and nitrite, very soft water, moderate alkalinity and healthy levels of dissolved oxygent.

### Management Recommendations

Overall conditions at Mel Killian Pond are good. The aquatic environment is conducive to maintaing a healthy fish population. Areas with eroded turfgrass should be overseeded for re-establishment. New tree plantings can be protected from damage by erecting wire mesh cages around the base of the tree trunks to discourage gnawing. A trapping program is currently underway to address the nutrea problem. Current pond management activities appear to be successful, and no other recommendations are warranted at this time.



### **Noted Bank and Aquatic Vegetation**

Common Bermudagrass Willow Baccharis Coastal Water Hyssop Southern Waxmyrtle Filamentous Algae Planktonic Algae Cattail Sedges Baldcypress Chinese Tallow Sweetgum Crepemyrtle Loblolly Pine Maidencane Common Reed

### **Noted Wildlife**

Minnows Largemouth Bass Nutrea (sign)

Size: 2.11 acres

Conveyance Date: 8/12/2005

Water Source: Meter



Sampled Pond

February 2011



Several young tree plantings have been destroyed by nutrea. No beaver dams were found on site. To prevent damage to trees, wire mesh cages can be erected around the trunk to a height of three feet to discourage gnawing



Eroded turfgrass along one bank. Overseeding with ryegrass in the fall-spring or bermudagrass in the spring-summer may be necessary



Forested edges make up a majority of the banks of Mel Killian Pond.



# The Woodlands Township Pond and Lake Management Plan



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Mel Killian Pond 187 N. Tranquil Path



**□**\_\_\_\_ Feet 0 50 100

February 2011





# The Woodlands Township

Pond and Lake Management Plan

### Mystic Lake

Location: 5100 Research Forest Drive

### **General Observations**

The pond was inspected on a 09/14/10, on a sunny to partly cloudy, hot, humid day. Water color was clear and dark with low turbidity. Water level was a few inches low, but normal for the time of year. Bank conditions were good, with minor turfgrass erosion in some areas due to duck feeding and foot traffic. Bank vegetation primarily consists of maintained turfgrass with occasional trees.

### Management Recommendations

Mystic Lake is in good overall health. vegetation is currently under control and actively providing benefits to the ecosystem. Fish populations appear to be healthy and in a range of sizes. Aeration appears to be sufficient based on active fish populations observed, however reports of past fish kills indicate that additional aeration may be needed. Also reported in the past were turtle kills. Turtles do no rely on air from the water like fish, therefore some other cause is likely. In most cases, turtles die of natural causes, however without sampling tissue from the turtles or confirming total quantity of deaths, little can be determined about the true cause



**Noted Bank and Aquatic Vegetation** 

St. Augustine Grass Coastal Water Hyssop Smartweed Planktonic Algae Filamentous Algae Sweetgum Persimmon Yaupon Iris **Black Willow** Loblolly Pine

### Noted Wildlife

Ducks Minnows Perch Largemouth Bass

Size: 3.03 acres

Conveyance Date: 1/23/1992

Water Source: Well

February 2011



Waterfalls such as this one at Mystic Lake offer a water-conserving alternative to fountains for aeration. Fountains tend to spray too fine of a mist, which is easily evaporated.



Mystic Lake supports a variety of wildlife species including perch, bass, feeder fish and ducks.



Trees lining the bank provide excellent cover for largemouth bass.



# The Woodlands Township Pond and Lake Management Plan



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Mystic Lake 5100 Research Forest Drive



□\_\_\_\_Feet 0 50 100

February 2011





# The Woodlands Township

Pond and Lake Management Plan

### **Olmstead Pond**

Location: 109 East Shore Drive

### **General Observations**

The pond was inspected on a 09/27/10, on a warm, sunny day. Water color was brown with high turbidity. Water levels were normal. Banks along the entire shoreline are concrete and stone bulkheads. Aeration is provided by two subsurface diffusers. On-site range testing of water chemistry indicated a relatively high alkalinity and pH with normal levels of hardness, nitrate, nitrite and dissolved oxygen. Elevated underwater platforms provide a substrate for wetland vegetation. Submerged vegetation is actively growing along the bottom of the majority of the pond.

### Management Recommendations

Olmstead pond was built in a very formal setting with well-defined landscaping. Water quality is good and capable of supporting a small fish population, Likelihood of sedimentation from external sources is low due to the bulkheaded banks. Aeration systems installed provide ideal water conservation while achieving the desired aeration levels. No current recommendations are offered for management beyond current practices.



### **Noted Bank and Aquatic Vegetation**

Cattail Arrowhead Common Reed Southern Naiad Filamentous Algae Planktonic Algae

Size: 0.75 acres

Conveyance Date: 12/15/2004

Water Source: Meter



Sampled Pond

February 2011



Elevated underwater platforms create a shelf for emergent wetland vegetation to thrive.



Subsurface diffusers provide ideal aeration without the additional evaporative loss of water that fountains often cause.



All banks along Olmstead Pond are concrete bulkheads providing a very formal landscape.



# The Woodlands Township Pond and Lake Management Plan



141-147) - Terretoria

Olmstead Pond 109 East Shore Drive



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February 2011





# The Woodlands Township

Pond and Lake Management Plan

### Lake Paloma

Location: 6535 Creekside Forest Drive

### **General Observations**

The pond was inspected on a 09/27/10, on a warm, sunny day. Water color was brown with high turbidity. Water levels were normal. The majority of banks along Lake Paloma are residential backyards with maintained turfgrass. With recent construction adjacent to, and nearby the lake, substantial sedimentation has occurred causing cloudy water. On-site range testing of water chemistry indicated that nitrate, nitrite and alkalinitiy levels were normal. Dissolved oxygen was relatively low. Emergent wetland vegetation growing along the banks had recently been treated with herbicides.

### Management Recommendations

Lake Paloma is the largest lake in The Woodlands pond and lake system. Access to the lake is provided in park areas and directly available to residents living along the shores. The lake is young and still becoming established, and therefore is not ready to support a fish population. Water chemistry is good for fisheries, however negatively charged clay particles are suspended throughout the water column, thereby creating cloudy water, which limits algae growth and fish suitability. Primary control of this problem will be to plant/retain aquatic vegetation and enforce siltation control in nearby construction areas, especially in areas near stormwater inlets.



Common Bermudagrass Creeping Water Primrose Cattail Baldcypress Loblolly Pine St. Augustine Grass Maidencane Filamentous Algae Southern Waxmyrtle Drummond Rattlebox Bushy Bluestem Pennywort Water Lily Horned Beaksedge

**Noted Bank and Aquatic Vegetation** Minnows Snowy Egrets



Size: 75.0 acres

Conveyance Date: 2007

Water Source: Surface Water



Sampled Pond

February 2011



Recent herbicidal control of ermegent wetland vegetation is evident on some banks. Maintaining some level of this vegetation would assist in efforts to clarify the water.



Lower reaches (to the southeast) of Lake Paloma are heavily sedimented due to recent construction



Boating is one of the popular activities for residents living along Lake Paloma.



# The Woodlands Township Pond and Lake Management Plan



**Feet** 0 250 500

February 2011





# The Woodlands Township

Pond and Lake Management Plan

### **Pastoral Pond**

Location: 105 Red Sable Drive

### **General Observations**

The pond was inspected on a 09/16/10, on a sunny to partly cloudy, hot, humid day. Water color was clear to green with moderate tubidity. Water level was normal to a few inches low. Bank conditions were good and primarily composed of maintained turfgrass with occasional trees. The majority of the shoreline is lined with residential backyards. In addition to well water, the pond receives stormwater runoff from several locations and outfalls excess water to an ajdacent drainage bayou. The pond provides an important ecological service by allowing sediments from runoff to settle prior to deposition downstream.

### Management Recommendations

Pastoral Pond is in good overall condition with well-established aquatic vegetation. Water quality is ideal for managing fish populations. Bank conditions are conducive to recreational activities. No recommendations are offered for additional maintenance activities at this time.



**Noted Bank and Aquatic Vegetation** 

Common Bermudagrass St. Augustine Grass Water Lily Coastal Water Hyssop Drummond Rattlebox Baldcypress Cedar Elm **River Birch** Willow Baccharis Sweetgum Spikerush Common Reed Sedges Chinese Tallow Planktonic Algae Maidencane Alligatorweed

### **Noted Wildlife**

Minnows Frogs Great Blue Heron Snowy Egret Ducks

Size: 4.29 acres

Conveyance Date: 11/1/1993

Water Source: Well

February 2011



Banks along the lake include residential backyards and a forested island.



Like several ponds in The Woodlands, Pastoral Pond collects stormwater drainage from the surrounding community. Ponds serve an important role in reducing downstream pollution by allowing sediments from runoff to settle



Park area is available at one end of the pond



# The Woodlands Township Pond and Lake Management Plan



Pastoral Pond 105 Red Sable Drive



Feet 0 50 100 200

February 2011





# The Woodlands Township

Pond and Lake Management Plan

### **Pepperdale Pond**

Location: 17 N. Pentwell Circle

### **General Observations**

The pond was inspected on a 09/16/10, on a sunny, clear, warm day. Water color was brown to green with high turbidity. Water level was 12 to 16 inches below normal. Bank conditions were good with the majority of the shoreline covered with well-established emergent aquatic vegetation. Sediments causing turbidity appear to be from stormwater runoff and clay particles from soil used in construction of the pond.

### Management Recommendations

Pepperdale Pond is a young pond in the process of becoming established. Current conditions are favorable for recreation and aesthetics. Established vegetation will aid in clarification of the water over time. Immediate results for water clarity can be achieved through a treatment of gyspum slurry or hydrated limestone. Consultation with the pond maintenance contractor should be made prior to treatment. Nutrient levels, as reported from the pond maintenance contractor on this day were within normal range, however Township staff report past problems with nutrient overloading, likely from lawn maintenance practices of adjacent landowners. An educational program to promote safe use of fertilizers and pesticides can go a long way towards addressing this issue.



### **Noted Bank and Aquatic Vegetation**

Common Bermudagrass St. Augustine Grass Spikerush Flatsedge **Bushy Seedbox** Goldenrod Pickerelweed Smartweed Sweetgum Riverbirch Baldcypress Southern Waxmyrtle **Black Willow** Coastal Water Hyssop Loblolly Pine Water Oak Horned Beaksedge Common Reed

Noted Wildlife

Turtles Minnows

Size: 2.10 acres

Conveyance Date: 7/15/2003

Water Source: Meter

February 2011



Emergent plants such as spikerush and pickerelweed are well-established along all banks.



Aeration fountains such as this are both aesthetically pleasing and beneficial to the pond ecosystem, however the pressure should be lowered, if possible, to reduce mist formation which accelerates evaporative water loss.



Water levels is currently 12 to 16 inches lower than normal due to dry conditions and evaporative water loss.



# The Woodkinds Township Pond and Lake Management Plan



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Pepperdale Pond 17 N. Pentenwell Circle



Feet 0 50 100

February 2011





# The Woodlands Township

Pond and Lake Management Plan

### **Player Bend Pond**

Location: 88 Lakeside Green

### **General Observations**

The pond was inspected on a 09/16/10, on a sunny, clear, warm day. Water color was clear to brown with low turbidity. Water level was normal to a few inches low. Bank conditions were good and comosed of matained turfgrass and emergent aquatic vegetation with a forested island. Stormwater overflows through a large weir to the storm sewer. Aeration appears to be adequate and supporting a population of perch, minnows and largemouth bass.

### Management Recommendations

Player Bend Pond is in excellent condition. Water quality is conducive to fish management, and banks are well maintained with a mixture of formal lanscape and native vegetation. No further management recommendations are warranted for this pond.



February 2011

### **Noted Bank and Aquatic Vegetation**

Common Bermudagrass St. Augustine Grass Cattail Southern Waxmyrtle Loblolly Pine Little Bluestem Vaseygrass Chinese Tallow Baldcypress Creeping Water Primrose Coastal Water Hyssop Dogfennel Flatsedge Broomsedge Pennywort **Black Willow** Filamentous Algae Planktonic Algae Common Reed Goldenrod Horned Beaksedge Waterleaf

### Noted Wildlife

Perch Minnows Largemouth Bass

Size: 2.00 acres

Conveyance Date: 9/14/2005

Water Source: Meter



Weir draining excess stormwater to the storm sewer. Debris has collected in the grates and needs to be cleaned out to prevent obstruction.



Concrete Bulkhead provides great public access from the connecting hike and bike trail.



Banks along Player Bend Pond host a diverse variety of emergent wetland plants contributing to a healthy pond ecosystem.



# The Woodlands Township Pond and Lake Management Plan



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Player Bend Pond 85 Lakeside Green



Feet 0 50 100 200 300

February 2011





# The Woodlands Township

## Pond and Lake Management Plan

**Reedy Pond** 

Location: 4727 Woodlands Parkway Size: 3.65 acres

Conveyance Date: 8/9/1996

Water Source: Well

### **General Observations**

The pond was inspected on a 09/24/10, on a sunny to partly cloudy, hot, humid day. Bank conditions were healthy with a vibrant establishment of emergent wetland vegetation. Water color was clear to brown with moderate to low turbidity. Water level was normal. Heavy misting was noted from the aeration fountain due to high winds of of Woodlands Parkway. Range testing of water chemistry indicated that nitrate, nitrite and alkalinity levels were normal and safe. Dissolved oxygen levels were ideal for fish production. Chinese Tallow trees were noted in a large enough quantity of mature trees and seedlings to warrant control measures.

### Management Recommendations

Reedy Pond is in excellent overall condition. Conditions are ideal for fish production. Vegetation along the banks is diverse and well-established. As a recreational resource, access could be improved by developing a more defined trail connecting the adjacent neighborhood. The aeration fountain, while aesthetically pleasing, generates excessive mist during high winds, thereby creating evaporative water loss. It is advisable to lower pump pressure if available for that model. Invasive Chinese Tallow trees should be removed to prevent their spread to other areas.



**Noted Bank and Aquatic Vegetation** 

Common Bermudagrass Flatsedge Pickerlweed Willow Baccharis Giant Cane Dewberry Chinese Tallow Filamentous Algae Planktonic Algae Coastal Water Hyssop Sweetgum Southern Catalpa Baldcypress Southern Waxmyrtle **Black Willow** Pennywort Cattail Goldenrod Maidencane Vaseygrass Variable-leaf Watermilfoil Iris Alligatorweed Smartweed Common Reed

Noted Wildlife

Perch Minnows Largemouth Bass Muscovy Ducks Frogs



Sampled Pond

February 2011



Reedy Pond supports a thriving population of perch and smallmouth bass.



Heavy misting was of the fountain spray can cause excessive loss of water due to evaporation. Adjusting the pump pressure may reduce this effect if the feature is available on that fountain model.



Pedestrian traffic has created a worn trail leading to the pond from Winter Wheat Drive.


## The Woodlands Township Pond and Lake Management Plan



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Reedy Pond 4727 Woodlands Parkway



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February 2011





# The Woodlands Township

Pond and Lake Management Plan

## Lake Robbins

Location: Interstate 45 at The Woodlands Mall

### **General Observations**

The pond was inspected on a 09/17/10, on a sunny to partly cloudy, hot, humid day. Water color was clear to green/brown with low turbidity. Water level was normal. Banks are composed primarily of maintained turfgrass and formal concrete bulkheads. Bank conditions were good with the exception of an eroded area where recent construction had occurred and erosion of the south bank, likely due to wind/wave action.

### Management Recommendations

Lake Robbins is unique among ponds and lakes in The Woodlands, in that it is entirely surrounded by commercial property and a transportation corridor. Ecologically this is challenging, as the primary water source for the lake is surface runoff from parking areas. An additional source of potential pollution is from the connecting Woodlands Waterway. Little mitigation is available in a developed landscape for filtration of potential contaminants, however landscape strips within mall parking areas could be redesigned as bioswales utilizing wetland vegetation to filter stormwater. Erosion along the south bank of the lake will need to be corrected in a timely manner. This can be facilitated by use of bulkheads or plantings of emergent wetland vegetation. A bulkhead near the south bridge is begining to fail and become undermined by rainwater. It appears that the concrete sacks were not reinforced with steel.



St. Augustine Grass Baldcypress Crepemyrtle Filamentous Algae Smartweed Loblolly Pine Coastal Water Hyssop Confederate Jasmine Live Oak Chinese Tallow

## Noted Bank and Aquatic Vegetation

Minnows Domestic Ducks Perch Frogs Wood Duck Freshwater Mussels



Size: 13.26 acres

**Conveyance Date**: 1999

Water Source: Surface Water

February 2011

### Noted Bank and Aquatic Vegetation



The southern bank is experiencing significant erosion. Stabilization can be performed through bulkheads or by planting of wetland vegetation.



Construction activities adjacent to the lake have resulted in minor siltation due to poor maintenance of silt fencing.



Bulkheads near the bridge are failing and becoming undermined by rainwater. There appears to be no steel reinforcement between layers of concrete bags.



## The Woodlands Township Pond and Lake Management Plan



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February 2011

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# The Woodlands Township

Pond and Lake Management Plan

## **Rob Fleming Pond**

Location: 6055 Creekside Forest Drive

### **General Observations**

The pond was inspected on a 09/24/10, on a sunny to partly cloudy, hot day. Water color was clear to green with low to moderate turbidity. Bank conditions were excellent with emergent wetland vegetation lining the entire shore, except where a formal concrete bulkhead is installed. A viewing boardwalk reaches into the wetland area providing opportunities for educational programs and/or interpretive signage. Wildlife observed included frogs and invertebrates.

### Management Recommendations

Rob Fleming Pond is a young, but well-established pond. No fish species were observed, however stocking is recommended, due to its location within a park, adequate aeration and water quality. No further management recommendations are warranted at this time.



**Noted Bank and Aquatic Vegetation** 

Cattail Common Reed Flatsedge Pickerelweed Southern Naiad Water Lily Spikerush Horned Beakrush Water Hyacinth Smartweed Drummond Rattlebox Buttonbush Filamentous Algae Planktonic Algae Coastal Water Hyssop Primrose

Size: 1.00 acres

Conveyance Date: 2007

Water Source: Meter

February 2011



Viewing boardwalks such as this present excellent opportunities for promoting educational programs for wetlands environments.



Well-established wetland vegetation is providing excellent filtration of stormwater and habitat for a wide variety of invertebrates and smalll mammals.



Wetland species such as Horned Beaksedge are welcome residents along pond edges, providing forage for birds and serving as bank stabilization.



## The Woodlands Township Pond and Lake Management Plan



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Rob Fleming Pond 6055 Creekside Forest Drive



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February 2011





# The Woodlands Township

Pond and Lake Management Plan

## Shadow Lake Marsh

Location: 5050 Lake Woodlands Drive

### **General Observations**

The pond was inspected on a 09/17/10, on a partly cloudy, hot, humid day. Water color was green to brown with high turbidity. Water level was a few inches low. Bank conditions were good with the exception of one area of erosion adjacent to a sidewalk due to foot traffic. The bank is composed of a combination of residential, maintained park areas and natural vegetation. A boardwalk with pier is located within the park area allowing visitors to enjoy interpretive signage regarding local flora and fauna.

### Management Recommendations

Shadow Lake Marsh is an older, established pond with few maintenance needs. Test results from the pond maintenance contractor indicate normal levels of nutrients and oxygen and safe levels of ammonia and nitrite. Given the age of the pond, depth study is recommended to determine the level of sedimentation. Erosion near the sidewalk should be repaired by topdressing the affected area with sand and overseeding with grass. Some graffiti was noted on interpretive signage that will need cleaning or replacement.



**Noted Bank and Aquatic Vegetation** 

Coastal Water Hyssop Water Lily Swamp Crinum Baldcypress Pennywort Common Bermudagrass Chinese Tallow Southern Waxmyrtle Smartweed Loblolly Pine Yaupon Chinkapin Oak Buttonbush Common Reed

### Noted Wildlife

Minnows Turtles Freshwater Mussels

Size: 5.43 acres

Conveyance Date: 10/3/1984

Water Source: Water Well



Viewing boardwalks with interpretive signage add to the experience at Shadow Lake Marsh.



Banks along the marsh are a mixture of residential backyards, maintained park areas and natural/restored marshland.



Minor erosion has occured along the sidewalk in the park area due to foot traffic. Topdressing with sand and overseeding with grass will restore this area and reduce erosion.



## The Woodlands Township Pond and Lake Management Plan



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Shadow Lake Marsh 5050 Lake Woodlands Drive



Feet 0 50 100 200

February 2011





# The Woodlands Township

Pond and Lake Management Plan

## **Shadowpoint Pond**

Location: 19 E. Shadowpoint Drive

### **General Observations**

The pond was inspected on a 09/15/10, on a sunny, clear, hot summer, humid day. Water color was clear to green with moderate turbidity. Water level was normal. Banks are primarily composed of maintained turfgrass. Banks within the park area are experiencing some erosion due to duck feeding. Reports indicate that fishing is very good with perch, catfish and largemouth bass up to seven pounds. An abandoned boat and some trash were found on the island that should be addressed.

### Management Recommendations

Shadowpoint Pond is in good overall condition with water conditions conducive to fishing and other recreational activities. Banks within the park area should be overseeded or sodded with turfgrass to prevent erosion. Trash should be removed from the island to improve aesthetics. No other maintenance recommendations are warranted. As with all established ponds, a depth study is recommended to determine levels of sedimentation over time due to buildup of organic matter.

**Noted Bank and Aquatic Vegetation** 

St. Augustine Grass Filamentous Algae Planktonic Algae Pennywort Common Bermudagrass Baldcypress Loblolly Pine Yaupon Southern Waxmyrtle

Noted Wildlife **Domestic Ducks** 

Minnows King Snake



Size: 3.12 acres

Conveyance Date: 11/1/1993

Water Source: Water Well

February 2011



Migratory and domestic ducks have taken up residence at Shadowpoint Pond. Excessive feeding by ducks along the banks has eroded the turfgrass.



The forested island offers pleasing views and refuge for ducks and other wildlife, however trash and an abandoned boat need to be removed.



The majority of the shoreline on Shadowpoint pond is residential backyards. Access is available from the park area along E. Shadowpoint Drive.



## The Woodkinds Township Pond and Lake Management Plan



Shadowpoint Pond 19 E. Shadowpoint Drive



Feet 0 50 100

February 2011





# The Woodlands Township

Pond and Lake Management Plan

## Somerset Pond

Location: 27 Somerset Pond Place

### **General Observations**

The pond was inspected on a 09/17/10, on a sunny to partly cloudy, hot, humid day. Water color was green to dark brown with moderate to low turbidity. Water level was normal. Bank conditions were good, with a majority of the shoreline comprised of maintained turfgrass and occasional trees and emergent aquatic vegetation.

### Management Recommendations

Somerset Pond is a well-established pond in good overall condition. Banks are well-maintained with no current needs. Water quality is successfully being managed within normal parameters. No recommendations are warranted at this time.



### **Noted Bank and Aquatic Vegetation**

Baldcypress St. Augustine Grass Loblolly Pine Southern Waxmyrtle Iris Common Reed Filamentous Algae Planktonic Algae **River Birch** Southern Naiad

Noted Wildlife Minnows Ducks Great Blue Heron Snowy Egret

Size: 0.88 acres

Conveyance Date: 2/2/1995

Water Source: Golf Coarse Well



The snowy egret is a frequent visitor to ponds in The Woodlands as shown here at Somerset Pond.



A bulkhead within the park area provides bank stabilization near the adjacent bridge. Remaining areas of the shoreline are composed of residential backyards.



Somerset Pond is home to a small population of domestic ducks.



## The Woodlands Township Pond and Lake Management Plan



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Somerset Pond 27 Somerset Pond Place



Feet 0 50

February 2011





# The Woodlands Township

Pond and Lake Management Plan

## **Spindle Tree Ponds**

Location: 11434 W. Branch Crossing

### **General Observations**

The pond was inspected on a 09/16/10, on a sunny, clear, warm day. Water color for both the north and south ponds was clear to brown with moderate to low turbidity. Water level for the north pond was normal, and water level for the south pond was slightly low. Some erosion has occured on the slopes of the south pond, where reseeding will be necessary. Baldcypress trees planted on the banks of the north pond are in poor condition. Dieback of the foliage could be caused by herbicidal burn or poor soil conditions related to the construction of the pond.

### Management Recommendations

Spindle Tree Ponds primarily serve as retention/detention facilities for upstream stormwater runoff. The overall condition of these ponds is good, however monitoring of contaminants would be advisable, as the ponds receive runoff from the parking lot of a major retail store. The baldcypress trees along the north pond will not likely survive given their present condition. With other vegetation in good health, it is difficult to identify the exact cause of their demise. Monitoring vegetation at this pond over time is recommended.

### **Noted Bank and Aquatic Vegetation**

Common Bermudagrass Pennywort Baldcypress Pickerelweed Coastal Water Hyssop Filamentous Algae Planktonic Algae Primrose Creeping Water Primrose Iris Flatsedge

### Noted Wildlife

Minnows Frogs Turtles



Size: 1.54 acres

Conveyance Date: 2/27/2009

Water Source: Surface Water

February 2011



The south pond serves as a retention pond during high rain events and outfalls to a connecting bayou.



Erosion on bank of south pond due to poor turf establishment.



The baldcypress tree along the banks of the north pond are in poor condition. Possible causes include herbicidal burn, poor plant stock, ar poor soil conditions (engineered soils).



## The Woodlands Township Pond and Lake Management Plan



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February 2011

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# The Woodlands Township

Pond and Lake Management Plan

## Stonecroft Pond

Location: Stonecroft and Cochran's Crossing

### **General Observations**

The pond was inspected on a 09/17/10, on a sunyy to partly cloudy, hot, humid day. Water color was brown with high turbidity. Banks are primarily composed of maintained turfgrass with a few trees and emergent wetland plants. Access to the site is somewhat limited with no convenient parking area.

### Management Recommendations

Stonecroft Pond is in good condition with no apparent maintenance needs. Water turbidity is relatively high and most likely associated with the proximity to the golf course, where high levels of fertilization are common. Fertilization encourages growth of algae and can become problematic when excess nutrients drain into the pond. Current algae management by the pond maintenance contractor is keeping algae under control.



**Noted Bank and Aquatic Vegetation** 

Tifway Bermudagrass Baldcypress Climbing Hempvine Smartweed Common Reed Alligatorweed St. Augustine Grass Southern Waxmyrtle Flatsedge Spikerush

Noted Wildlife Minnows

Size: 0.30 acres

Conveyance Date: 8/28/2010

Water Source: Meter

February 2011



Stonecroft Pond, a component of the golf course, has highly-maintained turfgrass along most of its banks.



Volunteer plants along one bank are actively filtering runoff from the adjacent golf course. Where feasible, maintaining a buffer of vegetation will aid in managing water quality



Access to the pond is somewhat limited with no available parking.



## The Woodlands Township Pond and Lake Management Plan

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Stonecroft Pond Stonecroft Place at Cochran's Crossing Drive



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# The Woodlands Township

## Pond and Lake Management Plan

## Summer Cloud Pond

Location: 78 N. Summer Cloud Circle

### **General Observations**

The pond was inspected on a 09/14/10, on a sunny to partly cloudy, hot, humid day. Water color was clear to green with low turbidity. Water level was normal. Bank conditions were good with only minor erosion of turfgrass due to foot traffic in the park area.

### Management Recommendations

Overall condition of Summer Cloud Pond is good. The water quality is high and actively supports a fish population. Minor erosion of turfgrass in the park area can be addressed with overseeding. No additional maintenance needs are noted.



**Noted Bank and Aquatic Vegetation** 

Widgeon Grass Coastal Water Hyssop Pennywort Southern Waxmyrtle Yaupon Water Oak Loblolly Pine St. Augustine Grass Cattail Iris

Noted Wildlife

Largemouth Bass Ducks Minnows Turtles Frogs

Size: 3.00 acres

Conveyance Date: 11/1/1993

Water Source: Well

February 2011



has become well-established on the bottom of Summer Cloud Pond, aiding in water quality management and providing forage for ducks.



Banks along the pond are primarily residential backyards. A park area is located on N. Summer Cloud Circle.



A small population of domestic ducks have taken up residence at the pond, where an active population of minnows and aquatic vegetation is available.



## The Woodlands Township Pond and Lake Management Plan



Summer Cloud Pond 78 N. Summer Cloud Circle



Feet 0 50 100

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# The Woodlands Township

Pond and Lake Management Plan

## **Tamarac Pond**

Location: 1300 N. Millbend Drive

### **General Observations**

The pond was inspected on a 09/27/10, on a sunny, clear cool day. Bank conditions were good, with the entire shore lined with forest edge vegetation. Water color was clear with a brown tint and low turbidity. Water level was normal. Structure provided by tree branches and shrubs along the bank is providing excellent habitat for fish production. Range testing of water chemistry indicated normal levels of nitrate, nitrite and alkalinity. The water was noted as being very soft. The pH level of the water was neutral to slightly basic with healthy dissolved oxygen quantities.

### Management Recommendations

Tamarac Pond is an older, well-established pond with few maintenance needs. There has likely been significant buildup of organic matter over time that will require desiltation in the future. The pond appears to be relatively shallow throughout, and a depth study is recommended to confirm additional maintenance needs.



### **Noted Bank and Aquatic Vegetation**

Loblolly Pine Southern Naiad Filamentous Algae Smartweed Yaupon Willow Baccharis Water Lily Vaseygrass Sweetgum Longleaf Uniola

### **Noted Bank and Aquatic Vegetation**

Minnows Perch Turtles Largemouth Bass Goldfish

Size: 0.85 acres

Conveyance Date: 3/27/1980

Water Source: Meter



Sampled Pond



A particularly large goldfish has bee released into Tamarac Pond.



Submerged vegetation such as Southern Naiad are indicators of good pond health and excellent tools for maintaining water clarity.



The brown tint to the water in Tamarac Pond is the result of tannic acid leached from the pine needles in the surrounding forest.



## The Woodlands Township Pond and Lake Management Plan



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# The Woodlands Township

## Pond and Lake Management Plan

## **Tamarac Mill Pond**

Location: 1300 N. Millbend Drive (south of Tamarac Pond)

### **General Observations**

The pond was inspected on a 09/27/10, on a sunny, clear cool day. Bank conditions were good, with a mixture of maintained turfgrass and forest edges. Water color was green and moderately turbid. Water level was one to two feet below normal, thereby exposing the standpipe.

### Management Recommendations

Tamarac Mill Pond is in overall healthy condition. Water levels are low due to dry weather. The broken fill pipe should be repaired in a timely manner. Trash was found littering many areas of the banks that should be picked up, but is a common problem with ponds located in frequently visited parks.



**Noted Bank and Aquatic Vegetation** 

Loblolly Pine Southern Red Oak St. Augustine Grass Common Bermudagrass Smartweed Iris Coastal Water Hyssop Planktonic Algae Filamentous Algae Water Oak Yaupon **Black Willow** 

### **Noted Wildlife**

Turtles Minnows Ducks

Size: 0.35 acres

Conveyance Date: 7/22/2005

Water Source: Meter



A broken fill line leading into the water needs repair.



Low water level has exposed the standpipe used to drain excess stormwater to the storm sewer.



Tamarac Mill Pond is frequently visited due to its offerings of amenities such as a pavilon, picnic areas, a basketball court and proximity to a nearby apartment complex.



## The Woodlands Township Pond and Lake Management Plan



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# The Woodlands Township

Pond and Lake Management Plan

## **Terrace Mill Pond**

Location: 13 Forest Steppes Court

### **General Observations**

The pond was inspected on a 09/14/10, on a sunny to partly cloudy, hot, humid day. Water color was brown with high turbidity. Water level was normal. Bank conditions were good with emergent wetland vegetation becoming established in many areas. Remaining areas of the bank were composed of maintained turfgrass. A mild algae bloom was noted, but not of a size to be considered problematic.

### Management Recommendations

Terrace Mill Pond is a relatively young pond, and is slowly becoming more established. Water clarity is likely the result of the young age, however improvements can be made by treating the water with a gyspum slurry or hydrated limestone in order to settle the clay particles currently suspended in the water column. No other maintenance recommendations are warranted at this time.



**Noted Bank and Aquatic Vegetation** 

Common Bermudagrass **Black Willow** Drummond Rattlebox Coastal Water Hyssop Creeping Water Primrose Sedges Filamentous Algae Planktonic Algae Iris Willow Baccharis Maidencane Primrose Red Maple Baldcypress Cattail Southern Waxmyrtle Pickerelweed Common Reed

**Noted Wildlife** Perch Minnows

Size: 1.70 acres

Conveyance Date: 7/22/2005

Water Source: Meter



Wetland vegetation along the banks helps filter overland flow of rainwater from a connecting swale.



The banks are largely composed of maintained grass with plenty of areas for passive recreation and fishing.



Sedges have established themselves along the banks of the pond, adding to the diversity of flora and stabilizing the bank.



## The Woodlands Township Pond and Lake Management Plan



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# The Woodlands Township

Pond and Lake Management Plan

## **Tupelo Park Pond**

Location: 240 W. Tupelo Green Circle

### **General Observations**

The pond was inspected on a 09/22/10 on a partly cloudy, humid day. Water color was brown with high turbidity. Water level was normal. Bank conditions were good, with maintained turfgrass and occasional emergent wetland plants. The pond is well-aerated with a fountain and circulation pump. Water quality is affected by the water source from Lake Paloma, which is currently experiencing significant siltation due to nearby construction.

### Management Recommendations

Tupelo Park Pond's primary maintenance issue at this time is water clarity. Treatments to improve water clarity at this time will be temporary at best due to upstream siltation issues, therefore no recommendations are available until conditions at Lake Paloma improve.



**Noted Bank and Aquatic Vegetation** 

Watermilfoil Creeping Water Primrose St. Augustine Grass Common Bermudagrass Primrose Maidencane Sedges Pickerelweed Baldcypress Spikerush Filamentous Algae Planktonic Algae Cattail

Size: 0.5 acres

Conveyance Date: 5/19/2010

Water Source: Lake Paloma



Circulation pumps offer a water-conserving alternative to fountains for providing aeration.



Water from the upper pond falls over a dam to the lower pond improving aeration.



Lake Paloma is the primary source of water for the pond. Muddy conditions are caused by ongoing construction in the Lake Paloma area.



## The Woodlands Township Pond and Lake Management Plan



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Tupelo Park Pond 240 W. Tupelo Green Drive



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February 2011





# The Woodlands Township

Pond and Lake Management Plan

## Venture's Tech Pond

Location: 8402 New Trails Drive

### **General Observations**

The pond was inspected on a 09/15/10, on a sunny, clear, hot, humid day. Water color was clear to brown with low turbidity. Bank conditions were good, with maintained turfgrass comprising the majority of the shoreline, however turfgrass in some areas is slow in becoming established. The pond is adjacent to a number of commercial properties, receiving runoff in addition to water from the meter to maintain desired water levels.

### Management Recommendations

The aeration fountain was not operating during site inspection. An inspection of the pump should be made to determine if it's functioning. Areas of slow to poor turfgrass establishment should be overseeded to prevent soil erosion.



**Noted Bank and Aquatic Vegetation** 

Common Bermudagrass St. Augustine Grass Coastal Water Hyssop Primrose Alligatorweed Baldcypress Filamentous Algae Planktonic Algae Common Reed Widgeon Grass Chinese Tallow **Black Willow** Cattail

**Noted Wildlife** Perch Minnows

Size: 1.00 acres

Frogs

Conveyance Date: 1/1/2010

Water Source: Meter



previous waterline. Water levels were lowered intentionally to address stormwater drainage issues.



Venture Tech Pond serves as a retention/ detention facility for stormwater runoff from the neighboring commercial properties.



The aeration fountain was not operating during the site inspection and may either be turned off or non-functioning.



## The Woodlands Township Pond and Lake Management Plan



Venture Tech Pond 8402 New Trails Drive



Feet 0 50 100

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# The Woodlands Township

## Pond and Lake Management Plan

## Wedgewood Pond

Location: 72 Wedgewood Forest Drive

### **General Observations**

The pond was inspected on a 09/17/10, on a sunny to partly cloudy, warm, humid day. Water color was clear to dark brown with low turbidity. Water level was normal to a few inches low. Bank conditions were good, with a majority of the shoreline composed of maintained turfgrass and occasional trees. In 2009, a population of Snowy Egrets became a nuisance while roosting in areas around the pond. An abatement program was enacted to address this issue.

### Management Recommendations

Wedgewood Pond is well-established and in good condition. Current maintenance practices are keeping the aquatic vegetation under control while allowing sufficient populations to remain in order to maintain water auality.



**Noted Bank and Aquatic Vegetation** 

Common Bermudagrass St. Augustine Grass Water Lettuce Duckweed Baldcypress Vaseygrass Climbing Hempvine Cattail Elephant Ear Willow Baccharis River Birch Pennywort Loblolly Pine Coastal Water Hyssop Sycamore

### **Noted Wildlife**

Turtles Minnows Perch Freshwater Mussels Snowy Egret Great Blue Heron

Size: 5.54 acres

Conveyance Date: 8/24/1990

Water Source: Storm Water



View of the linear section of Wedgewood Pond. Steep banks are lined with residential backyards.



View of the main pond area of Wedgewood Pond.



A linear section of Wedgewood Pond drains excess stormwater into a connecting drainage bayou.



## The Woodlands Township Pond and Lake Management Plan



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Wedgewood Pond 72 Wedgewood Forest Drive



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## **Fishery Management**

A healthy pond has balance between predator and prey populations. Stocking the proper number, sizes, and combination of fish helps maintain proper balance in the fish population. The surface acreage of water is the most important criteria for determining the number of fish to be stocked. To provide the best recreational fishing opportunities, only certain species are recommended when stocking a pond. The most common stocking strategy for ponds approximately one surface acre is to manage for multi-species such as largemouth bass, bluegill, Redear Sunfish, fathead minnows, and channel catfish. This combination generally works well and provides a variety of angling experiences. Successful multi-species management require that a combination of species be stocked to achieve a "balance" between predators (bass) and their principal forage species (bluegill and minnows).

### Fish Species Recommendations

Largemouth bass are predatory and eat a variety of foods. Their diet includes small fish, frogs, crawfish, and insects. Bass are well adapted to ponds and reproduce successfully, usually spawning only once a year. They grow rapidly in ponds where food is plentiful, generally reaching sexual maturity and spawning at one year of age. In the spring, mature males fan out depressions or "nests" on the pond bottom. Females lay their eggs in the nest. The male fertilizes the eggs, and they usually hatch within four days.

Bluegill and Redear Sunfish are also well adapted to ponds and eat a variety of foods. When small, they eat microscopic plants and animals. As they grow, their diet chants to include insects, snails, crawfish and small fish. If enough food is available, these fish grow rapidly, reaching sexual maturity at one year. In the spring, Redear sunfish begin spawning, followed by bluegill. Bluegill may spawn several times in one season, while Redear sunfish normally spawn only once or twice. Bluegill spawn in groups, and their collections of nests are called spawning "beds."

Channel Catfish may be stocked to provide additional fishing opportunities, but they are not necessary to maintain a balanced fish population. Channel Catfish has few disease problems. Natural foods include decaying organic matter, plant material, crawfish, small fish, and insects. You do not want to encourage catfish spawning because of potential crowding and disease problems. Channel Catfish may reproduce, but offspring usually do not survive because of bass predation. The catfish stocking strategy is certainly optional, but the fingerling bass will not reach a consistently "catchable" size for two to three years following stocking. Therefore, the catfish will serve to take up the slack during this interim period.

Bluegill and Redear Sunfish not only will provide excellent forage but also offers excellent fishing for kids and adults. The bluegill is one of the few forage species that can withstand the pressure of bass predation through its ability to spawn several times throughout the warm months of the year. This results in an abundance of forage of a variety of sizes for the use of the bass. This is important because for a bass to gain 1 pound of weight, it must consume approximately 5 to 6 pounds of bluegill. Fathead minnows also provide good forage for the fingerling bass and catfish. Bass feeding quickly eliminates these fish from ponds, and you have to restock them often.

Fish can be obtained from several private fish hatcheries in the state; however, we recommend that a local hatchery be selected so there will be less stress on the fish during transportation to the pond. Private hatcheries will deliver the fish directly to the pond and can provide fish at almost any time of the year. The fish arrive in containers and will be placed into the pond water (preferably in the shade) for at least 15 minutes. Pond water will gradually be let in the container until the water temperatures equalize and the fish will not be stressed. The fish will then be released into the pond preferably near areas that have some vegetation, rocks, or other structure.

Fish species that should not be stocked or brought in the pond include crappie, flathead catfish, carp and green sunfish. These fish can pose serious management problems in that they overpopulate and become stunted at sizes too small to be harvested. Under these conditions they will compete directly with both bass and bluegill for food.

### Fish Production and Pond Balance

In order to successfully manage a recreational fishing pond there are some basic principles that govern the status of the pond's fish population and ultimately the quality of the fishing. The organic and inorganic nutrients found in every pond serve as building blocks for the pond's aquatic food pyramid. Simply stated, these nutrients support the microscopic algae or phytoplankton which are eaten by equally small animals call zooplankton. Zooplankton is, in turn, eaten by small aquatic crustaceans, insects and other organisms. These food items are consumed by bluegill and young bass that ultimately are eaten by the pond's larger bass. Properly managed ponds maintain a more productive food web and have a higher carrying capacity or ability to support and grow fish than those that are neglected or are poorly managed.

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## Wildlife

Largemoutth Bass



Bluegill Perch



Redear Perch



Channel Catfish





Carrying capacity refers to the maximum weight (usually expressed in pounds per acre) of fish that a pond will support during a set period of time. In order to achieve and maintain a balanced fish population and proper stocking are essential. Balance refers to the ratio and weight of predatory fish (largemouth bass) to forage fish (bluegill, redear sunfish, minnows) in the pond. A well-balanced fish pond can sustain the growth and reproduction of each species, over time. The bass depend on a healthy, reproducing bluegill population for food and in turn serve to keep the numbers of bluegill in check.

For any number of reasons, a pond's fish population may become out of balance, including improper stocking, introduction of competitive species or excessive aquatic vegetation. Once a population imbalance occurs, all species are likely to be impacted and may exhibit symptoms of overcrowding, emaciated body condition and a reduced level of reproductive capacity. These situations ultimately result in poor fishing. The pond maintenance contractor provides an annual fish survey for the ponds and lakes and makes determinations for stocking. This schedule is sufficient for a pond system implementing a catch and relase fishing policy.

### Fish Attractors

Fish attractors can be a successful management practice of creating artificial fish habitat structure. Structures in a pond can consist of anything that provides for relief from the bottom. Structure is particularly necessary when managing for largemouth bass as it can supply spawning areas and protection for forage fish as well as a place to concentrate fish making them easier to catch. The most economical and effective fish attractors are constructed of brush piles, old culverts, cement blocks, bundles of tires discarded Christmas trees which are tied or weighted to the bottom. These materials are easy to obtain and normally do not require heavy equipment for placement. Several small fish attractors established in a pond are better than just one large one. Deeper bodies lakes and ponds in The Woodlands may benefit from fish attractors, but shallow ponds should not have them installed.

## Miscellaneous Problems and Considerations

### Fish Mortality

Fish die from a variety of natural causes. Observing a few dead fish in a pond is not uncommon and is no reason for concern unless it continues for several days. When fish die in large numbers, however, there is reason for concern.

A common cause of fish kills is oxygen depletion. Oxygen depletion usually occurs during summer in very fertile ponds as a result of pond turnover or die-off of an algae bloom. During hot weather most ponds have a layer of water near the bottom that contains little or no dissolved oxygen. When high winds or cold rain cause the water to mix with the upper pond water, oxygen levels often drop low enough to kill fish. Oxygen depletion also occurs when dead algae or other plants decay in the pond after herbicides have been applied to control weeds.

Similar fish kills may occur when consumption by respiration exceeds the amount of oxygen produced through photosynthesis. During the daylight hours, ample oxygen is usually available; aquatic plants are producing oxygen. However, at night, no oxygen is produced, but aquatic animals and bacteria continue to remove oxygen from the water. Therefore, the greatest stress and mortality of fish usually occurs just before sunrise prior to the resumption of oxygen production by aquatic plants. Such fish kills usually result after 2 or 3 hot, overcast, windless days. Often the fish are found dead or dying in the early morning hours (daylight) when the oxygen is usually at its lowest level. If fish are observed at the pond's surface gulping for air, this may be a sign that oxygen depletion is occurring.

Mechanical aeration using diffusers or sprayers can be used to increase dissolved oxygen levels during periods of low oxygen. Pulling water from near the surface and spraying it back over the pond will increase oxygen content in the top layer of the pond. The most critical time to operate the aeration system is from midnight to sunrise. Oxygen requirements in ponds can vary greatly. A common used rule is to use aerator with one horsepower per surface acre. To determine whether a pond needs a permanent aeration solution, monitor the weekly dissolved oxygen (DO) levels of the pond over a three month period. If the average DO level is less than 3 parts per million (ppm) then an aerator should be installed. It is important to test the water in the cool, early morning hours. The best time of year for monitoring is during the summer months when oxygen demands are highest among fish.

### Parasites and Diseases

Fish kills caused by diseases usually occur when the fish are already stressed by poor water quality or overcrowding. Parasites and diseases are common for fishes in warm pond waters. Infestations usually kill just a few fish at a time and generally present no major problem. The situation almost always corrects itself within a few weeks, and treatment is seldom practical, if even possible. A fishery biologist can often aid in identifying the problem and advise the best course of action.

## Wildlife





## Other Wildlife

### Feeding of Ducks and Geese

The Woodlands has posted signs about not feeding the ducks at all community ponds and lakes. Feeding ducks and geese in ponds can have serious consequences, including over-population and spreading of disease (to humans as well as to other ducks). Feeding ducks or geese can make them very sick. Their natural diet includes aquatic vegetation, insects and mollusks. The food that people usually give to ducks isn't good for them and can cause health problems. Bread and similar products such as crackers, chips, donuts and popcorn are a great source of carbohydrates but they offer little other nutritional value for ducks, waterfowl and other birds. In fact, bread is the equivalent to junk food for the ducks, and too much bread can lead to excessive weight and malnutrition as well as many other problems. In addition, feeding them can cause water pollution. When ducks and geese cannot eat all of the food given to them, the excess food will rot. Rotting food will contaminate the water and make it unhealthy for all of the animals nearby. Feeding ducks can cause other problems. Too much food can cause ducks to breed quickly and overpopulate the area. This overpopulation can cause duck feces to contaminate the water and lead to serious disease outbreaks in the warm months. When one area becomes over-populated, domestic ducks will look for new areas to lay their eggs, including backyards and swimming pools. When ducks become accustomed to handouts, they lose their fear of humans and may become very aggressive in order to get more food.

### **Beavers and Nutrea**

The beaver and nutria can be found in and around ponds in The Woodlands. Most of the damage caused by beavers and nutrias are the result of bank burrowing, dam building, interrupting water supplies, and destroying vegetation, tree cutting or flooding. When they do, they usually cause considerable damage. Beaver and nutria control are best accomplished as soon as there is evidence of damage. Trapping is the best way to remove these animals. Keep in mind that transporting a live wild animal in Texas without a permit is illegal. Trapping should be performed by a licensed trapper.

### **American Alligator**

Alligators are protected by law. Any potentially dangerous alligator should be reported to the Texas Parks and Wildlife Department so that proper handling can be initiated. Contact your local game warden or call 1-800-792-1112.

### Turtles

Turtles are common in ponds but normally there is little harm to fish populations and can actually improve fishing by removing unhealthy fish. These slow moving creatures are beneficial scavengers that feed primarily on aquatic plants and dying fish. The most common turtle in the region is the Red-Ear Slider.

### Snakes

Keeping snakes out of a pond is extremely impractical if not virtually impossible. Most snakes seen in ponds are non-venomous water snakes, pose no threat to humans, and should not be killed. Water snakes lack venom, but they can defend themselves by delivering a series of rapid bites while smearing feces and musk onto anyone attempting to capture them. Water snakes only bite whenever captured or handled and pose no threat to humans.

### Waterfowl

Currently, both domestic and migratory waterfowl use ponds/lakes in The Woodlands as resting places and feeding areas. Some waterfowl species commonly seen in The Woodlands include Black-bellied Whistling Duck, Blue-winged Teal, Domestic Ducks, Cinnamon Teal, Canvasback, Mallard, Muscovy, Wood Duck, Lesser Scaup, etc.

The most common wild duck in urban and suburban areas is the mallard, a dabbling duck that feeds on seeds, aquatic grasses and pond weeds. They will supplement their diet during the breeding season with insects and other invertebrates. Mallards frequently interbreed with domestic ducks, producing hybrids that may or may not look similar to mallards. Ponds and small lakes are attractive feeding and loafing areas for migrating waterfowl and may even attract nesting pairs of ducks and geese. Such waterfowl provide viewing pleasure, and their feeding habits may help to control some weed problems; however, they may cause problems if they become too abundant, especially in small ponds. They can cause turbidity and algal problems, damage shoreline vegetation and subsequent erosion, and leave unsightly droppings on pond banks or piers. Coliform bacteria thrive in water enriched with waterfowl droppings, especially when the ducks and geese use the pond year-round. They may also become aggressive during nesting season. A general rule of thumb for healthy duck populations is to maintain no more than 2 to 4 ducks per surface acre of pond. If the duck population has exceeded the recommended 2 to 4 ducks per surface acre, The Woodlands should consider whether some birds should be relocated to another pond. Relocation may only be necessary if water quality has diminished, vegetation is being destroyed or the birds are beoming a nuisance.

## Wildlife





### Muscovy Ducks

Currently, several ponds contain Muscovy ducks (Cairina moschata), a species native to South America that has begun to migrate into three counties in South Texas. Muscovies are considered to be a non-native species in all other counties throughout the state that compete with native species for food and habitat. The United States Fish and Wildlife Service (USFWS) issued regulations effective March 31, 2010, that impact all Muscovy ducks—wild, owned, and feral in the U.S.. Muscovy ducks are protected birds under the federal Migratory Bird Treaty Act (MBTA). The MBTA protects migratory birds within their natural range, and in the case of Muscovy ducks, this occurs naturally in Hidalgo, Starr and Zapata Counties in Texas. The March 31, 2010 control order offers a revision to the MBTA to allow for control of Muscovy ducks outside of their native range to prevent the spread of the species into new areas. Wildlife agencies and property owners are allowed to control free-ranging Muscovy ducks anywhere except the three Texas counties (where they are considered naturally occurring). Control can mean treating eggs so they don't hatch (addling), delivering the ducks to a food production facility or destroying the ducks. Muscovy ducks cannot be transferred live for any other purpose except for sale by a food producer. A major goal of the new regulations is to prevent more ducks from becoming feral, therefore no one may transfer or release Muscovys to the wild, including to the urban wilds of local ponds and parks. A copy of the official control order is available in the Appendix.

With as many ponds and lakes as there are in The Woodlands, Muscovy ducks can easily continue to reproduce and spread into new areas. When Muscovy duck populations exceed the healthy limit of 2 to 4 ducks per surface acre, they cannot be relocated to other ponds under Federal regulations, therefore other control options must be implemented. The Woodlands Township has clearly identified a goal of managing Muscovy ducks in accordance with Federal regulations and for the stewardship of native waterfowl habitat. The Woodlands Township should institute the following plan of action in the control of Muscovy ducks:

1. The Woodlands Township must control Muscovy ducks when populations exceed the recommended size to prevent further spread of this non-native species into new areas and to maintain the health of the pond ecosystems.

2. The Woodlands Township will seek to form a relationship with a duck producer in the region who may be willing to take possession of the Muscovy ducks in accordance with the revised Migratory Bird Treaty Act effective March 31, 2010 per U.S. Fish and Wildlife Service's control order.

3. The Woodlands Township may elect to humanely euthanize Muscovy ducks when necessary to control and reduce the population if necessary.

### Wading Birds

A wide variety of wading birds (herons, egrets), waterfowl (ducks and geese) and other birds (kingfishers) feed on water animals and attracted to ponds. Common egrets and herons in this area include Cattle Egret, Great Egret, Snowy Egret, Great Blue Heron, Green Heron, Little Blue Heron and Yellow-Crowned Night Heron. These birds do eat some fish, but rarely can catch enough fish to seriously affect fish populations and seeing them around a pond often provides pleasure to visitors. These birds can be beneficial predators that cull weak and diseased fish from ponds.

In recent years, egrets and herons have established rookeries or heronries near ponds in The Woodlands. Noise and odor from the volume of guano, regurgitated food and fallen nestlings have caused a nuisance and a health concern. These birds should be persuaded to leave before they begin to lay eggs. When birds arrive, use noise, light and water to persuade the birds to move. Protected by the Federal Migratory Bird Treaty Act, nesting birds, their young, eggs and active nests cannot be disturbed once the birds begin to nest.

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## Wildlife



# Environment









## Water Quality Management

Potential water sources for a pond include surface runoff, streams, springs, and wells. Surface runoff is rarely a source of disease or wild fish problems but leads to fluctuations in pond level during spring and fall. Streams are usually high in dissolved oxygen, but they also tend to fluctuate rapidly, are a source of silt, and are a potential source of diseases and wild fish invasions. Springs are considered the most desirable water source because they have a constant temperature and flow. However, they may contain high concentrations of undesirable gases (hydrogen sulfide and carbon dioxide) and the high clarity of water from springs encourages vegetation problems. Wells offer good quality water and can be placed where convenient, but are expensive to drill and operate. It is also important to consider land uses within the watershed where the pond is located, as those may degrade the water quality. Runoff can increase the amount of sediment reaching the pond and may cause turbidity. Residential, urban, and industrial runoff may contain substances (such as industrial waste, chemicals, oils, fertilizers and sediment from construction activities) that can adversely affect a pond's water quality and can cause algal blooms and fish kills.

Good water quality is essential to maintaining a healthy pond and ensuring successful fish production. It is vital in ensuring healthy plant and animal life in a pond. An understanding of some characteristics of water and how it affects fish will be helpful in managing ponds. Realistically, the success of a fisheries program depends on water quality. Water quality factors such as temperature, pH, alkalinity, hardness, and dissolved oxygen affect fish health and production. These factors are rarely constant in a pond. Temperature, dissolved oxygen and pH will change or cycle each day and alkalinity can change over longer periods of time.

There are two components to water quality. One is the actual chemical make up of the water including pH, alkalinity, dissolved oxygen, hardness, ammonia, nitrite, nitrate, and chemical additives, or impurities. The second aspect of water quality is water clarity. This contributes primarily to the enjoyment of the pond, but is important nevertheless because unless your water is clear, your pond will not look attractive. Murky water can be an indicator that something is wrong with the chemical composition or nutrient level in the pond.

The three most important water quality factors which affect fish health and production are pH, dissolved oxygen and alkalinity. These factors are rarely constant in a pond and can change or cycle each day. The first of these (pH), just as with soil analyses, determines the availability of nutrients. The pH of a pond cycles daily because of respiration and photosynthesis, but normally fluctuates between 6.5 and 9.0. The pH can range from 1 (acidic) to 14 (basic), with 7 being neutral. The pH level of a pond fluctuates throughout the day with the pH being lower (more acid) in the mornings and higher (more basic) in the evenings. If the pH is too far skewed toward acid or basic conditions, no amount of fertilization will benefit the system. The only method to manage pH changes is to increase the alkalinity of the pond by the addition of agricultural limestone.

The second diagnostic (dissolved oxygen) is the most critical water quality variable in a pond. It determines whether or not fish can survive. The oxygen level in a pond fluctuates with temperature, time of day, and the depth of water. Oxygen in ponds primarily arises from two sources. First, the most important source is photosynthesis which is the process plants use for manufacturing food. In the presence of sunlight, microscopic plants add oxygen to water as a by product of photosynthesis. Therefore, dissolved oxygen concentrations in ponds tend to rise throughout the day. At night dissolved oxygen slowly declines as fish, insects, zooplankton, bacteria, and algae consume oxygen through respiration. A good population of beneficial microscopic plants will assure high dissolved oxygen levels. Second, wind action in ponds causes waves to interface with the air, dissolving oxygen in the process. Under normal conditions, dissolved oxygen concentrations in ponds should not fall below 3 or 4 parts per million (ppm). Oxygen concentrations below 3 ppm stress fish and many fish will suffocate at concentrations below 3 ppm.

The final factor (alkalinity) is a measure of the bases (carbonates and bicarbonates) in the water. Bases react to neutralize acids and, therefore, directly influence pH. A good alkalinity is needed to absorb organic acid and biological activities occurring in the water. A total alkalinity of at least 20 ppm is necessary for proper algae growth and therefore good fish production. Agricultural limestone applications are also necessary to improve total alkalinity in ponds.

### **Blooms and Pond Color**

Plankton is a term used for all microscopic and near microscopic living things that float in the water. Plankton includes both tiny aquatic plants called phytoplankton or algae, and animals called zooplankton. Plankton algae serve as the base of the food chain. Zooplankton and aquatic insects feed on algae, and they in turn are eaten by small fish (fry). Small fish are then eaten by larger fish. Directly or indirectly, algae provide almost all the basic food for the pond except for a small quantity of insects and worms that fall or wash into the pond. Managing planktonic algae is essential in providing the food to produce an abundant and healthy fish population.

Changes in pond water color can be related to planktonic algae concentrations, called "blooms" or to suspended sediments and organic matter. Water which is good for fish production is green; the green color comes from billions of suspended microscopic algae. Water color changes if these algae blooms "die-off" rapidly, turning the water brown, black, milky or clear. When this happens, decomposition of the dead algae consumes oxygen, leading to possible stress, suffocation or disease in fish. Mechanical aeration may be necessary after algae die-offs to keep fish alive.

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## Muddy Water

Turbidity prevents light penetration and prevents the growth of beneficial phytoplankton, the base of the food chain in ponds. Muddy water is often a problem in ponds because it inhibits the growth of natural fish foods and is not aesthetically pleasing. Fishing is impacted because a chronically muddy pond reduces the amount of sunlight penetrating into the water which in turn reduces the amount of fish biomass (pound of fish) that can be supported. Additionally, desirable fish such as bluegills and largemouth bass are sight feeders. High turbidity levels negatively impact the ability of these species to feed and maintain themselves in a healthy condition.

All ponds and lakes can become temporarily muddy on occasion due to heavy rains. In most cases, these muddy conditions are short-lived and will clear in several days if no further rainfall occurs. Occasionally, a pond will become muddy (or turbid) and will fail to clear. These situations may necessitate measures to eliminate the turbidity and prevent future occurrence. Muddy water is caused by soil particles (typically clay) and is usually a chocolate brown color.

The first step in clearing a muddy pond is to inspect the watershed and shoreline for signs of erosion. The two primary biological causes of muddy water are fish and waterfowl (ducks and geese). Large populations of common carp, gold fish, and bullheads can cause muddy water due to their spawning and feeding activities in shallow water. The constant splashing and rooting around in shallow water not only causes re-suspension of bottom soils, but is detrimental to shallow water vegetation that helps protect shorelines from wind-induced wave action. Large numbers of domesticated ducks and geese cause similar problems. Additionally, waterfowl often eat bank vegetation which can increase erosion. If nuisance fish species are already present and causing muddy water, they need to be removed. Either drain the pond and remove them or treat the pond with a fish toxicant to eliminate the fish community. Restock with desirable fish species. If nuisance species are present but water clarity is acceptable, be sure to maintain a dense population of largemouth bass to ensure future control of nuisance fish species. Maintain proper populations of ducks and geese on the pond.

Some watershed activities disturb clay materials that can result in muddy water problems that are extremely difficult to correct. A prime example of this is construction activity in the watershed. Colloidal clay particles are very small and can take a very long time to sink to the bottom. If you take a jar of water from the pond and after several days it is still very cloudy in appearance, you likely have a problem with clay particles. Several techniques exist to greatly reduce the levels of suspended clay particles. These techniques involve flocculation, the "binding" of clay particles into larger particles which sink to the bottom much faster.

One method of dealing with suspended clay particles is the application of dry hay. The hay should be loosely distributed throughout shallow areas of the pond. As it decays, hay creates electrical charges that cause clay particles to clump together and settle out. It is important to use as little hay a necessary. Two small bales of hay per surface acre should be scattered at 14-day intervals until clearing occurs. The addition of large amounts of organic material, such as hay, can lead to oxygen depletion as the material decomposes. Hay applications should not be performed during summer months without supplemental aeration.

Agricultural gypsum (calcium sulfate) is another material for removing suspended clay and does not cause the concern of a fish kill associated with adding hay. Gypsum is also chemically neutral and therefore does not cause possible pH problems associated with alum, another commonly used material. It is best to add the gypsum at a conservative rate of 250-500 pounds per surface acre of water, wait several days and determine if additional gypsum is needed. Dissolve the gypsum in clean water and spray over the surface on a calm day. Water movement from the wind prevents the suspended clay from quickly settling out, reducing the effectiveness of gypsum.

Aluminum sulfate (alum) is the most effective material for clearing clay turbidity from a pond, often within a few hours. Application rates are typically 100-450 pounds per surface acre. Application procedures are identical to those described for gypsum. For alum, after application there is a chemical reaction that impacts the pH (acidity) of the water. The reaction produces small amounts of sulfuric acid which can decrease the pH significantly to levels harmful to aquatic life. To address the lowered pH, agricultural limestone should be supplemented with the alum at a rate of 40 pounds per surface acre.

Agricultural limestone (calcium carbonate) is a material commonly used to remove suspended clay from water. Application rates of 500 – 1,000 pounds per surface acre are typically used. Limestone can be added in the same manner described for gypsum.

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Low Turbidity — High Turbidity

Turbidity is commonly the result of postively charged clay particles remaining suspended in the water column.







## Pond and Lake Management Plan

All three chemical treatments to correct muddy water conditions are typically applied from a boat by hand broadcasting or using a water pump to spray the dry chemical or a slurry onto the surface. The pond management contractor can provide an estimated cost for application, as prices tend to vary significantly between contractors. Provided that sources of siltation are elminated such as erosion, nearby construction activities and excessive populations of rough fish such as carp and bullheads, the ponds should not require repeated treatments once desired clarity is achieved.

NCCOI	Recommended Application Rates for Chemical Clamication of Muddy				
Treatment	Application Rate	Mat			
Agricultural Limestone (calcium carbonate)	500 to 1,000 lbs per surface acre	\$10			
Agricultural Gypsum (calcium sulfate)	200 to 500 lbs per surface acre	\$200			
Aluminum Sulfate (alum)	100 to 400 lbs per surface acre	\$350			

## Recommended Application Rates for Chemical Clarification of Muddy Water

Preventative measures, such as proper pond construction and maintaining well-vegetated watersheds, typically will keep a pond from becoming muddy. Muddy water situations can be reduced if the surrounding watershed and shoreline are periodically inspected for erosion. Turbidity can be reduced by planting vegetation on all exposed soil areas (usually turfgrass). Areas of significant erosion (i.e., furrows or channels forming, or large chunks of soil falling away) may require addional stabilliation through installation of a bulkhead or planting of larger bank vegetation such as shrubs species. Reduced mowing or increased mowing height can help with the establishment of turfgrass more rapidly during the growing season.

Ensuring that stormwater pollution prevention measures are properly installed and maintained during construction activities can go a long way towards preventing excessive turbidity in ponds and lakes. State policies demand that these measures are taken, however experience tells us that they are not always implemented properly.

## **Pond Aeration**

Currently, there are 21 ponds/lakes with fountains. Oxygen in ponds comes from two sources: photosynthesis and diffusion from the air. The most important source is photosynthesis which is the process plants use from manufacturing food. In the presence of sunlight, plants add oxygen to water as a by-product of photosynthesis. At night, no oxygen is produced, but respiration of algae, fish and bacteria continues to remove oxygen from the water. Most of the time there is a desirable balance between how much oxygen is produced and how much is used, but under some conditions, the balance can be upset, and the oxygen concentration becomes low enough to stress or kill fish.

	Effects of Dissolved Oxygen on Fish
Dissolved Oxygen Concentration (DO)	Effect on Fish
Less than 1.5 or 2.0 mg/liter	Lethal if exposure lasts more than a few
2.0 to 5.0 mg/liter	Growth wll be slow if exposure to low E
5.0 mg/liter to saturation	Best condition for good growth
Above saturation (very rare)	Can be harmful if supersaturated cond

The amount of oxygen in pond water can vary considerably from pond to pond and from hour to hour. Typically, however, oxygen concentrations are lowest at dawn and highest during the late afternoon. Most low oxygen problems occur from June through September. Water can hold less oxygen as it becomes warmer. Respiration rates of both plants and animals increase with the warmer water, so more oxygen is used. Summer's still, hazy or cloudy days may reduce the amount of oxygen produced.

The most common oxygen problem occurs when consumption by respiration exceeds the amount of oxygen produced through photosynthesis and diffusion from the air. During the summer months, when water is warm, oxygen can be consumed faster than it can be replenished. Ponds and lakes can become "stratified", the warmer, oxygen-rich upper water laying on top of the cool, denser, lower-oxygen deeper water. Such conditions inhibit levels of beneficial bacteria and their breakdown of organics. This thermal stratification also makes conditions favorable for noxious ammonia and hydrogen sulfide gases. Another type of oxygen depletion occurs when algae dies suddenly. Predicting natural algae die-offs is difficult. However, they are often associated with surface algae scums and very heavy algal "blooms". The third and most serious kind of oxygen depletion is referred to as "turn-over", where warmer upper layers of the stratified pond suddenly cool and become mixed with lower oxygen-poor layers creating a net lower amount of available oxygen. Turnovers typically occur after rain events in the fall and spring.

With a regular fluctuation of DO levels, it is important to monitor them over time. For ponds without aeration systems, DO levels should be monitor for a three month period (June - August) to determine the average weekly concentration. If the average DO concentration is less less than 3 mg/liter, an aeration system should be considered a priority. The pond maintenance contractor measures these levels every week, and the data is available at request.

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erial Cost
o \$50 per ton
per ton
per ton

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O is continuous

ditions exist throughout volume





Oxygen concentrations can be measured using inexpensive chemical kits or electronic oxygen meters. Oxygen requirements in ponds can vary greatly. A commonly used rule of thumb is to use 1 horsepower/surface acre with an aerator rated at least 2.5 lbs. O2/hp per hour. This assumes normal oxygen cycles during the day and night, healthy fish, and maintenance of minimum oxygen levels above 2 or 3 ppm. Aeration systems create a vertical current using the rising force of millions of small bubbles to entrain the water column, "turning the pond over" and allowing oxygen to be observed at the pond's surface. By moving the lower-oxygen water up from the bottom and eliminating thermal stratification, oxygen levels throughout the water column are increased.

Aeration devices most commonly used include Fountain Type, Wind Aerators/Circulators, Vertical Pump Surface Agitators, Horizontal Aspirators, Horizontal Prop Units, Pumping or Cascading Water, and Diffused Air. The fountain type devices splash water into the air to create an aesthetically pleasing display. All types of equipment require occasional maintenance and repair to ensure longer life and dependability.

An important consideration when choosing an aeration solution is water conservation. The Woodlands Township currently pumps an approximate nine million gallons of well water into nine of the ponds and lakes annually to maintain consistent water levels. Water conservation is a leading issue at the State, County and local levels and will continue to be so for many years. Aeration systems using fountains are aesthetically pleasing and in high demand, however these systems tend to spray a fine mist of water into the air that can rapidly evaporate thereby causing undue water losses. Some fountain systems are capable of being adjusted to reduce pressure and spray pattern, and in those cases may need adjustment to lessen the effects of misting.

One alternative to spray/display fountain type aerators is to use diffusion systems such as those in place at Olmstead Pond. Diffusion systems pump air from the surface down to the bottom where air is released through porous diffuser plates and dispersed upward through the water column. These systems have two key advantages over other types of aeration: 1. no water is cast into the air thereby reducing evaporative water loss, and 2. air is distributed vertically through all depths of the water, thereby eliminating oxygen-depleted areas at the bottom typically responsible for turn-overs and resultant fish kills. Diffusion systems are somewhat unique to each manufacturer and will have different rates of oxygen transfer. Diffuser systems are most efficient in deeper ponds (8 feet or more) and have the added capability of circulating the water from the bottom to prevent low oxygen zones (destratification). Diffusers should be installed at 3/4 of the depth of the pond (e.g., install at 8 ft. deep area of a 12 ft. deep ond) to retain a cooler zone of water for hot summer periods. Consultation with a manufacturer will determine the size of system needed for a given pond or lake.

Another aeration alternative is the use of surface bubbler systems to aerate the pond without the loss of water to evaporation. Bubbler systems are highly effective, however more units will be needed per surface acre of water due to the small "footprint" of affected area. Factors affecting the ability of oxygenated water to be distributed throughout the pond include wind and currents.

Aeration systems vary in efficiency and cost greatly due to factors such as oxygen transfer rate, electrical needs, life expectancy and type. The table below describes an average annual cost for an aeration system based on initial capital investment, maintenance costs, operating costs and life expectancy as provided by a manufacturer

Aeration Option	Capital Investment	Annual Operating Cost	Annual Maintenance	Life Expectancy	Average Annual Cost
Electric Aerator (varied)	\$500	\$180	\$25	3	\$371.67
	\$1,000	\$240	\$25	5	\$465.00
	\$2,000	\$240	\$25	5	\$665.00

## Sediment Contamination in Storm Water Detention Ponds

Many species of birds directly use these storm water ponds for food, water, and breeding. Sediment dwelling animals, such as worms, crustaceans, and mussels, as well as fish, reptiles and mammals use these ponds. Because these ponds are designed to retain storm water, sediments, and any associated contaminants, wildlife inhabiting these ponds may be at risk to adverse effects resulting from exposure to contaminants retained within. Not only may wildlife be a risk from exposure to polluted storm water pond sediments, but humans may also be at risk as a result of recreational activities, such as fishing, and/or sediment disposal activities following maintenance dredging. As storm water ponds age, the accumulation of sediment reduces their overall efficiency and jeopardizes their ability to protect nearby natural receiving waters. To keep ponds fully functional, periodic removal of accumulated sediment is recommended. Polycyclic aromatic hydrocarbons (PAHs) are organic chemicals that persist in the environment and pose a risk to animals, plants, and people at elevated concentrations. These contaminants are formed by the incomplete combustion of organic materials, such as wood, oil, and coal, as well as occurring naturally in crude oil and coal

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Surface bubbler aeration systems provide for aeration needs without evaporative water loss.





PAHs can cause other detrimental effects in fish such as mouth tumors. PAHs are commonly associated with the vehicular combustion of gasoline and diesel. Another source of PAHs, is coal-tar-based pavement sealants used on parking lots. Sealants are applied to the surface of asphalt walkways, playgrounds, driveways, and parking lots in order to protect the asphalt pavement and to provide a deep black appearance for cosmetic purposes. Both lead and zinc in suburban areas have also been attributed to vehicular use, particularly the wearing of breaks and tires. Due to their unique physical/chemical properties, PAHs tend to attach to particles in the air, water, and sediment and also accumulate in the lipids (i.e., fat) of organisms that are unable to metabolize them. Although fish are able to metabolize PAHs, lessening their accumulation in tissues, as ponds age, the risk of exposure to elevated PAH levels for wildlife increases. As storm water ponds fill with sediment, these structures will lose their water quality functionality resulting in a greater load of contaminants and suspended sediments to downstream receiving waters. In filled storm water ponds, sediment-bound PAHs may be re-suspended and transported to downstream receiving waters, resulting in potential impacts to aquatic biota. For example, PAHs could kill or impair bottom-feeding organisms that comprise part of the aquatic food chain for fish, resulting in less fish for anglers to catch. In addition, PAHs can also cause external tumors on fish, raising concerns from the public. Storm water ponds that fill up with sediment, adversely impacting water quality and increasing concerns about mosquito-borne encephalitis and West Nile virus. Periodic sediment removal would reduce sediment levels of PAH and consequently the risk of adverse effects to wildlife from their exposure. Although recommendations for the frequency of periodic sediment removal vary, most states recommend removal approximately every 10 years, however swimming and catch-and-keep fishing are not permitted in The Woodlands ponds, thereby significantly decreasing the risk and need for frequent removal of sediments. In summary, studies suggest that PAHs are a contaminant of potential ecological and human health concern in detention ponds. Educate the public about pollution prevention strategies that will reduce sources of PAH-contaminated storm water pond sediments.

## Dredging and Deepening

Small ponds can be dredged using excavating Over time, ponds can fill with sediment, leaves and decayed vegetation until areas of the pond are very shallow, less than 3 feet deep. These ponds equipment from the shore. Large bodies of water are difficult to manage because much of the surface area is covered in dense aquatic vegetation. The removal of pond bottom sediments is a very require boat-mounted dredging equipment. effective way to control rooted waterweeds in shallow ponds. Ponds are commonly dredged roughly every 20 years to remove sediment buildup. If a pond is not dredged, the collected sediment built up over time could reduce the volume of water that the pond can hold, lessening its effectiveness for flood control and storm water management. Dredging reduces aquatic plant problems directly by removing the plants, bottom sediments, and associated nutrients. Dredging and deepening shallow shoreline areas limits weed growth indirectly by exposing a soil layer that may be nutrient-poor or impervious to plant roots and by decreasing the amount of sunlight available to plant life. Deepening a pond can also help the pond deal with nutrient loading. Dredging can also remove muck and sediment during the process, as well as provide a better habitat for fish. Dredging can be conducted on dry land, after the pond has been drained, or underwater. Hydraulic dredging is normally too expensive for use in small ponds, but draglines can be used for underwater pond dredging. On drained pond bottoms, dry-land excavation machinery such as bulldozers can be used. The dredge spoils should be moved to prevent soil runoff back into the pond. Deeper ponds will hold more storm water runoff. Dredging is not typically routine maintenance, unless the pond fills in rapidly. Dredging can be expensive and the pond environment will be disturbed for at least a couple of years from time the pond is dredged. Dredging should be scheduled for a pond when shallow areas have become problematic for vegetation management, recreation or aesthetics e.g., shallow are limits ability to use fishing piers, excessive aquatic vegetation growth, etc.

## Pond Depth Study

Implementing pond management practices necessitates knowing the surface area and volumes of the ponds. Aquatic herbicide applications and fish stocking rates are prescribed on the basis of area and/or volume of the pond. Average depth measurements should be re-calculated every ten years to account for the gradual filling in of the pond. Soil disturbances in the watershed or excessive accumulation of decomposing vegetation in the pond will require more frequent measurement of the water depth. Minimization of organic sediment accumulation on the bottom of the pond will greatly extend the life of your pond and push back the timeline for dredging. Currently, several of the ponds in The Woodlands are already scheduled for desiltation, however it is recommended that all ponds have a depth study conducted to prioritize which ponds need treatment first.

## **Pond Bottom Liners**

Currently, the only pond with a liner in The Woodlands is Evergreen Pond. Covering the bottom of small ponds with liners is an effective way to hold water in a pond. Properly installed, a liner is 100 percent effective in stopping seepage. These coverings limit the exchange of nutrients from the bottom muds to aquatic plants and inhibit the establishment of rooted aquatic plants. Many factors influence the selection of a liner material, and consumers have a wide choice of products. Modern plastics are environmentally safe, withstand freezing, and are UV stabilized for long-term exposure to the sun. With care, a pond liner can last 20 to 25 years or more. Liner thickness is measured in thousandths of an inch (mils). For permanent aquaculture facilities, 30 to 40 mil liners are recommended. Liners can be made from high density polyethylene (HDPE) or low density polyethylene (LDPE). LDPE is more flexible and is used where there is more shifting or movement of the soil, while HDPE is more resistant to chemicals. As a general rule, a pond liner does not need to be replaced unless it leaks.

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When other vegetation management tools are not sufficient, mechanical aquatic plant control may be necessary.





Soil additives such as sodium bentonite clays are much less expensive than synthetic liners, especially for large ponds and lakes. Sodium bentonite is a highly plastic clay that expands 8 to 20 times in volume when wet. It is used to fill in voids in porous soils. A partial drawback to this type of material is the requirement for an experienced applicator in order to ensure a quality seal for the pond or lake. Additionally clays can create muddy water conditions as colloidal clay particles (very fine particles that are suspended in the water) can be introduced to the pond.

## Vegetation Management

## **Aquatic Vegetation**

Vegetation is an important part of the small pond environment. Microscopic aquatic plants form the base of the chain and provide dissolved oxygen through photosynthesis. Larger aquatic plants (macrophytes) serve as habitat for aquatic insects and provide cover for small fish. Low to moderate amounts of vegetation (up to 15 to 20 percent coverage) are desirable in a pond. However, extensive growths of aquatic vegetation can cause problems and corrective measures are required. Such growth hinders fishing success and usually affords too much protection for small fish. Stunted and imbalanced fish populations are usually associated with excessive aquatic vegetation.

Aquatic plants fulfill many natural functions and are vital in aquatic and wetland environments. Whether aquatic vegetation causes problems or not depends on the goals of the pond, the types of vegetation present and the amounts of vegetation present. For most pond goals, it is very desirable to have some aquatic vegetation present. Aquatic vegetation helps maintain cleaner water; it provides fish and wildlife habitat; it helps stabilize pond banks, minimizing bank erosion, it ties-up many pollutants; and it can increase the attractiveness of a pond. Some aquatic plants are desirable and serve as food sources for waterfowl and other wildlife, habitat for fish, and a substrate and food source for invertebrates. Aquatic weeds often cause serious problems in ponds. If ponds were constructed without extensive shallow water areas and if fertilized properly each year, aquatic vegetation should not become a serious problem. Certain aquatic plants also offer food and cover (i.e., nesting, protection) for a variety of insects and utilized by both fish and wildlife.

The problem with weeds is uncontrolled growth. If too many weeds become established in the pond, too many small fish survive (overpopulate) and predators (i.e., largemouth bass) become too thin because they are not able to prey on the forage species. Large growths of weeds also remove nutrients, which reduces algae production (food). Aquatic vegetation can be a problem in any one of four forms: Algae, submerged plants, floating plants, or emergent plants. Microscopic algae (plankton) are responsible for the green color in fertile water and are highly beneficial for fish growth and reproduction. However, microscopic filamentous algae can form a surface scum that is unsightly and of little use to fish populations. Submerged plants occur under the water and are rooted. They are commonly referred as "moss". The most common types of submerged plants are pondweeds, water milfoil, bladderwort, wild celery, and waterweed. Floating plants include true floating plants with roots that feed from water rather that soil and plants which are rooted in soil but have mainly floating plants include duckweed, water meal, and water hyacinths. Common rooted plants with floating leaves are water lily, American lotus, and water shield. Emergent plants are those that have the majority of their leaves protruding above the water surface and are usually found in shallow areas and along the shoreline. Common emergents include cattails, smartweed, arrowhead, pickerelweed, coastal water hyssop, sedges and rushes. Emergent vegetation provides protection for small fish from bass, wading birds and other predators.

Overabundant plants are often a problem during the Summer when warm water and extended sunlight make growing conditions ideal. Shallow ponds and gradually sloping shorelines are very susceptible to weed problems. As the water warms in the Spring, sunlight hits the bottom soils and supports plant growth. There are several treatment options compatible with fish, and wildlife to control aquatic plants in ponds. Effective treatments vary with the types and species of plants so the first important step is to identify the pest plant. There are many common aquatic plants in Texas and treatment alternatives vary with the growing conditions. Control methods are not permanent solutions. Most aquatic plants die back naturally as temperatures drop in the fall, however, if conditions for weed growth are good, the plants will return. Vegetation controls can be placed in three main categories - mechanical, biological, and chemical. Each method has some merit, and one or more may be used in any pond depending upon kinds of vegetation and water usage.

## **Mechanical Control**

Mechanical or hand removal of weeds is sometimes possible but is usually feasible in situations where only a few plants are present or in very small ponds. Using rakes, draglines, or cutters are common methods of aquatic plant removal. Shoreline weeds are often controlled with mowers and string trimmers. In small areas, physically pulling up young plants by hand in early Spring will control the plants. Duckweed can be skimmed away with a seine. Some types of plants spread by fragmentation, so remove cuttings from the water. Mechanical plant removal is usually not a permanent solution, as plants may grow back quickly and recolonize.

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## **Biological Control**

The simplest and most economical long term aquatic weed control is through an annual fertilization program. A properly fertilized pond will be colored green (growth of microscopic free-floating algae) and will help prevent the growth of unwanted aquatic weeds by preventing deep penetration of sunlight. This technique also enhances the fish production in ponds. Another means of biological control of aquatic vegetation may be attained by stocking Triploid Grass Carp. Triploid grass carp are a sterile form of the original white amur. An exotic fish, the grass carp controls most submergent and some emergent plants. Unlike regular grass carp (called Diploid Grass Carp), the triploid grass carp are certified by the U.S. Fish and Wildlife Service as sterile. Stocking of triploid grass carp is regulated by the Texas Parks and Wildlife Department.

## **Chemical Control**

Aquatic herbicides are a widely used method of vegetation control in ponds. Properly applied, they can safely and efficiently combat a number of nuisance aquatic plant species. Accurate identification of the target plant is essential prior to treatment as many herbicides are very selective in their action and level of control on a particular weed species. Always obtain professional advice on the plant's identification and recommendations for the appropriate herbicide treatment. Use only herbicides that are federally-approved and labeled for aquatic weed control. Always read the entire label before you use any herbicide and follow label directions carefully. Misuse or the use of unapproved herbicides could be dangerous to fish, mammals, turtles, birds, bankside vegetation, etc.

Algae (phytoplankton) are free-floating, single-celled plants which are the basic building block of the aquatic food chain. However, filamentous algae (pond scum or moss) is a common problem in ponds during the Summer. Algae can be controlled by using chelated copper or copper sulfate (blue stone). Chelated copper is recommended because it remains suspended in the water longer. Repeated, frequent use of copper compounds can adversely affect fish production.

There are several herbicide products which can be used to control aquatic plants which are approved for use in water that do not affect fish, wildlife, or waterfowl. Some commonly used herbicides for the control of aquatic plants are Diquat, Hydrothol, Endothall, Fluridone, Rodeo, 2-4-D, Chelated Copper and others. Shoreline weeds or marginal weeds where no water is present can be controlled by Roundup (glyphosate). The success of these products depends on proper weed identification, accurate analysis of the volume of water to be treated, following the label directions precisely, and timing. Other important components of all herbicide labels are the restrictions and precautions. To avoid health hazards, harmful environmental effects, and non-target injury, such restrictions must be rigorously adhered to. The best months for chemical control of aquatic vegetation is April through May. If treatment is delayed till summer, take care to maintain adequate Dissolved Oxygen levels. Decaying plants use the dissolved oxygen in the water and a fish kill can result if the oxygen level is sufficiently reduced. Heavy aquatic plant infestations should be treated by dividing the pond into sections. Treat about 1/4 of the pond at a time. Determine the application rate for each section being treated according to herbicide product directions. Wait 10 to 14 days before treating the next section. Do not apply herbicides during cloudy weather. Aquatic weeds can be treated with herbicides by using a 5 gallon pressure-type hand pump sprayer.

## Invasive Bank Vegetation

Non-native invasive plant species are a common problem around ponds and lakes and must be monitored to keep them under control. These species are out of their native range and capable of outcompeting native vegetation for resources in a landscape. During inspection of the ponds and lakes of The Woodlands, a total of four species were identified that are classified as invasive by the USDA and Texas Parks and Wildlife. The four introduced invasive species are Chinese Tallow (Triadica sebiferum), Chinese Privet (Ligustrum sinense), Alligatorweed (Alternanthera philoxeroides) and Elephant Ear (Colocasia esculenta). These species have no natural predators and can spread rapidly into new areas. Their seeds can often be transferred by birds to new areas.

**Chinese Tallow (Triadica sebiferum)** was brought over from China for use in candlemaking, and later as a landscape tree due to its fast growth and fall color. Over the past thirty years, it has taken over the southeastern forests including southeast Texas and western Louisiana. Its ability to produce prolific amounts of seed and to re-sprout make it a difficult species to control. It also has a toxin in the leaves and roots that inhibits native plants from becoming established and is pest resistant. Control methods include mechanical removal of the trees or locally applied herbicides, typically injected/hack-n-spray application.

**Chinese Privet (Ligustrum sinense)** is a small tree/shrub that was introduced from China to the United States for ornamental planting because of its fast growth and aromatic flowers. It escaped cultivation and poses a great threat via large scale ecosystem modification due to its ability to successfully compete with and displace native vegetation. These plants mature rapidly and are prolific seed producers. They also reproduce vegetatively by means of root suckers. Once established, Chinese Privet is very difficult to eradicate because of its reproductive capacity. The most common control method is through the use of foliar applied herbicides.

Alligatorweed (Alternanthera philoxeroides [Mart.] Griseb.) is a South American immigrant that has invaded waterways in the United States, primarily in the southeastern states. The species is believed to have been introduced by release of foreign ballast water from merchant vessels. It also is a weed in tropical and mild temperate regions around the world. Alligatorweed roots readily along waterways and then grows over the water surface as an anchored floating plant. It also grows terrestrially during dry periods. Alligatorweed is a federal noxious weed and a prohibited or noxious plant in Arizona, California, Florida, and South Carolina (USDA, NRCS, 1999). Typical control is by use of foliar applied herbicides that are safe for aquatic systems.

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## Environment





Elephant ear (Colocasia esculenta) is a favorite ornamental plant among home gardeners and is an invasive perennial in the Southern United States. It can tolerate shade and sunlight as well as very moist or dry conditions. The plant has large arrow or heart shaped leaves which are dark green in color and are water repellent. It has thick tubers which grow under the soil. The plant is native to tropical, southeastern Asia. Elephant ear is spread easily through the movement and establishment of plant fragments and is widely sold in the United States for horticultural use. It is established in the CSWGCIN Region in Texas and Louisiana and along the Gulf of Mexico coast east to Florida. Its range in the United States also includes Georgia, North Carolina, South Carolina, Hawaii, and Puerto Rico. Elephant ear's ability to adapt to a variety of conditions makes it a favorite for gardeners and is also the underlying cause of its invasive character in natural habitats. When established in natural habitats, elephant ear forms dense populations and crowds out native flora along the shorelines of bayous, streams, lakes, and ponds. The most effective control is through the use of a foliar applied solution of glyphosate (Round-Up<sup>TM</sup>) with a surfactant.



Chinese Tallow (Triadica sebiferum) is most easily identified by its somewhat heart-shaped leaves with pointed tips.



Alligatorweed (Alternanthera philoxeroides) is a matforming plant with 2 to 4 inch leaves, found along the banks and in shallow waters.



Chinese Prive (Ligustrum sinense) is a small shrub most notably identified by the small leaves arranged in pairs along the stems. ©Larry Allain. USGS NWRC.



Elephant Ear (Colocasia esculenta) grows along the bankse of ponds, lakes and streams and has easilyidentifable haeart to diarrow shaped leaves.

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## Environment









## Pond and Lake Management Plan

## Interpretive Signage and Wayfinding

One of the key tools for fostering good stewardship of a resource is educating the public on the value of the resource and benefits it provides to the community and environment. With park and recreation features such as ponds and lakes, interpretive signage can help explain ecological concepts that help citizens understand why the ponds are managed the way they are. A precedent project in The Woodlands is at Shadow Lake Marsh, a restored wetlands with a boardwalk and interpretive signage detailing the flora and fauna found there and their importance to the environment.

## **Public Participation**

Management of the aquatic resources in The Woodlands requires considerable time, capital and coordination of resources. Since the majority of the support comes from residents in The Woodlands, public knowledge and approval are critical to the continued success of the program. Knowledge of the overall management program will also improve facilitation of management work.

Gathering public input is a time-tested tool for identying the needs and desires of the citizens for any planning effort. Often, however day-to-day operations of facilities can take center stage and leave the opinions of the public overlooked. A key tool for understanding these needs is public outreach in the form of surveys, planning charrettes and focus group meetings. Useful input may include the following:

- •Level of Use of Facilities
- Background Information and Perception of Existing Conditions
- •Wants and Needs Related to the Pond and Lake System
- Overall Satisfaction

## Favorite Activities

Interpretive sign at Shadow Lake Marsh. Upon completion of public input activities, an action plan should be drafted that prioritizes needs and identifies solutions to those needs in a clear and executable manner. The action plan will serve as a guide for implementation of action items as a component to the management plan. Each action plan is a temporal document that will need to be updated periodically to address changes in the community over time.

To create a 'buy in' of the pond management program, there are numerous programs to consider. 'Adopt – a – pond' Program - Each pond has proximity to a local village and the majority are of a manageable size to allow for the local citizens to assist with trash cleanup and monitoring for trespassing or unlawful use. Currently, there is a 'water watch' program set up through the Montgomery County Master Naturalists that assist with testing selected waterways and completing periodic trash pickup of these areas. This program could be expanded to include each village associated with a particular pond that could be integrated with the highly successful 'Neighborhood Watch' program. The Environmental Services Department of the The Woodlands Township has a superb staff that provides the information and programs that integrate very well with the type of public pond education needed. Programs such as; Adopt-a-Pathway, Earth Day, Lawn Care, and the Nature Lecture series fit in very well with the need for aquatic education.

Educational materials and programs could be developed to spread the word about the pollution problems caused by runoff from neighborhoods and storm water. Programs to teach homeowners about water conservation, proper use of pesticides and fertilizers, and the reduction of storm water pollution should be available. There is a large amount of information available to assist from State agencies to facilitate such programs.

Identify specific sources of pollution from runoff is difficult at best, therefore educating specific neighborhoods about pollution problems can be a challenge. Though signs are available at most ponds educating residents about the problems with feeding ducks, additional outreach may be needed to discourage the practice. Tools for bringing these issues to attention of residents may include additional signage at pond park areas and pamplets or flyers available for distibution, the monthly newsletter, or even posting information on The Township's website.

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Public workshops provide an interactive dialog between citizens and Staff and often bring to light new ideas and perspectives not previously heard.





## **School education**

There are 23 public schools and over 20 private schools in The Woodlands area that have access to the water resources for educational purposes. The ponds are an untapped resource for water quality, aquatic plant, aquatic animal and ecology education. There is a vast amount of information and materials on aquatic education available to teachers and educators. We recommend that you develop a program that connects certain schools to geographically accessible ponds for educational opportunities. The Woodlands High School, College Park High School, John Cooper School and The Woodlands Christian Academy have the older students that could provide more extensive study and testing of the larger bodies of water. There is a Health and Science Academy located at the College Park High School along with Conroe High School that offers advanced studies in the Science and Health profession. Both of these entities could provide an excellent source of monitoring and data collection. As with the neighborhood programs, certain schools should be selected to become connected to a specific pond or lake.

Grants - There are grants available to municipalities that are active in Stormwater management to prevent 'Nonpoint Source Water Pollution'. The Texas Commission on Environmental Quality (TCEQ) has grants available.

## Websites for Water Quality and Environmental Education

EPA - Kids/students pages, sorted by age category: http://www.epa.gov/epahome/students.htm

Facts about water (USGS): http://ga.water.usgs.gov/edu/mearth.html

Corps of Engineers water resources management page with link to kid's activities (Clubhouse): http://education.usace.army.mil/water/resmgmt.html

Ducks Unlimited - Wetlands education: http://www.greenwing.org/dueducator/noncssdu\_educator.html

The Water Cycle (USGS): http://ga.water.usgs.gov/edu/watercycle.html

## Resources for water monitoring/testing:

LaMotte: http://www.lamotte.com/images/pdfs/education/LaMotte%202010%20Environmental%20Science%20Education%20Products%20catalog.pdf

Project Wet: http://www.projectwet.org/

Project Wild Aquatic: http://www.projectwild.org/ProjectWILDK-12AquaticCurriculumandActivityGuide.htm

Wetland Education and materials: http://cfpub.epa.gov/npdes/stormwatermonth.cfm

Environmental grants for municipalities: http://www.tceq.state.tx.us/compliance/monitoring/nps/grants/grant-pgm.html

## **Economic Benefits**

An often overlooked attribute of a pond and lake system is the economic benefits offered by ecological services and relative increase in property values provided by the resource. The ponds and lakes of The Woodlands provide measurable services to mitigate stormwater runoff through detention, and improve water quality through the removal of polluants. These value of these services can be calculated in monetary terms, and understanding the true value of a resource can bolster support for management activities and enhancements to the facilities over time. Additionally, these facilities increase the property values of homes in close proximity. Much like the trail system in The Woodlands, the ponds and lakes are a quality-of-life amenity that often determines whether or not a family or company decides to move into the community.





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DEPARTMENT OF THE INTERIOR

50 CFR Part 21

Fish and Wildlife Service

[Docket Number FWS-R9-MB-2007-0017; 91200-1231-9BPP]

RIN 1018-AV34 Migratory Bird Permits: Control of Muscovy Ducks, Revisions to the Waterfowl Permit Exceptions and Waterfowl Sale and Disposal Permits

Regulations AGENCY: Fish and Wildlife Service,

ACTION: Final rule

SUMMARY: We, the U.S. Fish and Wildlife Service, change the regulations governing control of introduced migratory birds. The muscovy duck (Cairina moschata) occurs naturally only in southern Texas. It has been introduced in other locations, where it is considered an invasive species that sometimes creates problems through competition with native species, damage to property, and transmission of disease. We amend the regulations to prohibit sale, transfer, or propagation of muscovy ducks for hunting and any other purpose other than food production, and to allow their removal in locations in which the species does not occur naturally in the contiguous United States, Alaska, and Hawaii, and in U.S. territories and possessions. This requires revision of regulations governing permit exceptions for captive-bred migratory waterfowl other than mallard ducks, and waterfowl sale and disposal permits, and the addition of an order to allow control of muscovy

ducks, their nests, and eggs. We also have rewritten the affected regulations to make them easier to understand. DATES: This rule will be effective on March 31, 2010. FOR FURTHER INFORMATION CONTACT: Dr. George T. Allen, Division of Migratory Bird Management, U.S. Fish and Wildlife Service, 703–358–1825.

SUPPLEMENTARY INFORMATION: Rackground

The Fish and Wildlife Service is the Federal agency delegated the primary responsibility for managing migratory birds. The delegation is authorized by the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703 *et seq.*), which implements conventions with Great Britain (for Canada), Mexico, Japan, and the Soviet Union (Russia). We implement the MBTA through

Federal regulations found in title 50 of the Code of Federal Regulations (CFR). In 50 CFR 10.13, we list all species of migratory birds protected by the MBTA that are subject to the regulations protecting migratory birds in title 50, subchapter B (Taking, Possession, Transportation, Sale, Purchase, Barter Exportation, and Importation of Wildlife and Plants). In 50 CFR part 13 (General Permit Procedures) and part 21 (Migratory Bird Permits), regulations allow us to issue permits for certain activities otherwise prohibited in regard to migratory birds. In part 21, we issue permits for the taking, possession, transportation, sale, purchase, barter, importation, exportation, and banding and marking of migratory birds. In that part, we also provide certain exceptions to permit requirements for public, scientific, or educational institutions and establish depredation and control orders that provide limited exceptions to the MBTA.

#### Muscovy Duck

The muscovy is a large duck native to South America, Central America, and Mexico. Due to a recent northward expansion of the range of the species, there is a small natural population in three counties in southern Texas in which natural breeding of wild birds has been confirmed. For that reason, wincluded this species in the final rule published today to revise the list of migratory birds found at 50 CFR 10.13.

The muscovy duck normally inhabits forested swamps and mangrove ponds, lakes and streams, and freshwater ponds near wooded areas. The species often roosts in trees at night. The hen usually lays her eggs in a tree hole or hollow. However, muscovy ducks will

occasionally nest in abandoned nests of

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arge birds such as ospreys or eagles between palm tree fronds, and in wooden boxes or other man-made, elevated cavities. The species does not orm stable pairs.

Muscovy ducks can breed near urban and suburban lakes and on farms, nesting in tree cavities or on the ground. under shrubs in yards, on condominiu balconies, or under roof overhangs. Feral populations, particularly in Florida, are said to present problems. Feral muscovy ducks are wary and associate little with other species. Muscovy ducks feed on the roots, stems, leaves, and seeds of aquatic and terrestrial plants, including agricultural crops. They also eat small fishes, eptiles, crustaceans, insects,

millipedes, and termites. Muscovy ducks live alone or in groups of 4 to 12, rarely in large flocks. They are mainly active in the morning and afternoon, feeding on the shores of brackish waters, or in the flood savannah and underbrush. They often sleep at night in permanent roosts in trees along the river bank. Heavy and low-flying, they are silent and timid. Muscovy ducks swim much less than other ducks, and the males fly poorly We received comments from States and individuals expressing concern over control of muscovy ducks in response to the 2006 proposal to add the species to the list of those protected under the MBTA (50 CFR 10.13). In general, States expressed concern over feral and freeranging populations of muscovy ducks present as the result of human activity. or example, one State was concerned that protecting the species under the MBTA "would severely impede our efforts to manage the feral and freeranging populations of domestic muscovy ducks." Individuals expressed concern over property damage and aggressiveness demonstrated by the lucks. The muscovy duck is an introduced species in many locations in the United States. We believe it is prudent to prohibit activities that would

allow release of muscovy ducks in areas in which they are not native and may ompete with native species. We expect control of muscovy ducks to be undertaken primarily through the use of walk-in baited traps and through shooting. The use of baited traps will greatly limit the potential impacts to other species, especially passerines, which would be unlikely to enter properly placed traps. Shooting

undertaken by State agency or U.S. Department of Agriculture Wildlife Services personnel would be very unlikely to harm other species. We propose to revise 50 CFR 21.14 to prohibit sale and, in most cases,

sion, of muscovy ducks; to revise § 21.25 to prohibit sale or transfer of captive-bred muscovy ducks for hunting; and to add § 21.54 to allow removal of introduced muscovy ducks from any location in the contiguous United States outside Hidalgo, Starr, and Zapata Counties in Texas, and in Alaska, Hawaii, and U.S. territories and possessions. This removal is in keeping with the Service's other actions to reduce the spread of introduced species that compete with native species or harm habitats that they use. It also is in keeping with the intent of the Migratory Bird Treaty Reform Act of 2004 (16 U.S.C. 703 (b)), which excluded nonnative species from MBTA protection.

#### Comments on the Proposed Rule

We received ten sets of comments on the proposed rule published on August 22, 2008 (73 FR 49626-49631). The commenters raised the following issue Issue. One commenter suggested that

Cameron County, Texas not be included in the natural range of the muscovy duck in Texas.

"I suggest leaving Cameron County, TX out of 'native range' since birds there act quite tame and occur in urban/suburban settings." Reference Brush, T. 2005. Nesting Birds of a Tropical Frontier, the Lower Rio Grande Valley of Texas. Texas A&M

University Press, College Station, Texas. Response. We revised this regulation accordingly. The listing of counties now matches the information in the listing by the American Ornithologists' Union (1998. Check-list of North American Birds. 7th edition. American Ornithologists' Union, Washington, DC)

and subsequent updates. Issue. Escape to the wild and competition with native species.

\*\* \* these new proposed rules do not deal with domesticated farm populations. Regulation of feral populations may help to solve some problems, but efforts should be taken to regulate domesticated populations as well. On most farms, some animals escape from time to time. These escaped animals could easily set up a population and be responsible for the spread of Muscovy ducks. If the Fish and Wild Life Service's true goal is to control indigenous Muscovy ducks, it seems imperative that they should adopt provisions aimed at minimizing the potential for domesticated ducks to escape and then

reproduce." "I am happy to get rid of muscovy ducks because as anyone would probably heard, this species really mess up the lives of other bird species in Tampa Bay area. There is, in my opinion, way too many muscovy ducks hanging or hovering around aquatic ecosystem especially suburban pond or lake where many local species thrive. I personally saw muscovy ducks chasing white ibis and great egret from a lake not too far from my





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house. Not only the muscovy ducks take over the "aquatic territory", they multiply too fast. I am seeing locals feeding the duck making the ducks staying put so they would get easy food which also help supply the offspring as well. I've lived in Tampa Bay area for almost 15 years and noticed that the muscovy ducks are definitely taking over the local species habitat and pushing the local species to find other place where it get tougher with nent brewing. If we can manage the population by limiting eggs hatching and if possible, hunting, we can somewhat control the population. The muscovy ducks have been more of bad news than good news."

Response. Control of this species in areas in which it is invasive is the intent of this rulemaking.

Issue. Range expansion of this species to the north.

"These ducks are moving up because of global warming. Why when they seek the varmer weather up north are they being killed because of that natural movement

killed because of that natural movement?" "If the birds are expanding their range— why would you want to stop this?" "\* \* \* nowhere in the proposed rule does the agency make an allowance for natural populations that spread into neighboring counties. The language should be changed to allow for natural population acoust from allow for natural population growth from ative regions.

Response. We recognize that muscovy ducks have expanded their range slightly into very southern Texas However, they are introduced in most ocations in the U.S. in which they are found, and as such are an invasive species that competes with native species. Control of muscovy ducks within their natural range in southern Texas will not be allowed under the ontrol order. Any control of muscovy ducks in the three counties in which they have a natural population will require a depredation permit, just as with any other species protected by the MBTA. It is doubtful that we would issue any such permits unless current population levels increase significantly we may not issue depredation permits that potentially threaten a wildlife population under 50 CFR 13.21. We will consider this species' status and range in future updates of the list of the migratory birds at 50 CFR 10.13, and may amend this regulation accordingly. n Hidalgo, Starr, and Zapata counties in Texas, muscovy ducks will be ected as any other migratory bird isted in 10.13.

Issue. Interbreeding with other species.

"The species has "begun to interbreed with northern ducks." How does this proposal intend on dealing with this issue?" "\* \* the proposed rule makes no "\* \* the proposed rule makes no mention of so-called "mules," a cross between Muscovy ducks and other duck species. Mules, while unable to reproduce

s[t]ill have the potential to hamper government control of Muscovy duck pulations. This topic should be

Besponse. Any hybrid of a species listed at 50 CFR 10.13 is a Federallyregulated migratory bird species. As such, it may be managed under all relevant regulations. Hybrids of muscovy ducks in the wild may be controlled under this regulation. Issue. Production of muscovy ducks for food.

" muscovy ducks are produced in the millions in the United States generally for meat production \* \*. No permits are needed to possess domesticated barnyard fowl. This species is bought and sold in the millions being the most commonly held species of waterfowl in the United States. "I believe that problems associated with large feral populations of muscovy ducks are from domesticated varieties raised in Irom domesticated varieties raised in captivity that have wandered, or allowed to free range, and not from 'wild' type muscovies imported from Latin America. "The proposed regulation's goal of preventing additional human interduction of

ing additional human introduction of Muscovy ducks has great merit. It is far better to prevent populations from establishing than to subject more ducks to control later. to subject more ducks to control later. However, the proposed regulation limits acquisition, possession, and propagation for some owners but not for others. Accidental releases from food production are not addressed and could continue to allow Muscovy populations to become established. No clear reason is evident for targeting only Muscovies not in food production to prevent additional introductions. Why are Muscovies in food production excepted when this source of accidental releases may be

mificant? "The rule should be focused on controlling opulations, both feral and domestic, instead of destroying established populations. By controlling populations, the Fish and Wildlife Service can largely achieve the same goals without many of the potential harmful side effects.'

Response. This rule is intended to limit production and releases of muscovy ducks in locations in which the species is not native. However, it is unusual because we will continue to allow ongoing commercial endeavors with a species that was not protected under the MBTA. We are aware of the production of muscovy ducks for food. and this rule is intended to allow that production to continue. We will allow ontinued production of muscovy ducks for food because we do not want to create economic dislocation. We may review allowing possession for food production in the future if escapes and eleases from this source are shown to be a problem. However, the regulation: state that release of muscovy ducks to the wild is not to be allowed, regardless of the source of the birds.

Issue. Three commenters requested that use of OvoControlJ (nicarbazin) be allowed under the control order.

"The HSUS supports non-lethal tools to resolve conflicts such as when people feel Muscovy ducks are a nuisance. We strongly recommend that the final regulation recommend that the final regulation explicitly allows use of contraceptive technology to control Muscovy ducks. Nicarbazin is registered by the Environmental Protection Agency for Muscovy ducks. It prevents egg and embryo development so that additional ducklings do not hatch. This tool allows communities to humanohy nedrog Backs without the humanely reduce flocks without the controversy engendered by killing. Muscovy and other ducks are much loved by some members of the community even where they are considered a nuisance. Contraceptive technology must be available for communities that rightly reject killing neighborhood ducks."

Response. As with control of some other bird species, particularly Canada geese (Branta Canadensis), nicarbazin may be used if the applicator has a migratory bird permit to use it. However, we will work on the necess Endangered Species consultation to allow use of nicarbazin under this control order in the future.

Issue, USDA Wildlife Services requested that within Cameron, Hidalgo Starr. and Zapata counties in Texas. muscovy duck management be allowed consistent with rules and regulations for other migratory bird species, including take of birds and their nests and eggs. Response. Control of Muscovy ducks in Hidalgo, Starr, and Zapata counties (we removed Cameron county from the provisions in § 21.54) would be subject to the regulations for authorizing depredation permits and our general permit regulations. We added language o § 21.54 to address this concern Issue. Capture and transfer of muscovy ducks, and muscovy ducks on private property.

"Live-capture and transfer to responsible private ownership is also a humane resolution for so-called nuisance ducks. While the opportunities for such transfer are limited, where there are potential new homes it is humane to the ducks and offers unities an uncontroversial solution Communities an uncontroversial solution. With the proposed restrictions on propagation and release, this resolution would also achieve the regulation's goal. The final regulations should allow this option for

controlling Muscovy ducks." "The HSUS is very concerned about the proposed regulation's impact on currently owned ducks who are not kept for food production. As proposed, the regulations seem to outlaw these ducks. It is not clear what USFWS expects will become of them but it seems it would be illegal for their owners to continue to keep them. This would be unreasonable and unnecessarily cruel for both the ducks and their owners. Many people keep ducks as pets. Waterfowl

fanciers maintain hobby flocks. Waterfowl rescuers have removed ducks from places people considered them nuisances; keeping some and finding new private owners for others. Forcing all these private owners to kill their birds or be in violation of this regulation would be outrageous. However. that appears to be the only way to construct the proposed regulation."

Response. We allow private ownership of MBTA-protected species in few circumstances. We intend to disallow private possession of muscovy ducks, except to raise them to be sold as food (which has been ongoing for years). However, we will allow session of any live muscovy duck held on the date when this rule takes effect. In most every location, the muscovy

duck is an introduced, invasive species We will allow control of muscovy ducks as best suits the needs of the States and wildlife management agencies, who requested this authorization. Though the control order allows States and other entities to remove muscovy ducks, we do not expect that they will do so when the ducks are on private property. However, people who propagate muscovy ducks or allow them to multiply and move off their property should realize that the muscovy ducks may be subject to the control efforts that the State or local wildlife agency deems necessary.

#### **Required Determinations**

## Regulatory Planning and Review (Executive Order 12866)

The Office of Management and Budget (OMB) has determined that this rule is not significant and has not reviewed this rule under Executive Order 12866 OMB bases its determination upon the

following four criteria: (a) Whether the rule will have an annual effect of \$100 million or more on the economy or adversely affect an economic sector, productivity, jobs, the environment, or other units of the vernment. (b) Whether the rule will create

inconsistencies with other Federal

agencies' actions, (c) Whether the rule will materially affect entitlements, grants, user fees, loan programs, or the rights and

bligations of their recipients, and (d) Whether the rule raises novel legal or policy issues.

Regulatory Flexibility Act (5 U.S.C. 601 et seq.)

Under the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*, as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 (Pub. L. 104-121)), whenever an agency is

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required to publish a notice of lemaking for any proposed or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the effect of the rule on small entities (i.e., small businesses, small organizations and small government jurisdictions) However, no regulatory flexibility analysis is required if the head of an agency certifies the rule would not have significant economic impact on a ubstantial number of small entities. SBREFA amended the Regulatory Flexibility Act to require Federal agencies to provide the statement of the factual basis for certifying that a rule would not have a significant economi mpact on a substantial number of small entities. We have examined the rule's potential effects on small entities as equired by the Regulatory Flexibility Act. Commercial producers of muscovy ducks for sale to entities other than food-producers are few and widely scattered across the country. Therefore we have determined that this action will not have a significant economic impact on a substantial number of small entities, because the changes we are oposing are intended primarily to educe the spread of an invasive species little used in commercial endeavors There will very minimal costs, if any, ssociated with this regulations change Consequently, we certify that because this rule will not have a significant economic effect on a substantial number

of small entities, a regulatory flexibility nalysis is not required. This rule is not a major rule under SBREFA (5 U.S.C. 804(2)). It will not have a significant impact on a substantial number of small entities.

a. This rule will not have an annual effect on the economy of \$100 million

b. This rule will not cause a major increase in costs or prices for consumers; individual industries; Federal, State, or local government agencies; or geographic regions. c. This rule will not have significant adverse effects on competition, employment, investment, productivity, innovation, or the ability of U.S.-based nterprises to compete with foreignbased enterprises.

Unfunded Mandates Reform Act In accordance with the Unfunded Mandates Reform Act (2 U.S.C. 1501 et seq.), we have determined the following: a. This rule will not "significantly or uniquely" affect small governments. A small government agency plan is not required. Actions under the proposed egulation will not affect small

overnment activities in any significant b. This rule will not produce a Federal mandate of \$100 million or greater in any year; *i.e.*, it is not a

"significant regulatory action" under the Unfunded Mandates Reform Act. Takings

In accordance with E.O. 12630, the rule will not have significant takings implications. This rule will not contain a provision for taking of private property. Therefore, a takings implication assessment is not required Federalism

This rule will not have sufficient Federalism effects to warrant preparation of a Federalism ass under E.O. 13132. It will not interfere with the States' ability to manage themselves or their funds. No significant economic impacts are expected to result from control of muscovy ducks.

Civil Justice Reform

In accordance with E.O. 12988, the Office of the Solicitor has determined that the rule will not unduly burden the judicial system and meets the requirements of sections 3(a) and 3(b)(2) of the Order.

Paperwork Reduction Act

We examined these regulations under the Paperwork Reduction Act (44 U.S.C. 3501 *et seq.*). There are no new information collection requireme associated with this regulations change.

National Environmental Policy Act

We have analyzed this rule in accordance with the National Environmental Policy Act (NEPA), 42 U.S.C. 432–437(f), and part 516 of the U.S. Department of the Interior Manual (516 DM). The change we propose is to allow people and agencies to remove the muscovy duck a species from locations in the United States and United States territories in which the species may have been introduced. We completed an Environmental Assessment and a Finding of No Significant Impact in which we concluded that the regulations change allowing the removal of an introduced species does not require an environmental impact statement addressing potential impacts on the quality of the human environmen

Environmental Consequences of the

The primary change made in this final rule is to prohibit release of the muscovy duck in locations in which it does not occur naturally. It has been





#### Federal Register/Vol. 75, No. 39/Monday, March 1, 2010/Rules and Regulations 9320

introduced in other locations, where it is an invasive species that sometimes creates problems through competition with native species and damage to property. We amend 50 CFR part 21 to proĥibiť sale of muscovy ducks for unting, and to allow their removal in locations in which the species does not occur naturally in the contiguous United States, Alaska, and Hawaii, and in U.S. territories and possessions. Revisions are made to § 21.14 (permit exceptions for captive-bred migratory waterfowl other than mallard ducks) and §21.25 (waterfowl sale and disposa permits), and addition of § 21.54, an rder to allow control of muscow ducks, their nests, and eggs. The first two regulations are to prevent introduction of the species and will only have a positive environmental impact, if any. Because the muscovy duck occurs only in small numbers at scattered locations outside its natural range in southern Texas, the impacts of control of the species under a new regulation at § 21.54 are minimal.

Socioeconomic. This rule will have minimal socioeconomic impacts. Migratory bird populations. This rule will not affect migratory bird

populations. Endangered and threatened species. The regulation is for migratory bird species that are not threatened or endangered. It will not affect threatened or endangered species or critical habitats. Section 7 of the Endangered Species

Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*), requires that "The Secretary [of the Interior] shall review other programs administered by him and utilize such programs in

furtherance of the purposes of this chapter" (16 U.S.C. 1536(a)(1)). It further states that the Secretary must "insure that any action authorized, funded, or carried out\* \* \* is not likely to

ieopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [critical] habitat" (16 U.S.C. 1536(a)(2)). We have concluded that the regulations change would not affect listed species, and the Division of Migratory Bird Management has conducted an Endangered Species consultation on this rule to confirm this

Government-to-Government Relationship With Tribes

In accordance with the President's memorandum of April 29, 1994, "Government-to-Government Relations with Native American Tribal Governments" (59 FR 22951), E.O. 13175, and 512 DM 2, we have

evaluated potential effects on Federally cognized Indian Tribes and have letermined that there are no potentia effects. This rule will not interfere with the Tribes' ability to manage themselves or their funds or to regulate migratory bird activities on Tribal lands.

Energy Supply, Distribution, or Use (E.O. 13211) On May 18, 2001, the President issued

E.O. 13211 addressing regulations that significantly affect energy supply, distribution, and use, E.O. 13211 equires agencies to prepare Stateme of Energy Effects when undertaking certain actions. Because this rule will affect only import and export of birds in limited circumstances, it is not a significant regulatory action under E.O. 12866, and will not significantly affect energy supplies, distribution, or use. Therefore, this action is not a significant energy action and no Statement of Energy Effects is required.

List of Subjects in 50 CFR Part 21

Exports, Hunting, Imports, Reporting, and recordkeeping requiremen Transportation, Wildlife.

For the reasons stated in the preamble. we amend part 21 of subchapter B, chapter I, title 50 of the Code of Federal Regulations, as follows:

## PART 21-MIGRATORY BIRD PERMITS

■ 1. The authority citation for part 21 continues to read as follows:

Authority: Migratory Bird Treaty Act, 40 Stat. 755 (16 U.S.C. 703); Pub. L. 95–616, 92 Stat. 3112 (16 U.S.C. 712(2)); Pub. L. 106– 108, 113 Stat. 1491, Note following 16 U.S.C.

■ 2. Revise § 21.14 to read as follows:

## §21.14 Permit exceptions for captive-bred migratory waterfowl other than mallard ducks.

You may acquire captive-bred and properly marked migratory waterfowl of all species other than mallard ducks (Anas platyrhynchos), alive or dead, or their eggs, and possess and transport such birds or eggs and any progeny or eggs for your use without a permit, subject to the following conditions and restrictions. Additional restrictions on the acquisition and transfer of muscovy ducks (*Cairina moschata*) are in paragraph (g) of this section.

(a) You may acquire live waterfowl or their eggs only from a holder of a valid waterfowl sale and disposal permit in the United States. You also may awfully acquire them outside of the United States with appropriate permits (see § 21.21 of subpart C of this part).

(b) All progeny of captive-bred birds or eggs from captive-bred birds must be physically marked as set forth in §21.13(b)

(c) You may not transfer or dispose of captive-bred birds or their eggs, whether alive or dead, to any other person unless you have a waterfowl sale and disposal rmit (see § 21.25 of subpart C of this

part). (d) Lawfully possessed and properly marked birds may be killed, in any number, at any time or place, by any means except shooting. Such birds may be killed by shooting only in accordance with all applicable hunting regulations governing the taking of like species from the wild (see part 20 of this subchapter). (e) At all times during possession, transportation, and storage until the raw carcasses of such birds are finally processed immediately prior to cooking, smoking, or canning, you must leave the marked foot or wing attached to each carcass, unless the carcass was marked as provided in § 21.25(b)(6) and the foot or wing was removed prior to your acquisition of the carcass. (f) If you acquire captive-bred

erfowl or their eggs from a waterfowl sale and disposal permittee, you must retain the FWS Form 3–186, Notice of Waterfowl Sale or Transfer, from the permittee for as long as you have the birds, eggs, or progeny of them. (g) You may not acquire or possess

live muscovy ducks, their carcasses or parts, or their eggs, except to raise them to be sold as food, and except that you may possess any live muscovy duck that you lawfully acquired prior to March 31, 2010. If you possess muscovy ducks on that date, you may not propagate them or sell or transfer them to anyone for any purpose, except to be used as food. You may not release them to the wild, sell them to be hunted or released to the wild, or transfer them to anyone to be hunted or released to the wild. (h) Dealers in meat and game, hotels restaurants, and boarding houses may serve or sell to their customers the carcass of any bird acquired from a holder of a valid waterfowl sale and disposal permit.

■ 3. Revise § 21.25 to read as follows: §21.25 Waterfowl sale and disposal

(a) Permit requirement. You must have a waterfowl sale and disposal permit before you may lawfully sell, trade, donate, or otherwise dispose of, most species of captive-reared and properly marked migratory waterfowl or their eggs. You do not need a permit to sell or dispose of properly marked captive-reared mallard ducks (Anas platyrhynchos) or their eggs.

(b) Permit conditions. In addition to the general conditions set forth in part 13 of this subchapter B, waterfowl sale and disposal permits are subject to the following conditions: (1) You may not take migratory

waterfowl or their eggs from the wild, unless take is provided for elsewhere in this subchapter. (2) You may not acquire migratory

waterfowl or their eggs from any pers who does not have a valid waterfowl ropagation permit. (3) Before they are 6 weeks of age, all

live captive migratory waterfow possessed under authority of a valid waterfowl sale and disposal permit must be physically marked as defined in

(4) All offspring of birds hatched, reared, and retained in captivity also must be marked before they are 6 weeks of age in accordance with § 21.13(b), unless they are held in captivity at a public zoological park, or a public cientific or educational institution

(5) Properly marked captive-bred birds may be killed, in any number, at any time or place, by any means except shooting. They may be killed by shooting only in accordance with all the applicable hunting regulations rning the taking of like species from

the wild. (6) At all times during possession. transportation, and storage, until the raw carcasses of such birds are finally processed immediately prior to cooking, smoking, or canning, the marked foot or wing must remain attached to each carcass. However, if you have a State license, permit, or authorization that allows you to sell game, you may remove the marked foot or wing from the raw carcasses if the number of your State license, permit, or authorization has been legibly stamped in ink on the back of each carcass and on the wrapping or container in which each carcass is maintained or if each carcass is identified by a State band on a leg or wing pursuant to requirements of your State license, permit, or authorization.

(7) You may dispose of properly marked live or dead birds or their eggs (except muscovy ducks and their eggs) in any number at any time or place, transfer them to any person, if the birds are physically marked prior to sale or disposal, regardless of whether or not they have attained 6 weeks of age.

 (8) You may propagate muscovy ducks (*Cairina moschata*) only for sale for food. (i) You may not release muscovy

ducks to the wild or transfer them for release to the wild. (ii) You may not sell or transfer

scovy ducks to be killed by shooting.

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## A - Federal Policy for Muscovy Ducks

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9321

(9) If you transfer captive-bred birds or their eggs to another person, you must complete FWS Form 3-186, Notice of Waterfowl Sale or Transfer, and provide all information required on the rm, plus the method or methods by which individual birds are marked as

required by § 21.13(b). (i) Give the original of the completed form to the person acquiring the birds eggs. (ii) Retain one copy in your files.

(iii) Attach one copy to the shipping ontainer for the birds or eggs, or include it with shipping documents that accompany the shipping document. (iv) By the end of the month in which

vou complete the transfer, mail two copies to the Fish and Wildlife Service Regional Office that issued your permit. (c) Reporting requirements. You must submit an annual report by January 10th of each year to the Fish and Wildlife Service Regional Office that issued your permit. You must report the number of waterfowl of each species you possess on that date, and the method or methods y which each is marked. (d) Applying for a waterfowl

propagation permit. Submit your application for a waterfowl sale and osal permit to the appropriate Regional Director (Attention: Migratory Bird Permit Office). You can find addresses for the Regional Directors in 50 CFR 2.2. Your application must contain the general information and certification required in § 13.12(a) of subchapter A of this chapter, and the following additional information: (1) A description of the area where vou will keep waterfowl in your

(2) The species and numbers of waterfowl you possess and a statement showing from whom the birds were obtained:

(3) A statement indicating the method by which birds you hold will be marked as required by the provisions of this part 21: and

(4) The number and expiration of your State permit if you are required to have

(e) Term of permit. A waterfowl sale and disposal permit issued or renewed under this part expires on the date designated on the face of the permit inless amended or revoked, but the term of the permit will not exceed five (5) years from the date of issuance or enewal

■ 4. Add new § 21.54 to subpart D to read as follows:

## §21.54 Control order for muscovy ducks (a) Control of muscovy ducks.

Anywhere in the contiguous United

States except in Hidalgo, Starr, and Zapata Counties in Texas, and in Alaska, Hawaii, and U.S. territories and oossessions, landowners and Federal, State, Tribal, and local wildlife management agencies, and their tenants, employees, or agents may, without a Federal permit, remove or destroy muscovy ducks (Cairina moschata) (including hybrids of muscovy ducks). or their nests, or eggs at any time when found. Any authorized person may temporarily possess, transport, and dispose of muscovy ducks taken under this order.

(b) Muscovy ducks in Hidalgo, Starr and Zapata Counties in Texas. In these counties, take of muscovy ducks, their nests, and their eggs may be allowed if we issue a depredation permit for the activity.

(c) Disposal of muscovy ducks. You may donate muscovy ducks taken under this order to public museums or public institutions for scientific or educational purposes, or you may dispose of them by burying or incinerating them. You may not retain for personal use or consumption, offer for sale, or sell a muscovy duck removed under authority of this section, nor may you release it in any other location.

(d) Other provisions. (1) You must omply with any State, territorial, or Tribal laws or regulations governing the removal or destruction of muscovy ducks or their nests or eggs.

(2) You may not remove or destroy muscovy ducks or their nests or eggs if doing so will adversely affect other migratory birds or species designated as endangered or threatened under the authority of the Endangered Species Act. If you use a firearm to kill muscovy ducks under the provisions of this section, you must use nontoxic shot or iontoxic bullets to do so.

(3) If you operate under this order you must immediately report the take of any species protected under the Endangered Species Act, or any other bird species protected under the Migratory Bird Treaty Act, to the Fish and Wildlife Service Ecological Services Office for the State or location in which the take occurred.

(4) We reserve the right to suspend or revoke the authority of any agency or individual to undertake muscovy duck control if we find that the agency or individual has undertaken actions that may harm Federally listed threatened or endangered species or are contrary to the provisions of this part.

![](_page_122_Picture_68.jpeg)

# A CALCO AND AND A

# The Woodlands Township Pond and Lake Management Plan

Federal Register/Vol. 75, No. 39/Monday, March 1, 2010/Rules and Regulations 9322

Dated: February 3, 2010. Thomas L. Strickland, Assistant Secretary for Fish and Wildlife and Parks. [FR Doc. 2010–3284 Filed 2–26–10; 8:45 am] BILLING CODE 4310-55-P

February 2011

# A - Federal Policy for Muscovy Ducks IV

![](_page_123_Picture_7.jpeg)

![](_page_124_Picture_0.jpeg)

Pond and Lake Management Plan

AgriLIFE EXTE	AS A&M System		Wa Soil, ' Depa 345 H	ter Analysi Water and Fora rtment of Soil a leep Center, 24	s Report age Testing Labora and Crop Sciences 174 TAMU	atory
Report generated for: Burditt Consultants, LLC 310 Longmire			Colle 979-8	ge Station, TX 45-4816	77843-2474	
Conroe, TX 77304			Visit http:/	our website: /soiltesting.tan	nu.edu	
Laboratory #: Customer Sample ID: Date Processed: Sample from Montgomery Cour	17518 Woodlands P 10/13/2010	onds 1	Form	at based on pu	blication SCS-200	2-12
Water Source =Pond/Lake		Water Use =Aquacultur	e			
Parameter analyzed	Results	Units	Method	V. Limiting	Limiting	Accept
Calcium (Ca)	8	ppm	ICP	Report s	ent to Exte	nsion
Magnesium (Mg)	2	ppm	ICP	Fisherie	s Specialist	
Sodium (Na)	64	ppm	ICP	Dr. Mich	ael Masser	10 <sup>4</sup>
Potassium (K)	5	ppm	ICP	979-845	7370	
Boron (B)	0.09	ppm	ICP	m-mass	er@tamu ec	11
Carbonate (CO <sub>3</sub> )	0	ppm	Titr.	111111111111111111111111111111111111111	on with muilding	
Bicarbonate (HCO <sub>3</sub> )	155	ppm	Titr.			
Sulfate (SO4-calculated from total S)	8	ppm	ICP		(1) WHICH A PARTY AND	
Chloride (CI-)	46	ppm	Titr.			
Nitrate-N (NO <sub>3</sub> -N) <	0.01	ppm	Cd-red.			
Phosphorus (P)	0.10	ppm	ICP			
pH	7.54		ISE			
Conductivity	283	umhos/cm	Cond.			
Hardness	2	grains CaCO3/gallon	Calc.			
Hardness	28	ppm CaC03	Calc.		Sector Reality of	
Alkalinity	127	ppm CaC03	Calc.			
Total Dissolved Salts (TDS)	288	ppm	Calc.			
SAR	5.3		Calc.	AND THE REAL PROPERTY OF THE P		
Iron (Fe)					C. C. States and States	
Zinc (Zn)					and the second	
Copper (Cu)						
Manganese (Mn)						
Arsenic (As)					Constant of the second	
Barium (Ba)						
Nickel (Ni)					A CARLEN AND AND AND AND AND AND AND AND AND AN	
Cadmium (Cd)						
Lead (Pb)						
Chromium (Cr)						
Flouride (F)					A CARACTER	Sec. She
Charge Balance (cation/anion*100)	86		Calc.			
ppm=parts per million=milliorams per li	ter					
· · · · · · · · · · · · · · · · · · ·	10/07/1					

ICP, Inductively coupled plasma; Titr., titration; ISE, ion selective electrode; Cd-red., cadmium reduction; cond., conductivity; calc., calculate

AgriLIFE EXTENSION

Report generated for: Burditt Consultants, LLC 310 Longmire Conroe, TX 77304

Laboratory #:	17519
Customer Sample ID:	Woodlands Ponds 2
Date Processed:	10/13/2010
Sample from Montgomery C	ounty
Water Source =Pond/Lake	Wate

Parameter analyzed	Results
Calcium (Ca)	8
Magnesium (Mg)	1
Sodium (Na)	22
Potassium (K)	5
Boron (B)	0.05
Carbonate (CO <sub>3</sub> )	0
Bicarbonate (HCO <sub>3</sub> )	62
Sulfate (SO4-calculated from totat s)	7
Chloride (Cl-)	24
Nitrate-N (NO <sub>3</sub> -N)	0.05
Phosphorus (P)	0.15
рН	6.80
Conductivity	126
Hardness	2
Hardness	26
Alkalinity	51
Total Dissolved Salts (TDS)	130
SAR	1.9
Iron (Fe)	
Zinc (Zn)	
Copper (Cu)	
Manganese (Mn)	
Arsenic (As)	
Barium (Ba)	
Nickel (Ni)	
Cadmium (Cd)	
Lead (Pb)	
Chromium (Cr)	
Flouride (F)	
Charge Balance (cation/anion*100)	88

scriptions of each water parameter, potential use issues and ta ICP, Inductively coupled plasma; Titr., titration; ISE, ion selective

# B - Water Sample Results V

Water Analysis Report Soil, Water and Forage Testing Laboratory Department of Soil and Crop Sciences 345 Heep Center, 2474 TAMU College Station, TX 77843-2474 979-845-4816 Visit our website: http://soiltesting.tamu.edu					
ater Use =Aquacultur	e				
Units	Method	V. Limiting Limiting Acceptable			
ppm	ICP	Report sent to Extension			
maa	ICP	Fisheries Specialist			
ppm	ICP	Dr Michael Masser			
ppm	ICP	979-845-7370			
ppm	ICP	m-masser@tamu.edu			
ppm	Titr.				
ppm	Titr.				
ppm	ICP				
ppm	Titr.	A STATE OF AN AND A STATE OF			
ppm	Cd-red.				
ppm	ICP				
	ISE				
umhos/cm	Cond.				
rains CaCO3/gallon	Calc.				
ppm CaC03	Calc.				
ppm CaC03	Calc.				
ppm	Calc.	and the second			
	Calc.				
		and the second			
		and the second sec			
	Calc.				
d target levels are provide	d in publicatio	on SCS-2002-10, Description of Water Analysis Parameters.			
ive electrode; Cd-red., cad	dmium reduction	ion; cond., conductivity; calc., calculated			

![](_page_124_Picture_13.jpeg)

![](_page_125_Picture_0.jpeg)

Pond and Lake Management Plan

AgriLIFE EXTEN	A&M System		Wa Soil, <sup>I</sup> Depa 345 H	ter Analysis Nater and Forag rtment of Soil ar eep Center, 247	Report ge Testing Labo nd Crop Science 4 TAMU	ratory es
Report generated for: Burditt Consultants, LLC 310 Longmire			Colle 979-8	ge Station, TX 7 45-4816	7843-2474	
Conroe, TX 77304			Visit http:/	our website: /soiltesting.tam	u.edu	
Laboratory #: Customer Sample ID: Date Processed: Sample from Montromery County	17520 Woodlands P 10/13/2010	onds 3	Form	at based on pub	lication SCS-20	02-12
Water Source =Pond/Lake		Water Use =Aquacultur	e			
Parameter analyzed	Results	Units	Method	V. Limiting	Limiting	Accepta
Calcium (Ca)	8	ppm	ICP	Report se	ent to Exte	ension
Magnesium (Mg)	2	ppm	ICP	Fisheries	Specialis	+
Sodium (Na)	29	ppm	ICP	Dr. Micha	ael Masser	
Potassium (K)	5	ppm	ICP	979-845	7370	
Boron (B)	0.06	ppm	ICP	m-masse	r@tamu e	du
Carbonate (CO <sub>3</sub> )	0	ppm	Titr.	masse	a contraint of the	
Bicarbonate (HCO <sub>3</sub> )	69	ppm	Titr.	1 22		
Sulfate (SO4-calculated from total s)	5	ppm	ICP			
Chloride (Cl-)	30	ppm	Titr.	A STATE OF STATE		11.00 M
Nitrate-N (NO <sub>3</sub> -N) <	0.01	ppm	Cd-red.			
Phosphorus (P)	0.11	ppm	ICP			
pH	6.80	F.F.	ISE			
Conductivity	173	umhos/cm	Cond.			
Hardness	2	grains CaCO3/gallon	Calc.	a description of the second		CONTRACTOR OF CONTRACTOR
Hardness	26	ppm CaC03	Calc.			
Alkalinity	57	ppm CaC03	Calc			
Total Dissolved Salts (TDS)	148	ppm	Calc.	A STRATEGY		
SAR	2.4	F.P	Calc			
Iron (Fe)			Sulo.	A SAME STATE		
Zinc (Zn)						
Copper (Cu)						1000
Manganese (Mn)				and the second sec		
Arsenic (As)						Patrice of
Barium (Ba)						
Nickel (Ni)						
Cadmium (Cd)						
Lead (Pb)						
Chromium (Cr)						
Flouride (F)						
Charge Balance (cation/anion*100)	91		Calc.	-		All the second second
ppm=parts per million=milligrams per lite N/A, not applicable for this water use	r					
Descriptions of each water parameter	otontial use issue	and target levels are provide	d in publicatio	n SCS-2002-10 De	ecription of Water	Analysis Paran

ICP, Inductively coupled plasma; Titr., titration; ISE, ion selective electrode; Cd-red., cadmium reduction; cond., conductivity; calc., calculated

![](_page_125_Picture_5.jpeg)

Report generated for: Burditt Consultants, LLC 310 Longmire Conroe, TX 77304

Laboratory #:	17521
Customer Sample ID:	Woodlands Ponds 4
Date Processed:	10/13/2010
Sample from Montgomery C	County
Water Source =Pond/Lake	Water I

Parameter analyzed		Results
Calcium (Ca)		6
Magnesium (Mg)		2
Sodium (Na)		55
Potassium (K)		5
Boron (B)		0.09
Carbonate (CO <sub>3</sub> )		0
Bicarbonate (HCO <sub>3</sub> )		152
Sulfate (SO4-calculated from total S)		3
Chloride (CI-)		28
Nitrate-N (NO <sub>3</sub> -N)	<	0.01
Phosphorus (P)		0.04
pH		7.32
Conductivity		270
Hardness		1
Hardness		23
Alkalinity		124
Total Dissolved Salts (TDS)		250
SAR		5.0
Iron (Fe)		
Zinc (Zn)		
Copper (Cu)		
Manganese (Mn)		
Arsenic (As)		
Barium (Ba)		
Nickel (Ni)		
Cadmium (Cd)		
Lead (Pb)		
Chromium (Cr)		
Flouride (F)		
Charge Balance (cation/anion*100	22	88
pom=parts per million=milligrams pe	ar litor	

opm=parts per million=milligrams per liter N/A, not applicable for this water use

Descriptions of each water parameter, potential use issues and ta ICP, Inductively coupled plasma; Titr., titration; ISE, ion selective e

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# B - Water Sample Results VI

Water Analysis Report Soil, Water and Forage Testing Laboratory Department of Soil and Crop Sciences 345 Heep Center, 2474 TAMU College Station, TX 77843-2474 979-845-4816

Visit our website: http://soiltesting.tamu.edu

Format based on publication SCS-2002-12

## Water Use =Aquaculture

Units	Method	V. Limiting	Limiting	Acceptable
ppm	ICP	Report s	ent to Exte	nsion
ppm	ICP	Fisherie	s Specialis	t.
ppm	ICP	Dr. Mich	ael Masser	State States of States
ppm	ICP	979-845	7370	
ppm	ICP	m-mass	er@tamu.eo	du
ppm	Titr.			
ppm	Titr.	a state of the	a marganese	
ppm	ICP			
ppm	Titr.			100
ppm	Cd-red.			
ppm	ICP		THE REAL AND A	
	ISE			
umhos/cm	Cond.		Sold States	
grains CaCO3/gallon	Calc.			
ppm CaC03	Calc.		and the second second	NERVE TRANSPORT
ppm CaC03	Calc.			-
ppm	Calc.			
	Calc.			
			In the second second second	A CALIFORNIA CONTRACTOR
			The second second	The second s
			Constanting the	
			Sand States and	
			Contraction of the set	
			1 5	and the second se
				NEW CONSTRUCT
		in a substant	Course and a second	antines - Description
	Caic.			
		8		
and target levels are provide	d in nublicatio	n SCS-2002-10	Description of Water A	nalvsis Parametere
and target levels are provide		1 000-2002-10, 1	Description of Water P	naiyois Falameters.
ective electrode; Cd-red., cac	Imium reducti	on; cond., conduc	tivity; calc., calculated	L

![](_page_125_Picture_18.jpeg)

![](_page_126_Picture_0.jpeg)

Pond and Lake Management Plan

AgriLIFE EXT	TENSION Texas A&M System		Wa Soil, V Depa 345 H	Iter Analysis Water and Forag rtment of Soil an eep Center, 2474	Report le Testing Labor ld Crop Science 4 TAMU	atory s
Report generated for: Burditt Consultants, LLC 310 Longmire			Colleg 979-8	ge Station, TX 7 45-4816	7843-2474	
Conroe, TX 77304	47500		Visit o http://	our website: /soiltesting.tamu	ı.edu	
Customer Sample ID: Date Processed:	17522 Woodlands P 10/13/2010	onds 5	Form	at based on pub	lication SCS-20	02-12
Water Source =Pond/Lake	Junty	Water Use =Aquacultur	9			
Parameter analyzed	Results	Units	Method	V. Limiting	Limiting	Acceptable
Calcium (Ca)	13	ppm	ICP	Report se	ent to Exte	nsion
/lagnesium (Mg)	2	ppm	ICP	Fisheries	Specialis	
Sodium (Na)	23	ppm	ICP	Dr. Micha	el Masser	ing the strikes and
Potassium (K)	4	ppm	ICP	979-845-7	7370	100 100 100 100 100 100 100 100 100 100
Boron (B)	0.05	ppm	ICP	m-masse	r@tamu.e	Ju
Carbonate (CO <sub>3</sub> )	0	ppm	Titr.			
Bicarbonate (HCO <sub>3</sub> )	88	ppm	Titr.			
Sulfate (SO4-calculated from total S)	< 1	ppm	ICP			
Chloride (CI-)	23	ppm	Titr.			
Nitrate-N (NO <sub>3</sub> -N)	< 0.01	ppm	Cd-red.			
Phosphorus (P)	< 0.01	ppm	ICP			Sector States
рН	7.09		ISE			
Conductivity	164	umhos/cm	Cond.			in the second
Hardness	2	grains CaCO3/gallon	Calc.			
Hardness	39	ppm CaC03	Calc.			a stand a State stand
Alkalinity	72	ppm CaC03	Calc.			
Total Dissolved Salts (TDS)	154	ppm	Calc.			A STORE WAT
SAR	1.6		Calc.			
Iron (Fe)						A CONTRACTOR
Zinc (Zn)						
Copper (Cu)						
Manganese (Mn)						
Arsenic (As)						A CONTRACTOR OF THE OWNER
Barium (Ba)						
Nickel (Ni) Cadmium (Cd)						
Lead (Pb)						
Chromium (Cr)						
Flouride (F)						Man Langer 1
Charge Balance (cation/anion*10)	o) 89		Calc.			
ppm=parts per million=milligrams pe	er liter					
N/A, not applicable for this water us	se					
la constructione de la construction				- 000 0000 40 0-		5

![](_page_126_Picture_4.jpeg)

magnesium (mg)		2	
Sodium (Na)		22	
Potassium (K)		5	
Boron (B)		0.06	
Carbonate (CO <sub>3</sub> )		0	
Bicarbonate (HCO <sub>3</sub> )		80	
Sulfate (SO4-calculated from total S)		4	
Chloride (Cl-)		18	
Nitrate-N (NO <sub>3</sub> -N)	<	0.01	
Phosphorus (P)		0.07	
рН		6.74	
Conductivity		133	
Hardness		1	grain
Hardness		22	
Alkalinity		66	
Total Dissolved Salts (TDS)		138	
SAR		2.1	
Iron (Fe)			
Zinc (Zn)			
Copper (Cu)			
Manganese (Mn)			
Arsenic (As)			
Barium (Ba)			
Nickel (Ni)			
Cadmium (Cd)			
Lead (Pb)			
Chromium (Cr)			
Flouride (F)			
Charge Balance (cation/anion*100	).	81	
ppm=parts per million=milligrams pe	r liter		
N/A, not applicable for this water use	9		

scriptions of each water parameter, potential use issues and targ

ICP, Inductively coupled plasma; Titr., titration; ISE, ion selective el

# B - Water Sample Results VII

	Wa Soil, Depa 345 H Colle 979-8	Ater Analysis R Water and Forage rtment of Soil and leep Center, 2474 ge Station, TX 778 45-4816	Report Testing Laborate Crop Sciences FAMU 443-2474	ory	
	Visit http:/	our website: /soiltesting.tamu.e	du		
6	Form	at based on public	ation SCS-2002-	12	
r Use =Aquacultu	re				
Units	Method	V. Limiting	Limiting	Accentable	
ppm	ICP	Report sen	t to Extens	sion	
ppm	ICP	Fisheries S	specialist		
ppm	ICP	Dr. Michae	Masser		
ppm	ICP	979-845-73	70		
ppm	ICP	m-masser@	Dtamu.edu		
ppm	Titr.				
ppm	Titr.		23 TV PLAN		
ppm	ICP				
ppm	Titr.				
ppm	Cd-red.				
ppm	ICP		Stol and Stol		
	ISE				
umhos/cm	Cond.				
ns CaCO3/gallon	Calc.				
ppm CaC03	Calc.				
ppm CaC03	Calc.				
ppm	Calc.				
	Calc.				
		a succession of the			
		1	in the second		IN STREET
		REAL PROPERTY OF			2004
	Calc		12.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.		
	Galc.				

![](_page_126_Picture_11.jpeg)

![](_page_127_Picture_0.jpeg)

Pond and Lake Management Plan

AgriLIFE EXT Report generated for: Burditt Consultants, LLC	TEN Texas	A&M System		Wa Soil, V Depa 345 H Colles 979-8	Iter Analysis Water and Forag rtment of Soil an leep Center, 2474 ge Station, TX 7 45-4816	Report e Testing Labor: d Crop Sciences I TAMU 7843-2474	atory
310 Longmire Conroe, TX 77304				Visit o	our website: /soiltesting.tamu	.edu	
Laboratory #: Customer Sample ID: Date Processed: Sample from Montgomery Co	ounty	17524 Woodlands P 10/13/2010	onds 7	Form	at based on pub	ication SCS-200	12-12
Water Source =Pond/Lake			Water Use =Aquaculture				
Parameter analyzed		Results	Units	Method	V. Limiting	Limiting	Acceptab
Calcium (Ca)		19	ppm	ICP	Report se	ent to Exte	nsion
Magnesium (Mg)		3	ppm	ICP	<b>Fisheries</b>	Specialist	
Sodium (Na)		33	ppm	ICP	Dr. Micha	el Masser.	
Potassium (K)		5	ppm	ICP	979-845-7	370	
Boron (B)		0.07	ppm	ICP	m-masse	r@tamu.ed	lu
Carbonate (CO <sub>3</sub> )		0	ppm	Titr.			
Bicarbonate (HCO <sub>3</sub> )		113	ppm	Titr.			
Sulfate (SO4-calculated from total S)	<	1	ppm	ICP			
Chloride (Cl-)		32	ppm	Titr.			
Nitrate-N (NO <sub>3</sub> -N)	<	0.01	ppm	Cd-red.			
Phosphorus (P)	<	0.01	ppm	ICP			
рН		7.10		ISE			
Conductivity		246	umhos/cm	Cond.		Long Street St	
Hardness		3	grains CaCO3/gallon	Calc.			
Hardness		58	ppm CaC03	Calc.	1.505 CO.		
Alkalinity		93	ppm CaC03	Calc.		States and States	
Total Dissolved Salts (TDS)		205	ppm	Calc.			
SAR		1.9		Calc.	and the second		-
Iron (Fe)							
Zinc (Zn)							
Copper (Cu)						Control of the second	14
Manganese (Mn)						an and a second	
Arsenic (As)							and the lives of
Barium (Ba)					and the second second		- Coperation
NICKEI (NI)					a second second		
Laad (Db)							
Chromium (Cr)							
Flouride (F)							1. Carlor 1977
Charge Balance (cation/anion*10	10)	97		Calc.			
ppm=parts per million=milliorame p	er liter						
N/A, not applicable for this water up	se						
non, not applicable for this water us	96						

![](_page_127_Picture_4.jpeg)

Report generated for: Burditt Consultants, LLC 310 Longmire Conroe, TX 77304

Laboratory #: Customer Sample ID: Date Processed: 17525 Woodlands Ponds 8 10/13/2010 Sample from Montgomery County Water Source =Pond/Lake Wate

Parameter analyzed		Results	
Calcium (Ca)		14	
Magnesium (Mg)		3	
Sodium (Na)		32	
Potassium (K)		7	
Boron (B)		0.08	
Carbonate (CO <sub>3</sub> )		0	
Bicarbonate (HCO <sub>3</sub> )		108	
Sulfate (SO4-calculated from total S)		7	
Chloride (CI-)		27	
Nitrate-N (NO <sub>3</sub> -N)	<	0.01	
Phosphorus (P)	<	0.01	
pH		7.17	
Conductivity		226	
Hardness		3	grai
Hardness		46	
Alkalinity		88	
Total Dissolved Salts (TD	S)	198	
SAR		2.1	
Iron (Fe)			
Zinc (Zn)			
Copper (Cu)			
Manganese (Mn)			
Arsenic (As)			
Barium (Ba)			
Nickel (Ni)			
Cadmium (Cd)			
Lead (Pb)			
Chromium (Cr)			
Flouride (F)			
Charge Balance (cation/anion	n*100)	92	
ppm=parts per million=milligran	ns per liter		
N/A, not applicable for this wate	er use		

ICP, Inductively coupled plasma; Titr., titration; ISE, ion selective

# B - Water Sample Results VIII

AgriLIFE EXT	TENSION Texas A&M System		Wa Soil, V Depa 345 H	Iter Analysis Report Water and Forage Testing Laboratory rtment of Soil and Crop Sciences leep Center, 2474 TAMU
ort generated for: ditt Consultants, LLC			Colle 979-8	ge Station, TX 77843-2474 45-4816
roe, TX 77304			Visit	our website: /soiltesting.tamu.edu
oratory #: tomer Sample ID: e Processed:	17525 Woodlands Po 10/13/2010	onds 8	Form	at based on publication SCS-2002-12
ple from Montgomery Co er Source =Pond/Lake	ounty	Water Use =Aquacultur	е	
ameter analyzed	Results	Units	Method	V. Limiting Limiting Acceptable
cium (Ca)	14	ppm	ICP	Report sent to Extension
nesium (Mg)	3	ppm	ICP	Fisheries Specialist
ium (Na)	32	ppm	ICP	Dr. Michael Masser
assium (K)	7	ppm	ICP	979-845-7370
on (B)	0.08	ppm	ICP	m-masser@tamu.edu
ponate (CO <sub>3</sub> )	0	ppm	Titr.	
arbonate (HCO <sub>3</sub> )	108	ppm	Titr.	
ate (SO4-calculated from total S)	7	ppm	ICP	
oride (CI-)	27	ppm	Titr.	
ate-N (NO <sub>3</sub> -N)	< 0.01	ppm	Cd-red.	
sphorus (P)	< 0.01	ppm	ICP	A STATE OF A
	7.17		ISE	
ductivity	226	umhos/cm	Cond.	
iness	3	grains CaCO3/gallon	Calc.	
Iness	46	ppm CaC03	Calc.	a state of the second sec
linity	88	ppm CaC03	Calc.	
al Dissolved Salts (TDS)	198	ppm	Calc.	The second second second
{	2.1		Calc.	<ul> <li>C. C. S. Schler Province Contractional Society (1998) - Articity and Contraction (1998) - Article State (1998)</li> </ul>
(Fe)				
c (Zn)				
oper (Cu)				A REAL PROPERTY AND A REAL PROPERTY.
nganese (Mn)				
enic (As)				
ium (Ba)				
kel (Ni)				
lmium (Cd)				
d (Pb)				
omium (Cr)				
uride (F)				
(rge Balance (cation/anion*10)	92		Calc.	
=parts per million=milligrams p	er liter			
not applicable for this water us	e			
criptions of each water paramet	ler, potential use issues	and target levels are provide	d in publicatio	n SCS-2002-10, Description of Water Analysis Parameters.
Inductively coupled plasma: Ti	tr., titration; ISE, ion se	lective electrode: Cd-red cad	mium reductio	on; cond., conductivity; calc., calculated
and a subject approve protonita, in				,, oonwooding, owor, odiounitou

![](_page_127_Picture_13.jpeg)

![](_page_128_Picture_0.jpeg)

![](_page_128_Picture_1.jpeg)

![](_page_128_Picture_2.jpeg)

Pond and Lake Management Plan

AgriLIFE EXT	<b>ENSION</b> Texas A&M System		Wa Soil, Depa	tter Analysis Water and Fora	s Report age Testing Labo and Crop Scienc	oratory es
eport generated for: urditt Consultants, LLC I0 Longmire			345 F Colle 979-8	leep Center, 24 ge Station, TX 45-4816	74 TAMU 77843-2474	
onroe, TX 77304	17526		Visit http:/	our website: /soiltesting.tam	nu.edu	
aboratory #: ustomer Sample ID: ate Processed: ample from Montgomery Co	17526 Woodlands 10/13/2010 unty	s Ponds 9	Form	at based on pu	blication SCS-20	002-12
ater Source =Pond/Lake		Water Use =Aquacultur	e			
arameter analyzed	Results	Units	Method	V. Limiting	Limiting	Acceptable
alcium (Ca)	7	ppm	ICP	Report	ent to Ext	ension
agnesium (Mg)	1	ppm	ICP	Fisherio	s Specialie	t
odium (Na)	26	ppm	ICP	Dr Mich	ael Masse	A Charles Street
otassium (K)	3	pom	ICP	979-845	7370	
pron (B)	0.06	ppm	ICP	m-mass	or@tamu o	du
arbonate (CO <sub>3</sub> )	0	maa	Titr.	111-111035	citutaniu.e	u u
carbonate (HCO <sub>2</sub> )	84	ppm	Titr			1. 1950 - 1920
lifate (SO areatenated from total S)	3	npm	ICP		Show a barrent	A CONTRACTOR ST
aloride (CL)	14	ppm	Titr		Electronic Contractor	Succession and
trate_N (NO_N)	< 0.01	ppm	Cd rod		and the second second second	A STATE OF A
nate-iv (NO3-IV)	0.05	ppm		V STREET OF	Para and a state of the	A STATE OF STATE
	6.03	ppin	ICF			Manager States
	1/0	upph and fam	Cond			the second second
onductivity	143	umnos/cm	Cona.		No. of Contraction	
aroness	1	grains CaCO3/gailon	Calc.	- Tomasana	Constraint and	Instant States 18
ardness	22	ppm CaC03	Calc.		a dente son a solo	
kalinity	69	ppm CaC03	Calc.			A REAL PROPERTY OF THE PARTY OF T
otal Dissolved Salts (TDS)	139	ppm	Calc.	A MICH School		
AR	2.4		Calc.		And the second	
on (Fe)					A Participation of the local	
inc (Zn)					al initial and the Victor	AND STREET
opper (Cu)					The second second	
langanese (Mn)					14 J. 52	- FROM AND A
rsenic (As)					in the second second	a the second
arium (Ba)						
ickel (Ni)						
admium (Cd)				and the second second second		
ead (Pb)						
hromium (Cr)						
louride (F)						
harge Balance (cation/anion*100	) 89		Calc.			
pm=parts per million=milligrams pe	er liter					
/A not applicable for this water us	e					

ICP, Inductively coupled plasma; Titr., titration; ISE, ion selective electrode; Cd-red., cadmium reduction; cond., conductivity; calc., calculated

AgriLIFE EXTENSION Report generated for: Burditt Consultants, LLC 310 Longmire Conroe, TX 77304 Laboratory #: 17527 Customer Sample ID: Date Processed: Woodlands Ponds 10/13/2010 Sample from Montgomery County Water Source =Pond/Lake Wate Parameter analyzed Results 11 Calcium (Ca) 3 Magnesium (Mg) Sodium (Na) 57 Potassium (K) 7 0.08 Boron (B) Carbonate (CO<sub>3</sub>) 0 168 Bicarbonate (HCO<sub>3</sub>) Sulfate (SO4-calculated from total s) 7 25 Chloride (CI-) 0.01 Nitrate-N (NO<sub>3</sub>-N) 0.10 Phosphorus (P) 7.17 pH 318 Conductivity Hardness 2 grai 39 Hardness 138 Alkalinity Total Dissolved Salts (TDS) 279 SAR 4.0 Iron (Fe) Zinc (Zn) Copper (Cu) Manganese (Mn) Arsenic (As) Barium (Ba) Nickel (Ni) Cadmium (Cd) Lead (Pb) Chromium (Cr) Flouride (F) Charge Balance (cation/anion\*100) 95 opm=parts per million=milligrams per liter N/A, not applicable for this water use escriptions of each water parameter, potential use issues and ta ICP, Inductively coupled plasma; Titr., titration; ISE, ion selective

# **B** - Water Sample Results IX

	Wa Soil, 1 Depa 345 H Colles 979-8	ter Analysis Report Vater and Forage Testing L tment of Soil and Crop Scie sep Center, 2474 TAMU le Station, TX 77843-2474 15-4816	aboratory ences
	Visit ( http://	ur website: soiltesting.tamu.edu	
10	Form	t based on publication SC	S-2002-12
r Use =Aquacultur	e		
Units	Method	V. Limiting Limiting	Acceptable
ppm	ICP	Report sent to E	xtension
ppm	ICP	Fisheries Specia	list.
ppm	ICP	Dr. Michael Mass	ser
ppm	ICP	979-845-7370	
ppm	ICP	m-masser@tam	Ledu
ppm	Titr.	in masserwidht	
ppm	Titr.	The lot of the lot of the	150
ppm	ICP		
ppm	Titr.	Second	
ppm	Cd-red.		
ppm	ICP		AN REPORT OF STREET
	ISE		
umhos/cm	Cond.		CONTRACT SAID
ins CaCO3/gallon	Calc.		
ppm CaC03	Calc.		
ppm CaC03	Calc.		
ppm	Calc.		
	Calc.		
		Contraction of the second	THE MELTING
		100	
	Calc.		
			the second s
arget levels are provide	d in publicatio	SCS-2002-10, Description of Wa	ater Analysis Parameters.
electrode; Cd-red., cad	Imium reductio	n; cond., conductivity; calc., calcu	lated

![](_page_128_Picture_10.jpeg)

## Pond and Lake Management Plan

![](_page_129_Picture_2.jpeg)

SCS-2002-10

## Description of Water Analysis Parameters

T. L. Provin and J. L. Pitt

Extension Soil Chemist and Extension Associate, Soil and Crop Sciences Department

Water analysis reports from a number of laboratories often lack basic Water analysis reports from a number of laboratories often lack basic descriptions for terminology, potential sources of contaminates or parameters, and/or fail to provide the end user an idea of potential concerns over the use of the water. The following discussion, while developed for the Texas Cooperative Extension Soil, Water and Forage Testing Laboratory water analysis report, should assist the reader in understanding basic inorganic water analyses reports.

#### Calcium (Ca)

Source Calcium in water is from dissolved rock, limestone, gypsum, salts and soil. Issues Calcium is a component of water hardness and can combine with bicarbonate

and carbonates resulting in "lime deposits," scale, extremely hard water and and carbonates resulting in line deposits, society externely hard rate and states and st

or similar ion exchange methods

Target Concentrations Domestic water: No EPA drinking water standard set, see TDS section.

Irrigation water: Current limit not established, see TDS section. Livestock water: Current limit not established, see TDS section, potential problems with dairy cattle > 500 ppm.

#### Magnesium (Mg)\_ Source

Magnesium is dissolved from rock, dolomite, salts and soil.

Issues Magnesium is a component of water hardness and can combine with bicarbonate and carbonates resulting in "lime deposits," scale, extremely hard

Dicationate and advortates resoluting in time deposits, scale, extension and water and salinity (see Hardness). *Treatment/Practices* Reduction in Mg levels is normally accomplished through use of water softeners or similar ion exchange methods.

Target Concentrations Domestic water: No EPA drinking water standard set, see TDS section. Irrigation water: Current limit not established, see TDS section.

Livestock water: Current limit not established, see TDS section, potential problems with dairy cattle >125 ppm.

### Sodium (Na)\_

Source Sodium is dissolved from rock, salts, and soil. It is also found in oil-field brine, sea water, industrial brine, and reclaimed effluent water, etc ssues

Moderate amounts of sodium have little effect on the usefulness of water; nowever persons on low sodium diets should consult their physician for levels above 20 ppm. (See SAR for information on sodium's role in water and soil

access to ppin. See SXR for information of social a role in water and som *Treatment/Practices* Reverse osmosis treatment is considered the only economical method for sodium removal for household uses. Reverse osmosis is more often used for drinking water rather than the whole household due to costs. Target Concentrations

Domestic water: Secondary Water Standard is 20 ppm limit. Persons on

Domestic water: Secondary Water Standard is 20 ppm limit. Persons on restricted sodium diets may be limited to 20 ppm. High sodium may contribute to corrosion of copper plumbing and metal fixtures. Irrigation water: Use of water containing greater than 400 ppm Na may create significant foliar burn. High levels of Na in irrigation water may cause Na to build up in soils, resulting in poor soil structure. Livestock water: Current limit not established, see TDS section.

#### Potassium (K)

urce tassium is dissolved from rock, fertilizer, salt, and soil.

High potassium levels in irrigation water may significantly increase potassiun concentrations in forage grasses, thus potentially creating concerns with

## Boron (B)\_\_\_

Issues Sensitive crops may be affected at levels of 0.33 ppm; semi-tolerant crops may be affected at levels of 0.33 – 0.67 ppm; and tolerant crops may be affected at levels above 0.67 ppm. Boron can become toxic to some plants when the soil-water concentration exceeds that required for optimum plant when the softwater concentration exceeds that requires to optimize the growth. Generally, toxic boron concentrations in the softwater found only in ariding regions of fexas. Crops vary to tolerance of  $b_{\rm c}$  (an, therefore, water that is marginal for sensitive plants may still be used for more tolerant crops.

Imigation water: Toxicity to many sensitive plants may occur at ppm. Most perennial grasses are relatively tolerant at 2-10 ppm. (Rowe and Abdel-Mazid, record)

Bicarbonate and Carbonate (HCO3 and CO32)\_

Dissolution of limestone, dolomite, and atmospheric carbon dioxide.

Dissolution of intrestore, dolorine, and antophenic calcon dioxide. Issues Bicarbonate and carbonate serve as charge balancing anions (negatively charged ions) for calcium, magnesium, sodium and other cations (positively charged ions). High bicarbonate and carbonate levels in the preserve of calcium and magnesium may lead to formation of lime deposits in plumbing and integrating nucleons.

## and irrigation systems Treatment/Practices

Target Concentrations Domestic water: No EPA drinking water standard set, see TDS section.

Livestock water: Current limit not established, see TDS section.

#### Sulfate (SO,)

Sulfate in water containing calcium forms hard scale in steam boilers. In large

Reverse osmosis is considered the best overall method for sulfate reduction. Target Concentrations

Treatment/Practices

Domestic water: > 250 ppm can cause diarrhea (Secondary Drinking Water Standard)

rrigation water: Moderate concentration of sulfate can reduce growth or cause specific injury. Refer to salinity section. Livestock water: > 2000 ppm can cause diarrhea in most livestock.

Chloride (CI)\_

Source Naturally occurring chloride is caused by dissolving minerals. It may be found Naturally occurring chloride is caused by dissolving minerals. It may be round in large amounts in oil-field brine, see water and industrial brine. Chlorides may also be found in surface water from road salt, fertilizers, industrial wastes, or sewage. Issues When combined with sodium, chloride gives a salty taste to drinking water

and may increase the corrosiveness of water. Chlorides may also result in blackening or pitting of stainless steel. *Treatment/Practices* everse osmosis is considered the best overall method for chloride reduction

Reverse osmosis is considered the best overall method for chloride reduction. *Target Concentrations Domestic water:* > 250 ppm may cause safty taste in water. (Secondary Drinking Water Standard). *Irrigation water:* > 900 ppm is considered non-suitable for all agronomic crops. *Livestock water:* Current limit not established, see TDS section.

## Nitrate (NO,-N)\_\_\_\_

Source Decaying organic matter, sewage, fertilizers, manures, and nitrates in the soil result in soluble nitrates.

Issues Water with high nitrate content may cause methemoglobinemia (blue-baby syndrome) and should not be used by pregnant women or for infant feeding. High concentrations of nitrate in rivers, streams, and lakes encourage the growth of algae and other organisms that may produce undesirable tastes and odors in water.

## Treatment/Practices

Treatment/Practices Reverse osmosis is considered the best overall method for nitrate reduction. Target Concentrations Domestic water: < 10 ppm (EPA Primary drinking water standard) Irrigation water: Levels > 40 ppm may be very limiting for some plants, while only 10-20 ppm may be limiting for others. Livestock water: < 100 ppm (NAS), 300 ppm (CAST).

#### Phosphorus (P)

Source Phosphorus may be found naturally in ground water and in surface water from landscape runoff or discharges from sewage treatment facilities.

Issues Elevated phosphorus in surface water can lead to algal blooms and lowe dissolved oxygen content, thereby reducing desired aquatic life and creating

water taste issues.

Treatment/Practices Reverse osmosis is considered the best overall method for phosphorus

Target Concentrations

Target concentrations Domestic water. No EPA drinking water standard set, see TDS section. Levels above 0.1 ppm in still waters may give rise to algal blooms. Irrigation water: Current limit not established, see TDS section. Livestock water: Current limit not established, see TDS section.

## nH

Acids, acid-generating salts, and free carbon dioxide lower pH. Carbonates Acids, acid-generating saits, and free carbon dioxide lower ph. Carbonates, bicarbonates, hydroxides, phosphates, silicates and borates raise ph. Water with high acidity may dissolve iron from pumping facilities and mains and produce a "red water" problem. Fabrics may be stained from the action of acid water on plumbing and appliances. Detergents do not perform as well in acid water as in neutral or alkaline water. To remove nust-colored stains from white or colorfast fabrics, use a commercial rust remover. Follow product directions, water using the water has marking. but avoid use in the washing machine.

Rating	pH Range
ligh Acidity	< 6.5
Adderate Acidity	6.5 - 7.0
Adderate Alkalinity	7.0 - 8.5
ligh Alkalinity	> 8.5
/Practices	
a adjusted using sold	foodore (lower pH) or

feeders (lower pH) or by use of soda ash Water pH is adjust feeders (raise pH)

# lactating livestock. Treatment/Practices

Limited treatment practices for reducing K levels. Consider distillation, reverse osmosis or ion exchange methods.

Target Concentrations Domestic water: No EPA drinking water standard set, see TDS section. Irrigation water: Current limit not established, see TDS section. Livestock water: Current limit not established, see TDS section.

Source Source Boron may be naturally found in ground water, in surface water as an industrial pollutant or as a product of agricultural runoff and decaying plant materials.

Note: If the boron level in your water exceeds 1.0 ppm, then boron levels may increase in your soil. Clay soils accumulate boron faster than sandy soils. *Treatment/Practices* Reverse osmosis and distillation.

Target Concentrations Domestic water: No EPA drinking water standard set, see TDS section.

1995). Livestock water: CAST levels established at 5.0 ppm.

Source

Carbonate and bicarbonates can be reduced by lowering the pH of water

Domestic water, two EPA offinking water standard set, see TDS section. Irrigation water, CaCO<sub>5</sub> may form on equipment or plants, Levels of 180-600 ppm can present a severe hazard (Camberato, 2001). Refer to alkalinity

Issues

amounts, sulfates can result in bitter, medicinal tastes, laxative effects or "rotte egg" odor from hydrogen sulfide gas formation (see TCE L-5312).

Educational programs of the Texas Agrit ife Extension Service are open to all people without regard to race, color, sex, disability, religion, age,or national origin

## **B** - Water Sample Results

Target Concentrations Domestic water: EPA secondary drinking water standards of 6.5-8.5. Irrigation water: pH can greatly affect the solubility/availability of many trace elements in the soil. Exceedingly low (< 5.5) or high (> 8.5) pH may result in corrosion of equipment. High pH values (> 8.5) indicate alkalinity and may trace servicity lowcers column barand pose a sodicity (excess sodium) hazard.

Livestock water: 5.5 - 8.5 Levels outside of this range may cause problems for dairy cattle

#### Conductivity ource

Conductivity is an indicator of salinity. Salinity (or salts) often originate from the earth's crust, although the additions of fertilizers and organic matter may also contribute salts. Through weathering, small amounts of rock and other deposits are dissolved and carried away by water. This slow weathering may use an accumulation of salts in both surface and subsurface waters. Surface cause an accumulation of salts in both surface and subsurface waters. Surface runoff of these dissolved salts has caused the salt concentrations in oceans and lakes. The term salt and salinity are often used interchangeably, and sometimes incorrectly. A salt is simply an inorganic mineral that is subject to dissolving in water. Many individuals often associate salt with sodium chloride. common table salt. In reality, the salts which affect both surface and ground-waters often are a combination of sodium, calcium, polassium, and magnesium, with chloride, nitrate, sulfate, bicarbonate, and carbonate. Issues

High conductivity is an indication of (TDS) total dissolved salts. This value should only be used as an initial screening parameter. Other individual characteristics should be evaluated when conductivity levels are high.

Characteristics should be evaluated when conductivity levels are right. Treatment/Practices Steam distillation, ion exchange (H\* and OH\* saturated resin only) and reverse osmosis are common treatment methods for reducing TDS and conductivity

Target Concentrations Target: Current limit not established, see TDS section. Irrigation water: Concern over soil salinity is greatest when irrigating with water high in salts, where soils are poorly drained and allow for excessive urface evaporation, or where soils are naturally high in salts due to limited surface evaporation, or where solls are naturally high in salts due to limited leaching and shallow water tables. As soluble sait levels increase, plant utilization of soil water often declines. This is because plant roots contain varying concentrations of ions (salts) that cause a natural gradient for water to flow from the soli into the plant roots. As the soil salt levels approach the concentration of salts in the plant roots. As the soil salt levels approach the root. Naturally, each plant species contains varying levels of root salts, thus some plants continue to thrive when others die. The buildup of salts in soils that are termed saline, saline-sodic or sodic. Each of these twoes of exist has rearried to the room at the targuing enceil a management. types of soils has unique properties that require special management. Conductivity is an indication of the amount of salinity, or TDS in water. Water can be classified according to its conductivity. Permissible limits for classes

of irrigation water are listed in the following table. .ivestock water: Current limit not established, see TDS section.

Classes of Water	EC, dSm <sup>-1</sup> mmho cm <sup>-1*</sup>	TDS, ppm	Comments
Class 1, Excellent	0-0.250	175	No damage expected, no additional management needed
Class 2, Good	0.250-0.750	475-525	Damage to sensitive plants will occur, use of low salinity water may be required periodically.
Class 3, Permissible	0.750-2.0	525-1400	Damage to plants with low salinity tolerance will likely occur. Plant growth and quality will be improved with excess irrigation for leaching and/or periodic use of low salinity water.
Class 4, Doubtful	2.0-3.0	1400-2100	Damage to plants with high tolerance to salinity may occur. Successful use as irrigation source requires salt tolerant plants, good soil drainage, excess irrigation for leaching, and/or periodic utilization of low salinity water.
Class 5, Unsuitable	>3.0	>2100	Same as above.

ed to umbos cm<sup>-1</sup> multiply by 100

Hardness (expressed as CaCO<sub>3</sub>)\_ Source

Total hardness is caused by the presence of calcium and magnesium.

Hard water consumes soap before lather will form and interferes with almost Hard water consumes soap before raties with form and interferes with annous every cleaning and cooking task. It deposits film on surfaces, causing spots and dingy clothes. It creates scale in boilers, water heaters and pipes. It forms white flakes in ice that are visible after the ice melts. Check the Water Hardness Rating Scale to evaluate the relative hardness of your water.

## Pond and Lake Management Plan

Rating	Grains per Gallon	Total Hardness (ppm)
Soft	0-1	0.0-17.17
Slightly hard	1-3.5	17.18-60
Moderately hard	3.5-7	61-120
Hard	7.1-10.5	121-180
Very hard	>10.5	>180

#### Treatment/Practices

Hardness can be reduced through use of water softener, or distillation methods. Target Concentrations ic water. No EPA drinking water standard set, see sections on alkalinity

and/or TDS. Irrigation water: See alkalinity, Ca, and Mg sections. Livestock water: Current limit not established, see TDS section

Alkalinity (expressed as CaCO<sub>3</sub>)\_ Source

Source Alkalinity is a buffering property caused by the presence of bicarbonates and carbonates, but calculated based on the concentration of calcium and magnesium. Issues Alkalinity is an estimate of the ability of water to resist change in pH upon addition of acid. Treatment/Practices The acidification of the water will lower water pH and reduce actual alkalinity: because only the reduction in calcium + magnesium levels through water

however, only the reduction in calcium + magnesium levels through water softening or distillation will reduce calculated numbers. Target Concentrations

stic water No EPA drinking water standard set, see TDS section. Water with low alkalinity is more likely to be corrosive and cause deterioration

Water With two anamity is investigation of plumbing. Irrigation water: Current limit not established, see TDS section. Water with low alkalinity is more likely to be corrosive and cause deterioration of plumbing. Livestock water: Levels above 500 ppm may pose problems for dairy cattle.

## Total Dissolved Salts (TDS)

Source Total dissolved salts are determined by the summation of all measured ions (cations and anions).

Issues Total dissolved salts may be used interchangeably with total dissolved solids in clear non-turbid waters. See conductivity and SAR for more information. Treatment/Practices

See conductivity section.

## Target Concentrations

Domestic water: EPA secondary drinking water standard of 500 ppm. Irrigation water: Refer to conductivity section regarding classification of waters based on TDS. Livestock water: Levels above 3000 ppm should be avoided for lactating

animals; levels above 7000 ppm may pose significant risks for many animals Refer to TCE publication L-2374. Sodium Adsorption Ratio (SAR)

The SAR is a measure of the sodium concentration in relation to calcium and magnesium charge concentrations in meq/L or eq/L. ncentration in relation to the

## SAR Rating/Comments

- <10 No sodium hazard. May be used on all sensitive crops.
- Medium sodium hazard. Gypsum and leaching needed. 10 - 18
- 18 26 High sodium hazard. Generally unsuitable for continued use. Very high sodium hazard. Generally unsuitable for use.
- >26

Treatment/Practices See TCE publication E-60 "Managing Soil Salinity". Target Concentrations Domestic water: No EPA drinking water standard, refer to salinity section. Irrigation water: Current limit not established, see TDS section. Livestock water: Current limit not established, see TDS section.

#### Iron (Fe)

Source Iron may be dissolved from rock and soil. It may also come from iron pipes. imps and other equipment if low pH water is present.

Issues On exposure to air, iron in ground water oxidizes to reddish-brown (or rust) water that may stain laundry and utensils. Large quantities can cause unpleasant taste and encourage the growth of iron bacteria.

Treatment/Practices 1) Continuous chlorination followed by sediment filter and carbon filter. 2) Aerate water in storage tank or use potassium permanganate (KMnO<sub>4</sub>) feeder, then sediment filter. 3) Use sediment filter and water softener. 4) Adjust pH to 7.0 or more, then treat with manganese oxidizing green sand filter

#### 5) Trickle over crushed limestone bed.

5) Trickle over crushed limestone bed. Target Concentrations Domestic water: Secondary EPA drinking water standard of 0.3 ppm. Laundry Practices: Avoid the use of chlorine bleach. Iron reacts with bleach in the water to cause permanent stains. To remove rust discoloration from white and colorfast washable fabric, use a commercial rust remover. Follow product the relative backwords the practice proteins proteins. directions. Do not use in the washing machine.

Irrigation water. 5 ppm. High iron (greater than 5 ppm) may significantly reduce photosynthesis as films form on leaf surfaces. Livestock water: Levels above 0.3 ppm may reduce consumption quantities due to taste issues.

#### Zinc (Zn)\_\_\_\_ Source

Zinc occurs naturally, but it may also result from industrial pollution. Additionally, low water pH can result in release of zinc from corrosion of copper-zinc alloys commonly used in plumbing systems. Issues

Issues Zinc can produce a chalky appearance in water and produce a disagreeable taste. Treatment/Practices Treatment practices are dependent on zinc source. Treatment of water naturally high in zinc includes ion exchange, reverse osmosis and distillation. Elevated zinc levels due to contact of low pH water with metal alloys is treated by use of coda ash feader. soda ash feeder. **Target Concentrations** 

Domestic water: 5.0 ppm (Secondary EPA drinking water standard) Irrigation water: 2.0 ppm, (See Other Terms section) Livestock water: 25 ppm established by CAST

#### Copper (Cu)\_\_\_\_

Source Copper is sometimes caused by contamination from mining operations, acid waters and corrosion in copper plumbing.

Issues Copper poisoning symptoms include jaundice and anemia. High levels may cause staining and bad tastes in addition to producing a corrosive effect. Treatment/Practices

Increase pH using soda ash (sodium carbonate). Corrosion created by high dissolved oxygen or total salts can be prevented using a polyphosphate feede system.

Target Concentrations Domestic water: 1.3 ppm. (Primary EPA drinking water standard, 1.0 ppm secondary EPA drinking water standard. Irrigation water: 0.2 ppm (See Other Terms section) Livestock water: 0.5 ppm level established by CAST

Manganese (Mn)

#### Source Manganese is dissolved from shale, sandstone or river basin material and

Excessive manganese gives water a grayish/black appearance and may stain plumbing fixtures and laundry. Manganese can also produce taste problems.

1) Oxidizing treatments convert reduced manganese to oxidized manganese

chlorophyll. Livestock water: Levels above 0.05 ppm may cause taste issue reducing

#### Arsenic (As)\_

Source Arsenic may be found in ground water naturally and in surface water as an industrial pollutant or as a product of agricultural runoff from previously used pesticides.

Trahmigh toxicity of arsenic is cumulative in the body with sym from fatigue to coma and death. Treatment/Practices Reduction of As levels is best performed by use of reverse os Toxical Concentrations.

Target Concentrations Domestic water: Primary EPA drinking water standard. 0.05 pp

to 0.01 ppm. Irrigation water: 0.10 ppm for long term use; 2.0 ppm for

(Rowe and Abdel-Mazid 1995). Livestock water: Reported problems with dairy cows at lev CAST has established level of 0.5 ppm.

#### Barium (Ba)\_\_\_\_

Source Barium may be found in ground water naturally or in surface industrial pollutant often related to oil and gas.

Issues Barium may have a toxic effect on the heart, blood vessels, nerv Treatment/Practices Reverse osmosis is considered the best overall method for Ba

reduction. Target Concentrations Domestic water: Primary EPA drinking water standard 2.0 pp Irrigation water: Diniking water standard 2.0 ppm. Livestock water: Reported health issues with dairy cattle at le CAST has not established any limits.

#### Nickel (Ni)

Source Nickel may be found in ground water naturally or in surface wa or an industrial pollutant

or an industrial poliutant. Issues Chronic exposure to nickel may decrease body weight, induce damage, and dermatitis problems. Treatment/Practices Reverse osmosis is considered best overall method for Ni reduction

reduction. Target Concentrations Domestic water. Primary EPA drinking water standard 0.1 ppr Irrigation water. 0.2 ppm for long-term use; 2.0 for short-tern (Rowe and Abdel-Mazid, 1995). Livestock water. NAS established recommended limit of 1.0

## Cadmium (Cd)\_

Source Cadmium is primarily found in surface water as a pollutant such as electroplating.

Issues Potential damage from cadmium may take the form of anemia, and increased hypertension. Treatment/Practices Reverse osmosis is considered best overall method for Ca

## eduction

Target Concentrations Domestic water Primary drinking water standard 0.05 ppm

Division water in thinking that any set of the set of t

## Lead (Pb)\_

Source Source Lead is normally found in surface water from industrial pollul Texas groundwater naturally contains elevated levels. *Issues* Lead symptoms range from gastrointestinal disturbances to in the brain and spinal cord. Brain damage is common among chi to high levels of lead. Transment/Paraticas

Treatment/Practices Reverse osmosis methods are considered best overall

concentration reduction. Some point source Pb precipitation on the market.

Target Concentrations Domestic water: Primary drinking water standard 0.015 ppn Irrigation water: 5.0 ppm for long-term use; 10.0 for short-1 and Abdel-Mazid, 1995). Elevated levels may cause plur

problems. Livestock water: 0.10 ppm established by both NAS and CA

![](_page_130_Picture_85.jpeg)

AVELON AND AND A

## may be found in surface water in swampy areas. issues Treatment/Practices

Oxidizing treatments convert reduced manganese to oxidized manganese followed by precipitate filtration (air spray system and KMnQ (edeers).
 Low levels can be removed through ion-exchange water softeners. *Target Concentrations* Domestic water: 0.05 ppm. (Secondary EPA drinking water standard) *Irrigation water*: 0.2 ppm. High manganese concentrations can reduce photosynthesis by coating leaf surfaces, thus limiting sunlight adsorption by exboration.

livestock consumption; 0.1 ppm has been established by CAST

## **B** - Water Sample Results XI

ptoms ranging	Chromium (Cr)		
00	Source		
	Chromium may be found in grou surface water as an industrial po	und water as a natural occurrence and in Ilutant commonly from the plating industry.	
mosis.	Issues Chromium can be toxic to human	is and produce skin irritations when external	
n, may change	exposures occur. Liver and kidne Treatment/Practices	y damage may result from internal exposure.	
short-term use	Reverse osmosis methods are concentration reduction.	a considered best overall method for Cr	
els > 0.2 ppm;	Target Concentrations Domestic water: Primary drinkin	g water standard 0.10 ppm.	
	Irrigation water: 0.1 ppm for long	-term use; 1.0 for short-term use (Rowe and	
	Livestock water: 1.00 ppm estat	plished by CAST.	
e water as an	Fluoride (F)		
s and kidneys.	Source Fluoride may be found naturally b	by dissolving small quantities of rock and soil	
concentration	In the water. Fluonde is also add	ten to uninking water by some water unines.	
	Fluoride concentrations of 1 ppm against dental cavities. Howev	er, excessive levels may cause brownish	
n	discoloration of the teeth. The ma depends on the quantity and terr	iximum recommended fluoride concentration operature average per year	
els > 10 ppm;	Temperature	In which we can a based a previous with the data and with state of the order of the	
	°E	ppm	
	63.9 - 70.6 70.7 - 79.2	1.8	
er as a mining	79.3 - 90.5	1.4	
	Treatment/Practices	a second dense according to the P	
neart and liver	Reverse osmosis methods an concentration reduction.	e considered best overall method for F	
1.1.1.1.2.1	Target Concentrations	n water standard 4.0 ppm Elevated levels	
concentration	may cause skeletal damage, bor Inrigation water: 1.0 for long-te	rm use: 15.0 for short-term use (Rowe and	
	Abdel-Mazid, 1995). Livestock water: NAS recommer	nded limit of 2.0 ppm; CAST limit established	
use	at 3.0 ppm.	annan an an ann an Anna Air Air an Air ann an Air ann an Air ann an Air an Air an Air an Air an Air an Air an A	
pm.	Charge Balance	the second se	
	and cations. Ideally, this term w	ill equal 100, thus indicating the amount of	
	negative charges (anions) equal	is the amount of positive charges (cations)	
om industries	non-analyzed substances are pr	esent.	
starded growth	Other Terms	hat such significant management or treatment	
A DECK OF A DECK	v. Limiting - This term indicates t		
	is required that the water may no	ot be economically or technically feasible for	
concentration	is required that the water may no the intended use.	t a biober than normal level of management	
concentration	is required that the water may no the intended use. <i>Limiting</i> - Limiting indicates that or treatment is needed to utilize	t a higher than normal level of management the water for a given application.	
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