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Comite Resources, Inc.

Town of Broussard
Wetland Wastewater
Discharge Preliminary
Assessment (Pre-
UAA)

draft

Prepared for
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Town of Broussard Wetland Wastewater Discharge Preliminary Assessment

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Executive Summary

The Town of Broussard is considering an investigation of the feasibility of discharging their secondarily treated effluent from a new oxidation pond facility adjacent to the Cote Gelee wetlands. The Cote Gelee wetlands in the vicinity of the proposed pond are composed of freshwater-forested wetlands.

Water bodies in the vicinity of Broussard are generally in a eutrophic state and in the next 3-5 years, it is expected that Louisiana Department of Environmental Quality (LDEQ) will lower the allowable concentrations for nitrogen and phosphorus and, in the future, water quality standards will become more stringent. The current treatment level of the Town of Broussard will not meet more stringent standards.

Implementation of a wetland discharge program will result in substantial nutrient reductions, which will allow the Town to meet these newer standards. Wetland assimilation will provide the most economical approach for Broussard to meet its water quality objectives.

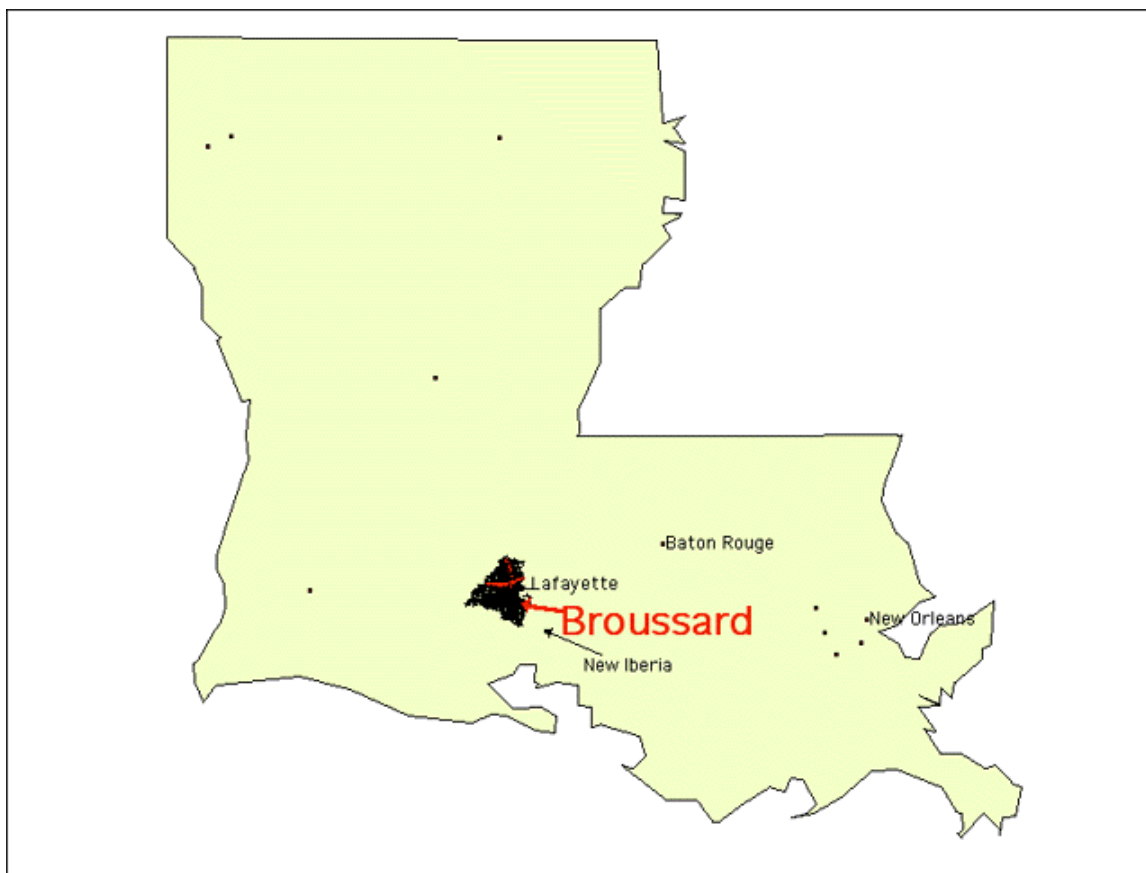
It is recommended that the Town of Broussard approach LDEQ and US Environmental Protection Agency (EPA) and proceed with carrying out a Use Attainability Analysis (UAA) as the next step to adoption of wetland assimilation for the Cote Gelee wetlands.



Cote Gelee wetland January, 2001

Introduction

The Town of Broussard is considering an investigation of the feasibility of discharging their secondarily treated effluent from a proposed new treatment facility to the adjacent Cote Gelee wetlands. This investigation is based upon information provided by The Town of Broussard, scientific literature, data sources, and two site visits January 11, 2001 and January 30, 2001.

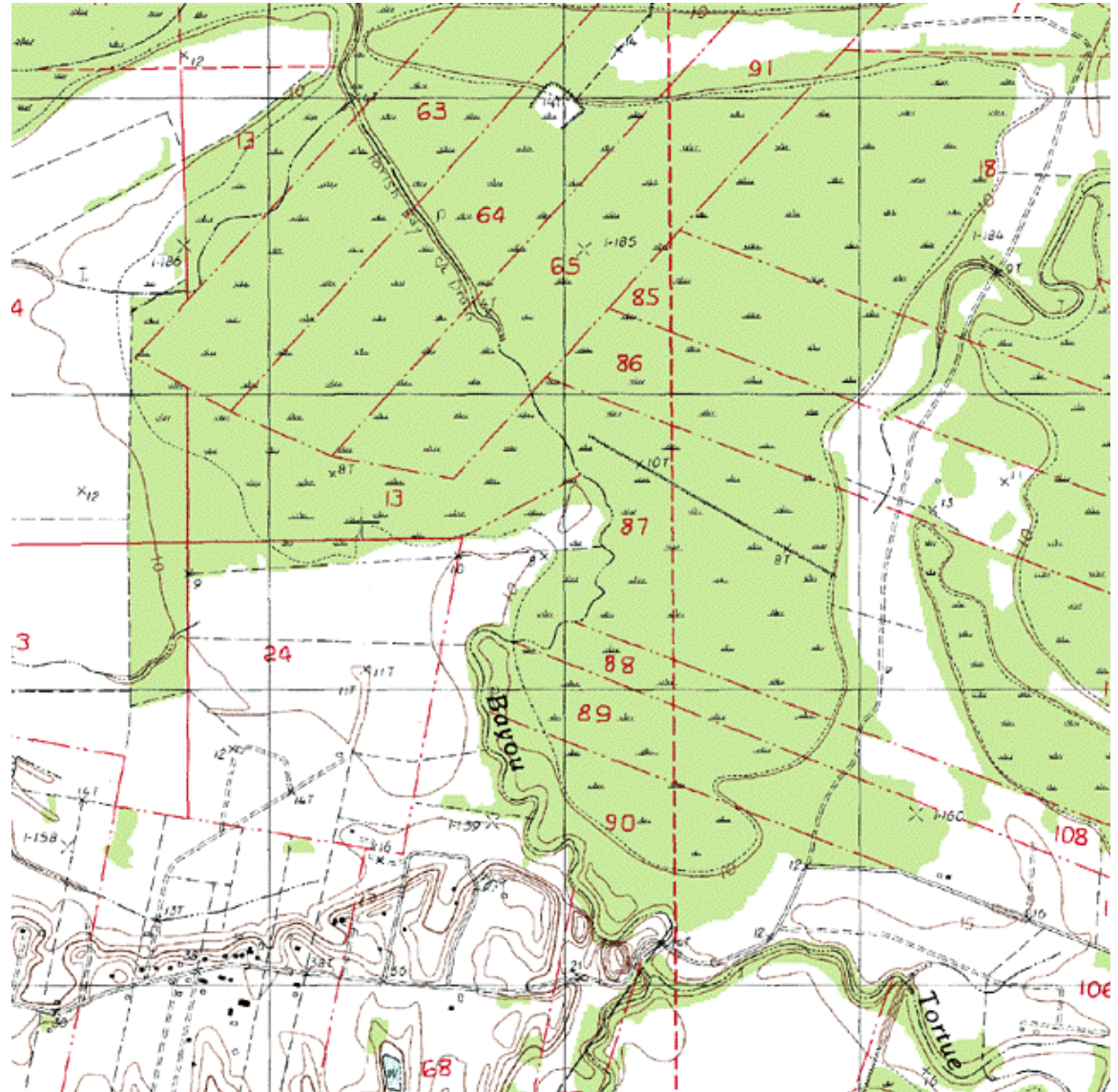


Town of Broussard

The Town of Broussard is in the southwestern part of Louisiana, near Lafayette. The total land area is 7.942 sq. kilometers. Broussard is positioned 30.15 degrees north of the equator and 91.97 degrees west of the prime meridian.

The population of Broussard is approximately 3,514 (1995). The approximate number of families is 1,300 (1990).

This Town is located on the western edge of the Mississippi River Alluvial Plain. The potential wetland assimilation area, Cote Gelee wetlands, occupies a band along the eastern edge of Lafayette Parish. Just to the west is an abrupt escarpment that rises 15 to 40 feet from the western edge of the Mississippi alluvial plain to the level of the terrace upland (see Map 1.).

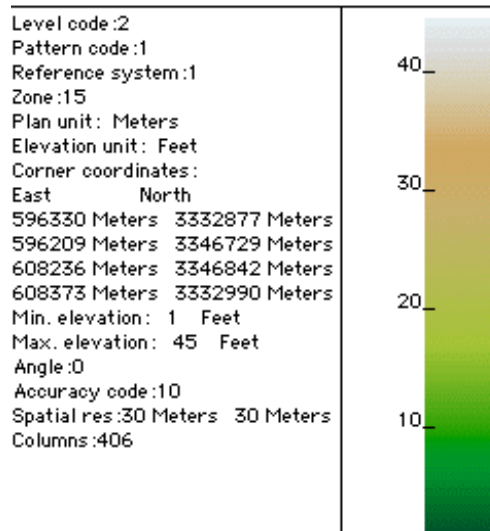
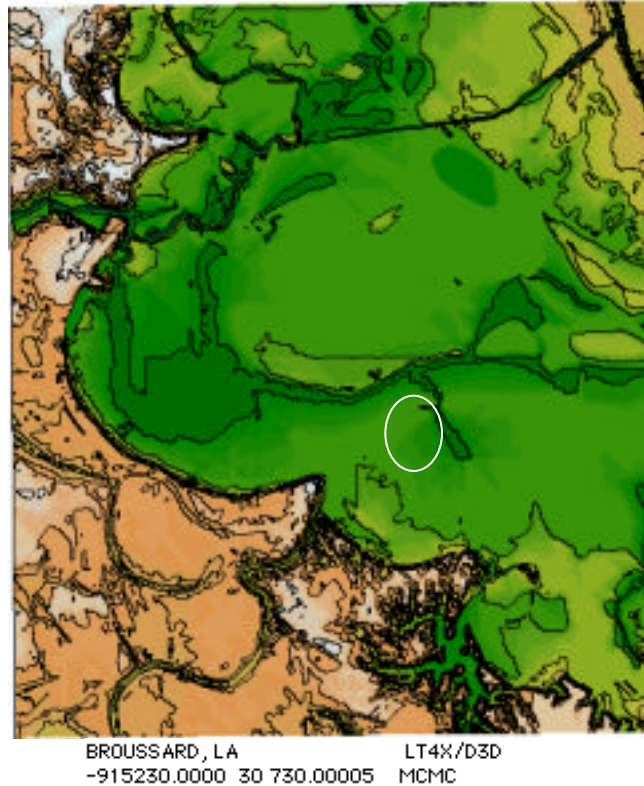


Map 1.

Landforms and surface geology

The area west of Bayou Tortue and east of US Highway 90 is characterized by a distinctive meander belt topography in which a number of abandoned channels and courses are apparent. Much of this area has been described as an upper deltaic plain or lower alluvia plain of the Mississippi River. These alluvial deposits are not exposed at the surface in the area. The area is covered with loessial deposits that range to 20 feet or more in thickness. These meander belt features such as natural levees and abandoned channels can be seen on aerial photographs and contour maps (see Map 1.)

Elevation ranges from 15 feet above sea level on the natural levees along the Mississippi River to about 5 feet below sea level in the former marshes and swamps that have been drained. Most of the undrained marshes and swamps range in elevation from just above sea level to several feet above sea level. The USGS Digital Elevation Model (DEM) data files for this area that are shown below (Map 2.) are digital representations of cartographic information in a raster form. DEMs consist of a sampled array of elevations for a number of ground positions at regularly spaced intervals. The U.S. Geological Survey (USGS) produces these digital cartographic/geographic data files as part of the National Mapping Program. The white circle in Map 2 shows location of Cote Gelee wetlands.



Map 2. The five foot contour is shown on the DEM image

Wetland Assimilation

Wetlands have been used to treat wastewater for centuries, but only in the past several decades has the response to such use been scientifically analyzed in a comprehensive way (Richardson & Davis 1987). The ability of wetlands to perform certain water purification functions has been well established for natural watersheds (Conner et al. 1989; Kadlec and Alvord 1989; Kemp et al. 1985; Khalid et al. 1981 a&b; Knight et al. 1987; Nichols 1983; Richardson & Davis 1987; Richardson & Nichols 1985; U.S. EPA 1987, Kadlec and Knight 1996, Faulkner and Richardson). Studies in the southeastern United States (Wharton 1970; Shih and Hallett 1974; Kitchens et al. 1975; Boyt 1976; Nessel 1978; Yarbrow 1979; Nessel and Bayley 1984; Yarbrow et al. 1982; Tuschall et al. 1981; Kuenzler 1987, Zhang et al. 2000) have shown that wetlands chemically, physically, and biologically remove pollutants, sediments and nutrients from water flowing through them. Some questions remain as to the ability of wetlands to serve as long-term storage reservoirs, but there are cypress systems in Florida that continue to remove major amounts of sewage nutrients even after 20-45 years (Boyt et al. 1977; Ewel & Bayley 1978; Lemlich & Ewel 1984; Nessel & Bayley 1984). Recently Hesse et al. (1998) showed that cypress trees at Breaux Bridge which have received wastewater effluent for 50 years had a higher growth rate than trees not receiving effluent.

From an ecological perspective, interest in wetlands to assimilate effluent is based on a belief that the free energies of the natural system are both capable of and efficient at driving the cycle of production, use, degradation, and reuse (Odum 1978). The basic principle underlying wetland wastewater assimilation is that the rate of application must balance the rate of decay or immobilization. The primary mechanisms by which this balance is achieved are physical settling and filtration, chemical precipitation and adsorption, and biological metabolic processes resulting in eventual burial, storage in vegetation, and denitrification (Patrick 1990; Kadlec & Alvord 1989; Conner et al. 1989). Effluent discharge generally introduces nutrients as NO_3 , NH_4 , PO_4 , or organic forms. The nitrogen and phosphorus supplied in the wastewater can be removed in the short-term by plant uptake, in the long-term by peat and sediment accumulation and permanently by denitrification (Hemond and Benoit 1988). Wetlands with long residence times are best suited for BOD reduction and bacteria dieback. Many pathogenic microorganisms in sewage effluent cannot survive for long periods outside of their host organisms. Protozoa present in shallow waters actively feed on bacteria. The presence of vegetation can also improve the BOD purifying capacity by trapping particulate organic matter and providing sites of attachment for decomposing bacteria. Root excretions from some wetland plants can kill pathogenic bacteria (Hemond and Benoit 1988).

The purpose of the Louisiana Water Control Law and Federal Clean Water Act is to protect or enhance the quality of public water, including wetlands. Three components of the water quality standards adopted by Louisiana and approved by the EPA are; 1) beneficial water uses such as propagation of fish and wildlife, 2) criteria to protect these beneficial uses and 3) an antidegradation policy which limits the lowering of water quality. In Louisiana, discharging treated effluent into wetlands can allow for the potential enhancement and restoration of the functional attributes associated with wetlands (e.g.

groundwater re-charge, flood control, biological productivity) (Kadlec and Knight 1996; Rybczyk et al. 1996a, Day et al. 2000). Specifically, most coastal wetlands have been hydrologically altered, and are isolated from the alluvial systems responsible for their creation (Boesch 1994). This makes these wetlands especially vulnerable to the high rates of relative sea level rise (RSLR: subsidence plus eustatic sea level rise) associated with a deltaic systems (Penland 1988) and to predicted increases in eustatic sea level rise (Gornitz 1995).

Wetlands have been shown to persist in the face of RSLR when vertical accretion equals or exceeds the rate of subsidence (Baumann et al. 1984, Delaune et al. 1983, Stevenson et al. 1986). In the past, seasonal overbank flooding of the Mississippi River deposited large amounts of sediments into the interdistributary wetlands of the delta plain. Not only did these floods provide an allochthonous source of mineral sediments, which contributed directly to vertical accretion, but the nutrients associated with these sediments promoted vertical accretion through increased autochthonous organic matter production and deposition, and the formation of soil through increased root growth. This sediment and nutrient source has been eliminated since the 1930's with the completion of levees along the entire course of the lower Mississippi, resulting in vertical accretion deficits (RSLR > accretion) throughout the coastal region.

Contributing further to the problem of vertical accretion deficits, many wetlands in the deltaic region have been hydrologically isolated from surrounding marshes, swamps and bayous due to an exponential increase in the construction of canals and spoil banks during the past century (Turner and Cordes 1987). In addition to impeding drainage and, in many cases, physically impounding wetlands, these spoil banks also prevent the overland flow of sediments and nutrients into coastal wetland forests, creating essentially ombrotrophic systems.

The total acreage of swamp forest in the Louisiana coastal zone has decreased by 50% from 1956 to 1990 (Barras et al. 1994). Furthermore it has been predicted that increased rates of eustatic sea level rise could eliminate most of the remaining forested wetlands (Delaune et al. 1987). In the wetland forests of southeastern Louisiana, Conner and Day (1988) estimated vertical accretion deficits ranging from 2.5 to 10.8 mm yr⁻¹, which leads directly to increased flooding duration, frequency and intensity. Productivity decreases observed in these wetlands may be attributed to either the direct physio-chemical effects of flooding (i.e. anoxia or toxicity due to the reduced species of S and Fe), flood related nutrient limitations (i.e. denitrification or the inhibition of mineralization), nutrient limitations due to a reduction in allochthonous nutrient supplies, lack of regeneration, or most likely, some combination of these factors (Mitsch and Gosselink 1986).

Recent efforts to restore and enhance wetlands in the subsiding delta region have focused on attempts to decrease vertical accretion deficits by either physically adding sediments to wetlands or by installing sediment trapping mechanisms (i.e. sediment fences), thus increasing elevation and relieving the physio-chemical flooding stress (Boesch et al 1994). Day et al. (1992) proposed an alternate restoration strategy by hypothesizing that adding nutrient rich secondarily treated wastewater to hydrologically isolated and subsiding wetlands could promote vertical accretion through increased organic matter

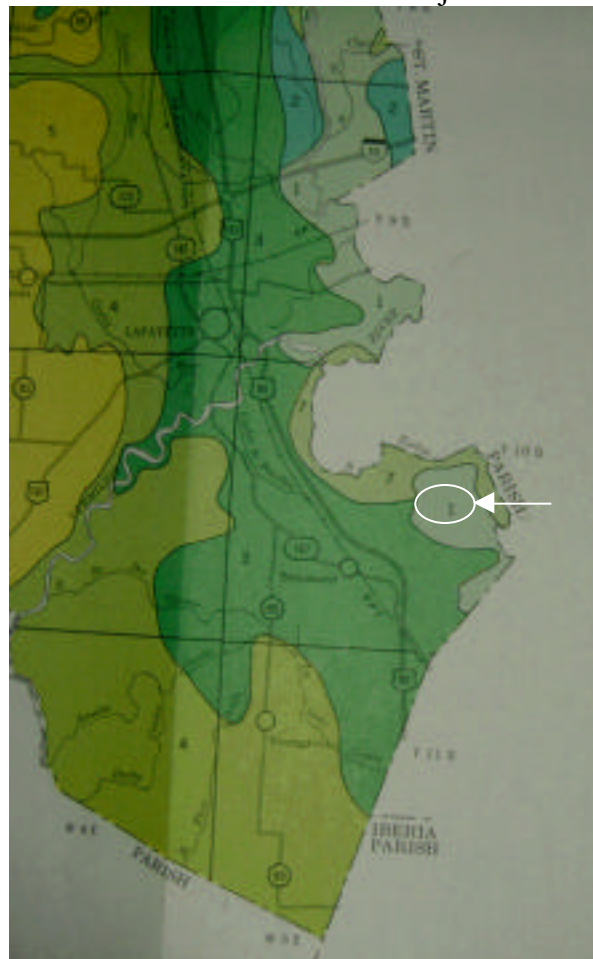
production and deposition. His work, and other studies, have shown that treated wastewater does stimulate productivity and accretion in wetlands (Odum et al. 1975, Mudroch and Copobianco 1979, Bayley et al. 1985, Turner et al. 1976; Knight 1992; Craft and Richardson 1993; Hesse 1996; Rybczyk 1997, Day et al. 2000).

An analysis of the Cote Gelee wetlands benefits from recently completed Use Attainability Analyses (UAA) and ongoing monitoring of similar systems at Thibodaux, Breaux Bridge, St. Bernard, Amelia, and Mandeville, Louisiana. Much of the design of the Cote Gelee study will be based on the successful work at Thibodaux, St. Bernard, Amelia, and Breaux Bridge.

General Characteristics of Soils and Wetlands

Soils of Cote Gelee wetlands

The general soil map (Map 3.) of the Cote Gelee wetlands (circle) shows, in color, the map units for broad land-use planning. Each map unit is a unique natural landscape that has a distinct pattern of soils and of relief and drainage features. A unit typically consists of one or more soils of major extent and some soils of minor extent. It is named for the major soils.



Map 3.

The Cote Gelee wetland soils (see square in Map 4.) are classified as Sharkey – Baldwin – Iberia. These soils are described as level to nearly level, poorly drained clayey and loamy soils that formed in alluvium.

Sharkey soils are somewhat lower in elevation than Baldwin soils and slightly lower in elevation than Iberia soils. Sharkey soils have a surface layer of clay, Baldwin soils have a surface layer of silty clay. All three soils have a clayey subsoil, have a seasonal high water table, and are poorly drained. The area is used mainly as pastureland and woodland. Soil wetness is the main limitation to most uses. These soils make the area very suitable for wetland assimilation.

24--Sharkey clay

This level soil is in board areas adjacent to the natural level. It formed in clayey alluvium. Slopes are less than .5 percent. Typically, the surface area is mildly alkaline, dark gray clay about 8 inches thick. The subsoil, to a depth of 45 inches, is moderately alkaline, gray clay mottled with shades of brown. (see Map 4.)



Map 4. Soil Delineation for Cote Gelee wetlands. Source USDA SCS.

This soil is high in fertility. Plant roots penetrate the soil with some difficulty, and water and air move at a very slow rate through the soil. Water runs off the surface at a slow rate. The seasonal high water fluctuates between a depth of 2 feet and the surface during December through April. The soils swell when wet and shrinks and cracks when dry. The surface layer is wet for extended periods in winter and spring. There is sufficient water for plants most years.

Potential as cropland and pastureland is good, but potential urban use is poor. Potential for intensive recreation areas is poor. Wetness and high shrink-swell potential are limitations.

25-Sharkey clay, frequently flooded

This level of soil formed in clayey alluvium. Slopes are less than 0.5 percent. This soil is subject to frequent flooding by runoff from higher areas. Usually the surface layer is neutral, dark grayish brown clay about 3 inches thick. The subsoil to a depth of 12 inches is mildly alkaline, gray clay mottled with yellowish brown. To a depth of 46 inches, it is moderately alkaline, light brownish gray clay mottled with yellowish brown. The underlying material, to a depth of 60 inches or more, is moderately alkaline, gray clay mottled with yellowish brown.

This soil is very fertile. Roots penetrate the soil with difficulty, and water and air move slowly rate through the soil. Run-off from the surface is very slow through the soil. The soil is flooded with 1 to 3 feet of water once or more each year. During periods when the soil is not flooded, the seasonal high water table fluctuates between a depth of 2 feet and the surface. The soil swells when wet and shrinks and cracks when dry. Sufficient water is available to plants in most years. Most of the area is woodland. Potential as cropland is very poor, and potential, as pastureland is poor.

26-Udifluent, loamy

These soils are made up of highly variable, dominantly loamy material. The deposits range from silty clay to loamy fine sand. Slopes are generally less than 1 percent, but the surface is uneven and contains numerous small swales and potholes. Elevation ranges from 15 feet to 25 feet above sea level.

This group consists mainly of level, somewhat poorly drained loamy, clayey, and mucky soils in former swamps and marshes. These areas are protected from most flooding by levees and drained by pumps. These areas comprise about 6 percent of the land area of the parish. Pastures make up most of this area.

Preliminary Reconnaissance of Cote Gelee wetland

The proposed wetland discharge area is located east of the Town of Broussard.

Location and General Description of Sites

For this preliminary investigation we characterized the potential wetland sites. See Map 5. The primary receiving wetland is south of the proposed oxidation pond and west of Bayou Tortue. Additional potential receiving wetlands are located east of Bayou Tortue and north of the existing oxidation pond.



Map 5.

Characteristics of Selected Wetland Candidate Sites

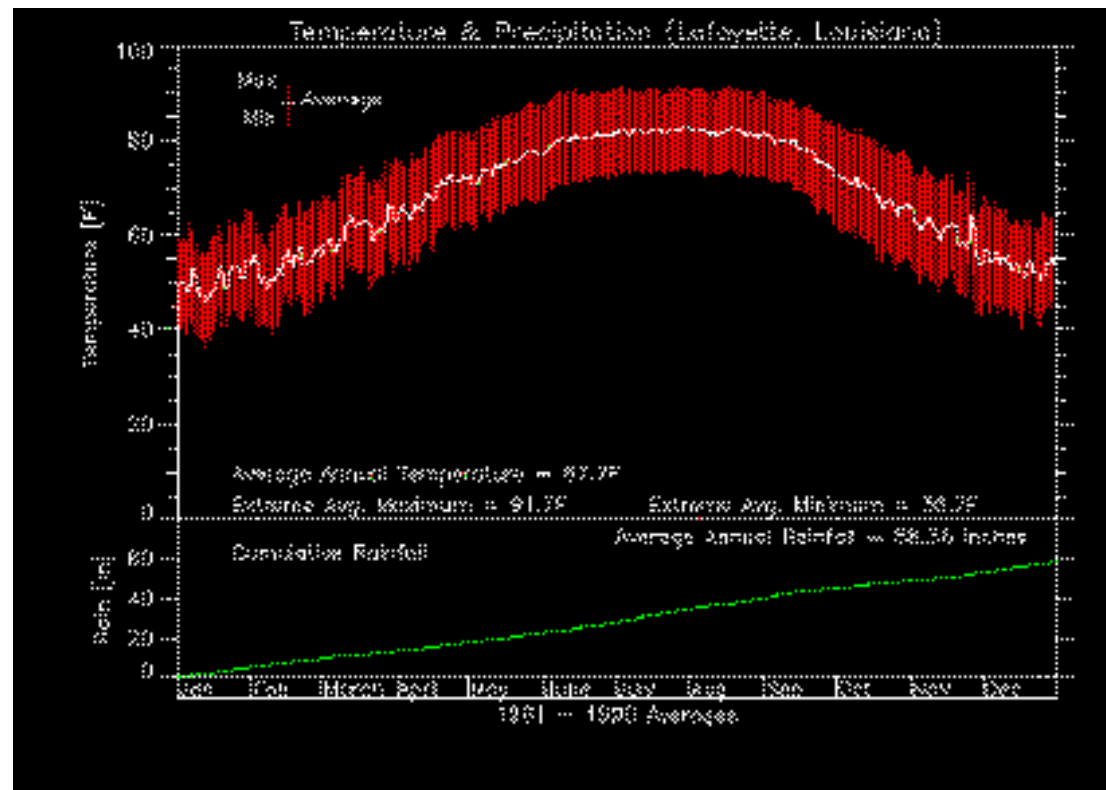
Land Use and Ownership

Most of these wetlands are in woodland and are used as habitat for wetland wildlife and for hunting. The major landowner is Billeaud Company, according to Tex Plumley, general manager. Discussions with Mr. Plumley and Mr. Robert Boese indicate that the landowner is fully supportive of the wetland assimilation project.

Hydrology and Hydroperiod

The area receives water primarily from rainfall. Average annual precipitation (P) 143.15 cm (58.36 inches) for Lafayette. Rainfall near this site varies seasonally through the year.

The Cote Gelee swamp is hydrologically controlled by rainfall and potentially from back flooding from Bayou Tortue. Much of the area seems to drain naturally during periods of low water in Bayou Tortue, which eventually flows into the Vermilion River. Rainfall and runoff likely dominate the hydrology.



Water Quality

Water Quality in the Vermilion River Basin

The utilization of wetlands for assimilation of effluent from the Town of Broussard will allow the Town to meet more stringent water quality standards at a minimum cost.

The Vermilion River is the receiving water body for Bayou Tortue. Recent water quality data for the Vermilion River are show in Table 1 below.

Table 1.

Subsegment	060801	060802
Stream Description	Vermilion River – Headwaters at Bayou Fusilier – Bourbeux junction to New Flanders (Ambassador Caffery) Bridge, Hwy. 3073	Vermilion River – New Flanders (Ambassador Caffery) Bridge, Hwy. 3073, to Intracoastal Waterway
Criteria		
Cl, mg/l	230	230
So ₄ , mg/l	35	35
DO, mg/l	5	5 : JAN – APR 3.5 : May - DEC
PH, su	6.0 – 8.5	6.0 –8.5
BAC	1	1
Temperature Degrees C	32	32
TDS, mg/l	350	350

Source: Louisiana Department of Environmental Quality, Vermilion River TMDL Review, Table 3, page 4, Nov. 19, 1999, Revised Dec. 15, 1999

Vegetation Communities

The wetland classifications of the study area include palustrine forested, palustrine scrub-shrub, and palustrine emergent, and estuarine emergent (Cowardin et al. 1979). Most of the wetland area in the vicinity of the proposed treatment area and along Bayou Tortue is a broadleaf and needle-leaved deciduous forested wetland dominated by water tupelo (*Nyssa sylvatica* var. *aquatica*) and baldcypress (*Taxodium distichum*). These forests seem are periodically flooded depending on recent rainfall. In the slightly elevated parts of the area, there is a mixed forest with bottomland hardwood species including pumpkin ash (), water hickory (), and red maple () and water elm (). Much of the area seems to drain naturally during periods of low water in Bayou Tortue which eventually flows into the Vermilion River. The southern and western part of the area, drainage is restricted by the presence of old access roads and low levees. The forest in this area is composed of smaller trees composed mostly of maple.

During the visit to the area, a transect was taken through the well-drained forest. This is a mature, relatively unimpacted area. Water depths over the transect was from 0 to 25cm, with the depth increasing as the forest floor sloped gradually towards the bayou. The average distance between trees is 2.37 m, the total density of trees is 1783 trees per ha, and the basal area of the forest is 76.7 m²/ha.



*Dr. John Day conducting site visit in
Cote Gelee forested wetland January 2001*

The forest community structure is shown in Table 2.

Table 2.

Tree Species	Absolute Density – trees/ha	Relative Density
baldcypress	134	0.075
watertupelo	1059	0.65
red maple	802	0.45
elm	178	0.1
willow	89	.05

The forested wetland areas have basal area and absolute density values that are similar or higher than at the Amelia site (Day et. al 1997) and the Breaux Bridge site (Delgado-Sanchez 1995), and much higher than at the Thibodaux site (Day et. al. 1993). The vegetation under the forest is sparse and includes: marsh purslane, dwarf palmetto (*Sabal minor*), marsh spider lily (*Hymenocallis crassifolia*), lizard's tail (*Saururus cernuus*), and duck weed (*Lemna minor*).

Faunal Communities

Forested wetlands are known to provide valuable habitat to wildlife mainly because of the abundance of food and cover found in these areas (Harris et al. 1984). Unfortunately, however, there is a lack of information pertaining to the wetland habitat requirements of most species living in these areas with the exception of nutria, beaver, and some species of waterfowl (Sather and Smith 1984).

Frequency of Occurrence

Studies in the Atchafalaya Basin indicate that bottomland forests can support from two to five times as many game animals as pine-hardwood areas, and during the winter may contain ten times as many birds per acre as pinelands (Harris et al. 1984).

Species Diversity

Partial descriptions of wildlife communities have been reported, but thorough characterizations are not available for most wetland areas (Brinson et al. 1981). While we have not yet identified any studies concerning the fauna on these wetland sites, we know that wetlands provide habitat for a wide variety of wildlife. The importance of wetlands to wildlife can be attributed to specific biological and physical features, which include:

1. Predominance of woody plant material;
2. Presence of surface water and abundant soil moisture;
3. Close proximity of diverse structural features (live and dead vegetation, water bodies, non-vegetated areas), resulting in a heterogeneous habitat; and
4. Distribution in long corridors or size that provide protective pathways for movement (Brinson et al. 1981).

Some animals are completely dependent on wetlands for food, protection, resting areas, reproductive sites, and other life requisites (Sather and Smith

1984). Although some animals spend their entire lifetime in a particular wetland, others are resident for only part of their life cycle or as temporary residents as they travel from one place to another. Wetlands also provide critical habitat for many rare and endangered species of animals. Reasons for the high diversity of animals within a wetland depend on many factors, including the structure and diversity of the vegetation, surrounding land uses, spatial patterns within the wetland, vertical and horizontal zonation, size of the wetland, and water chemistry (Sather and Smith 1984).

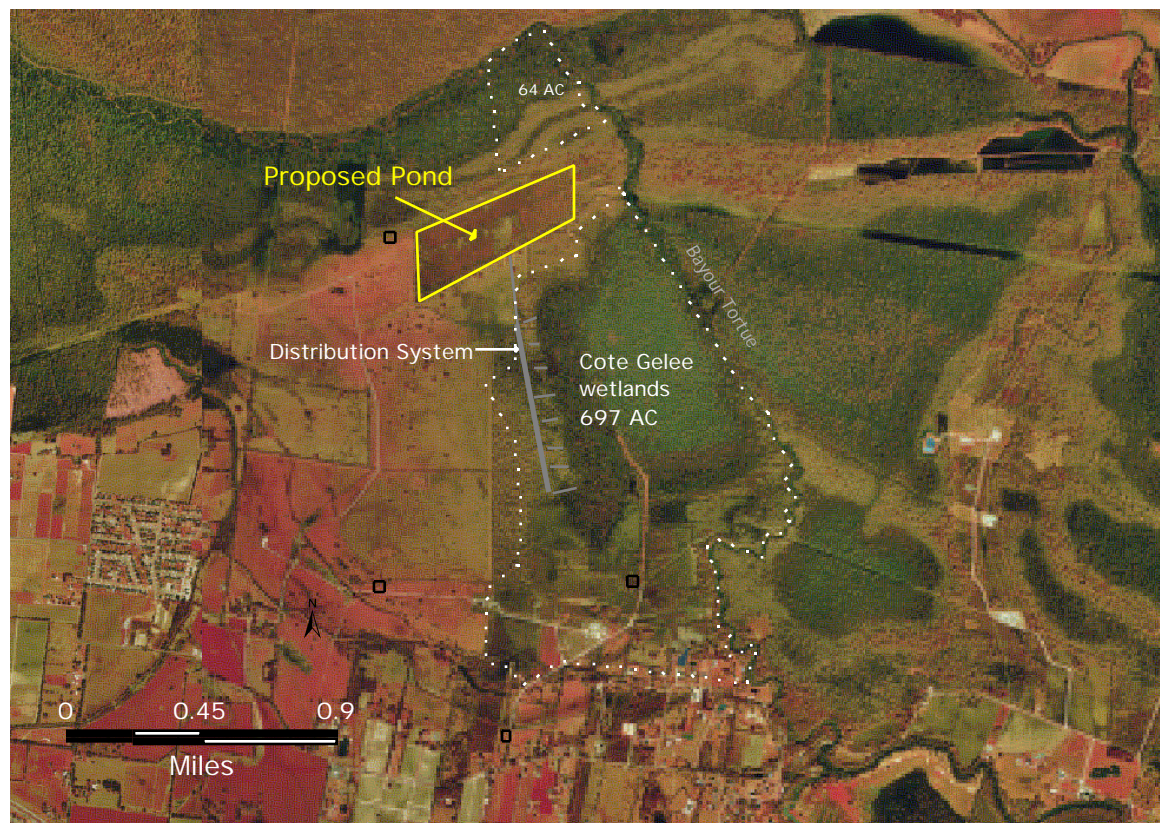
Characteristic bird species found in these wetland forests include numerous passerine species, several birds of prey, several upland game birds, and a variety of birds associated with aquatic habitats. The number of mammal species generally ranges from 5-30 with population densities varying greatly from area to area. A typical forested wetland site may include several furbearers, a few small and medium sized mammals, and one or more large mammals. Amphibians and reptiles have generally been neglected in favor of the more economically important animals. However, these latter groups are important in aquatic food chains and are becoming more recognized as valuable indicators of environmental quality (Orser and Shure 1972, Dodd 1978).

Protected Species Occurrence

A request was made to the Louisiana National Heritage Program, to determine if there are any rare, threatened or endangered species known to occur in the potential treatment areas.

Conceptual Design

The conceptual site plan is presented in this section. Distribution headers will be constructed at the approximate locations shown in Map 6 below. Each distribution header will consist of pipe. Each header will be supplied with rectangular orifices, spaced at regular intervals, to provide uniform distribution of effluent over the wetland. Details of the specific locations, type of pipe used, spacing between outlets, and design specs will be developed as part of the Use Attainability Analysis (UAA) and permitting process.



Map 6.

Regulatory Constraints

The US EPA is willing to permit the use of natural wetlands for wastewater management in some cases, and has encouraged the states to approve wetland projects on the basis of the "anti-degradation" rule. The anti-degradation rule provides for the protection of the "existing uses" of the wetlands, whether as a wildlife habitat, recreation, groundwater supply, etc. This rule seeks to guard these "uses" by making sure that the water quality and health of the wetland which support these uses are not damaged. If the use of a wetland for wastewater management would "degrade" or prevent any given current use of the wetland, a permit to discharge effluent will likely be denied. Currently in Louisiana, a Use Attainability Analysis (UAA) is carried out during an initial (pilot) phase of the permitting process. A UAA must evaluate, normally over a period of one year, the existing uses of the wetland and determine the impact of the wastewater on the site before a final permit is issued.

John Day and Joel Lindsey met with Mr. Dugan Sabins and Ms. Kristine Pintado, Louisiana Department of Environmental Quality (LDEQ) January 18, 2001 in Baton Rouge. The purpose of the meeting was to discuss the Cote Gelee wetland wastewater assimilation project. The meeting notes are attached.

Mr. Sabins stated it is apparent the existing pond was not large enough to accommodate the increased flow. Mr. Sabins felt this was a positive thing for the Town to be doing for the area is growing. Lafayette is expanding southwest. Dr. Day pointed out this project is designed to accommodate future growth.

Dr. Day explained the distribution system would be close up to the point where the system is at the wetland. Mr. Sabins asked where the flow will go. Mr. Sabins, also, stated he thinks this one is fine since we have quite away before you get to the bayou system and plus there is a lot of wetlands. The Town needs to explain what they are going to do with the old pond.

In Table 3 below, the monitoring requirements for a typical Use Attainability Analysis (UAA) are given. It should be noted that monitoring requirements might change given specific circumstances or conditions for each proposed wetland system. The Louisiana DEQ has permitted projects for the discharge of secondarily-treated effluent to wetlands near Thibodaux and Breaux Bridge and permits are currently being processed for Amelia, St. Bernard, and Mandeville.

Table 3
Louisiana DEQ Permit for Wetland Wastewater Management:
General Wetland Monitoring Schedule

Parameter	Frequency of Wetland Monitoring By Component			
	Flora	Fauna	Sediment	Surface Water
Species	2X/yr	2X/yr	None	None
Classification				
% Composition of Species	2X/yr	2X/yr	None	None
Growth Studies	Year 1,4	None	None	None
Stage (Water Level)	None	None	None	None
Metal Analysis Mg, Pb, Cd, Cr III, Cr IV, Cu, Zn, Fe, Ni, Ag, Se	Year 1,4	None	Year 1,4	1X/yr
Nutrient Analysis TKN, Phosphorous, Ammonia, Nitrate, Nitrite	Year 1,4	None	Year 1,4 Year 1,4	1X/yr 1X/yr
BOD, TSS	None	None	None	2X/yr
pH	None	None	Year 1,4	2X/yr

ESTIMATES OF LOADING RATES AND WETLAND ASSIMILATION

The ability of wetlands to remove nutrients from inflowing water is primarily dependent on the nutrient concentration and volume of the input water and the area of wetland. Temperature and the hydrology of the specific wetland site also influence nutrient uptake.

The inflow into a wetland is normally expressed as a loading rate which integrates the concentration and volume of the inflow over time and the area of the receiving wetland. Loading rate is expressed as the amount of nutrient introduced per unit area of wetland per unit time; normally as $\text{g N or P m}^{-2} \text{ y}^{-1}$. Loading rate incorporates residence time since it has units of time.

Nutrient removal is inversely related to loading rate. Richardson and Nichols (1985) reviewed a number of wetland wastewater treatment systems and found a relationship between loading rate and nutrient removal efficiency (Figure 1). Nutrient removal efficiency is the percentage of nutrients removed from the overlying water column and retained within the wetland ecosystem or released into the atmosphere. The relationship between nutrient removal efficiency and loading rate is not linear and there is very efficient removal at low loading rates but removal efficiency decreases rapidly with increasing loading rate.

The curves of Richardson and Nichols (1985) (Figure 1) are for wetland sewage treatment systems located in many different parts of the United States. There are a number of studies from Louisiana where loading rates and nutrient reduction have been reported for receiving wetlands. Breaux and Day (1994) provided estimates of loading rate and removal efficiencies for forested wetlands near Thibodaux and Breaux Bridge where secondarily treated sewage was being discharged.

Day et al. (2000) reviewed the performance of several wetland assimilation systems receiving treated sewage wastewater. Nutrient uptake has also been demonstrated for the Caernarvon diversion which is similar to the above-cited studies (Lane et al. 1999). Wetlands of the Caernarvon area, and those of the sewage treatment systems are ecologically similar to wetlands within and surrounding the Cote Gelee area. Therefore, we used the loading rates reported in these studies to estimate nutrient retention in the Cote Gelee wetlands.

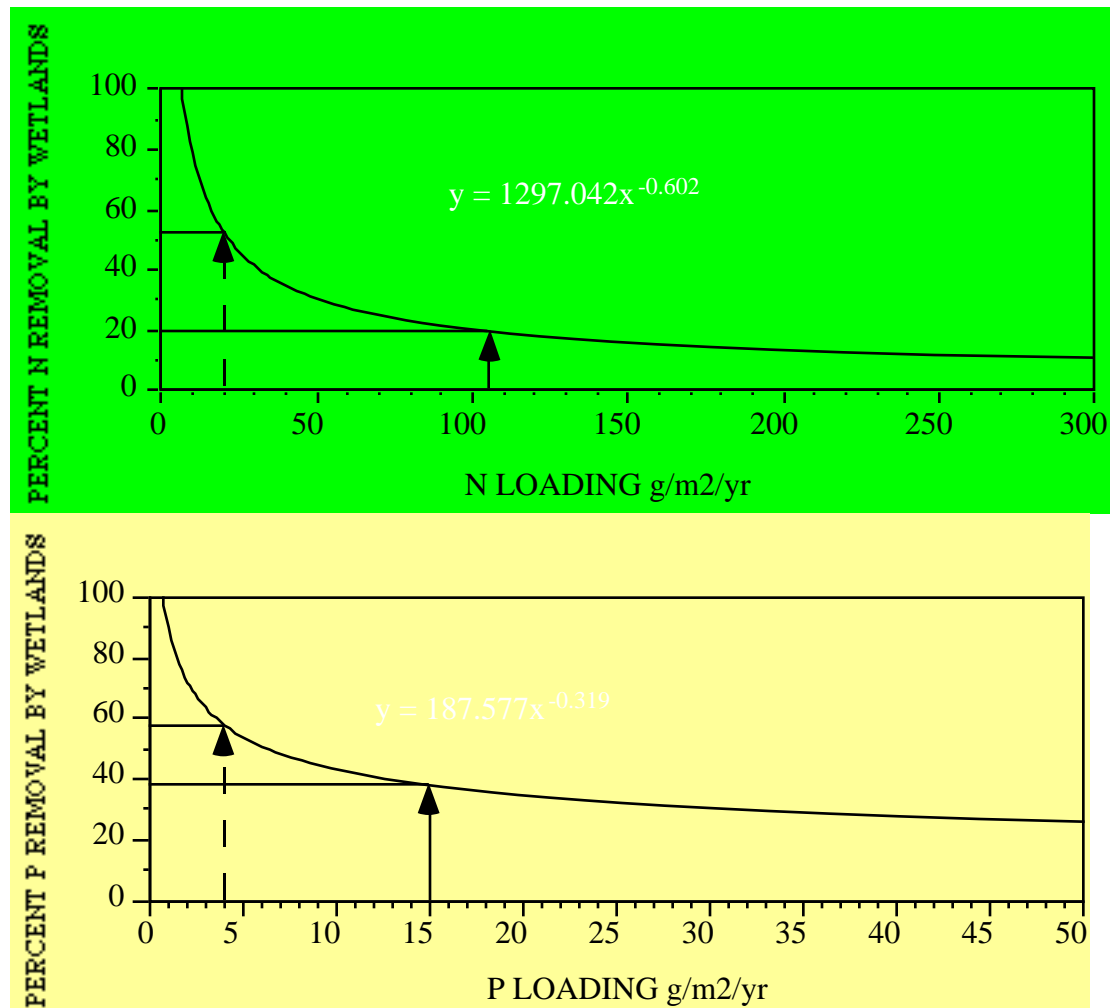


Figure 1. Nitrogen and phosphorus removal efficiency as a function of loading rate (Richardson & Nichols, 1985). The arrows indicate how the loading rate and percent nutrient removal are related.

In order to estimate nutrient removal, the concentrations of total nitrogen (TN) and total phosphorus (TP) and the area of wetlands are needed. TN and TP values are not available for the Cote Gelee wetlands, so average values for secondarily treated wastewater for other wetland assimilation in coastal Louisiana systems were used (Day et al. 1999). Based on these studies at Amelia, Breaux Bridge, St. Bernard and Thibodaux, we used 10 mg/l TN and 3 mg/l TP. Total amounts of nitrogen and phosphorus discharge from the treatment plant were calculated based on the TN and TP concentrations given above and the estimated discharge from the proposed treatment system. We used a range of values here. The discharge from Broussard is 350,000 to 500,000 GPD. If Youngsville is included, this will add an additional 350,5000 to 500,000 GPD. We used for our calculations, discharge rates of 500,000 and 1,000,000. Thus, our uptake estimates are somewhat conservative since we used the higher estimates for flows.

The area of wetlands used in the loading rate calculations was based on the two areas of wetlands in the Cote Gelee wetlands. The area west of Bayou Tortue and immediately south of the proposed oxidation pond is approximately 390 acres. The total area of wetlands in the Bayou Tortue property is about 690 acres. Thus, based on the TN and TP

concentrations, the estimated discharge rates, and the wetland area available, we calculated loading rates for the area. Finally, to estimate nutrient retention, we used the curves of Richardson and Nichols and results from other wetland assimilation systems in Louisiana.

Based on these calculations, the loading rate for the Cote Gelee wetland is within values for existing wetland treatment systems in Louisiana. Loading rates for nitrogen ranged from 2.4 to 9.3 gN/m²/yr and loading rates for phosphorus ranged from 0.7 to 2.8 gP/m²/yr. Based on these loading rates, retention for nitrogen should be in the range of 70-90% and for phosphorus, in the range of 70 to greater than 90%. Actual loading may be lower and retention higher if the discharge is lower than the values used in these calculations. Actual loading and retention will be determined more accurately when measurements are made.

Additional wetland area is available in the vicinity of the old oxidation pond. If this area continues to be used, then loading rates will be lower and retention rates higher than those calculated above. This area also provides additional wetlands for projected future growth.

Table 4. Total nitrogen and total phosphorus loading rates for the Cote Gelee wetlands assuming two different wetland areas. (mgd = million gallons per day).

Area of Wetland (Acres)	Nitrogen Loading Rate (g N/m ² /yr)		Phosphorus Loading Rate (g P/m ² /yr)	
	0.5 mgd	1.0 mgd	0.5 mgd	1.0 mgd
360	4.63	9.26	1.39	2.78
690	2.45	4.89	0.73	1.47

Wetland Discharge System Loading and Performance in Louisiana

The basic principal underlying the use of wetlands for wastewater management is that the rate of application of material to the wetland must balance the rate of removal. Therefore, one of the most important controls in wetland systems is the *loading rate*. In general, a loading rate refers to the rate per unit of area at which a material (e.g. a constituent in the effluent) is discharged to a system over a given time period. Specific to wetland systems receiving secondarily treated effluent, loading rates are normally used in reference to the quantities of either nutrients (principally nitrogen and phosphorus) or the volume of the effluent itself being discharged. Loading rates used for total suspended solids (TSS) and organic carbon (measured as biological oxygen demand or BOD) are frequently used in the management of conventional wastewater treatment systems.

Wetland systems have a high capacity to assimilate organic carbon and suspended solids, so it is usually less critical to monitor the BOD and TSS loading rate for wetlands. In addition, some wetland waters are naturally low in oxygen, so the traditional concept of BOD is not always applicable to these systems.

In wetland systems, high loading rates may not allow for sufficient processing time, resulting in a wetland that is over-loaded in constituents with a reduced capacity for assimilation. Conversely, at low loading rates, the wetland may remain with a higher capacity to remove contaminants, but the area required to assimilate the effluent will be much greater.

For wetland treatment systems in Louisiana, loading rates for total nitrogen range from 2 to 20 g/m²/yr and for total phosphorus from 0.4 to 2 g/m²/yr. Removal efficiencies for total nitrogen and total phosphorus average between 65 and 90%, while removal for nitrate is between 90 and 100%, respectively.

Monitoring is an important part of wetland wastewater assimilation. Biological and water monitoring throughout the project are essential to ensure the application of effluent is balanced with the rate of removal.

Use Attainability Analysis (UAA) outline

The contents of a typical UAA is presented below. The purpose of a UAA is to characterize the ecosystem under study in order to set baseline conditions against which monitoring results in the permit can be compared in order to determine any changes in the system. A UAA study characterizes the hydrology, soils, water chemistry, vegetation and fauna. The UAA also contains information about planning and geomorphology as well as listing the criteria and regulatory issues by which the wetland treatment system will be judged. A UAA lasts for one year and is a major part of the permit application for wetland discharge. We propose to do this for you.

Here is the Table of Contents for a recent UAA.

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CONCLUSIONS

Based on research and preliminary Comite Resources' evaluation of the area we feel there are sufficient wetlands in the vicinity of the treatment plant to achieve substantial reductions of nutrients in applied effluent. If this were done, then the Town of Broussard will achieve a long-term solution to their waste treatment needs at the Cote Gelee wetlands.

It is recommended that Town of Broussard approach Louisiana Department of Environmental Quality (LDEQ) and US Environmental Protection Agency (EPA) and consider carrying out a UAA as the next step to adoption of wetland assimilation at the Cote Gelee wetlands. The Town should also approach the Corps of Engineers, New Orleans District, to seek partial support for the Use Attainability Analysis (UAA).

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