

# Discerning nutrient limitations to phytoplankton growth in rivers and bayous on the North shore of Lake Pontchartrain, Louisiana

## Basic Information

<b>Title:</b>	Discerning nutrient limitations to phytoplankton growth in rivers and bayous on the North shore of Lake Pontchartrain, Louisiana
<b>Project Number:</b>	2007LA51B
<b>Start Date:</b>	3/1/2007
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<b>Research Category:</b>	Water Quality
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<b>Descriptors:</b>	nitrogen, phosphorus, eutrophication, estuary
<b>Principal Investigators:</b>	Sarah Fearnley

## Publication

1. Fearnley, Sarah and Carl Bohling, 2007, Discerning the limiting nutrient to phytoplankton growth in rivers and bayous on the north shore of Lake Pontchartrain “in” Geological Society of America – Abstracts with Programs, Vol 39(6), Geological Society of America, Boulder, Colorado, 427.

## A. RESEARCH

### SYNOPSIS

**Title** Discerning nutrient limitations to phytoplankton growth in rivers and bayous on the north shore of Lake Pontchartrain, Louisiana

#### **Problem and Research Objectives**

Rapid population growth and development along the north shore of Lake Pontchartrain has resulted in high concentrations of nutrients in surface waters that flow into the lake (Lake Pontchartrain Basin Foundation (LPBF), 2006; Fearnley *et al.*, 2006; Xu and Viosca, 2005). Eutrophication (excess nutrients) ranks among the most pressing water quality problems facing this area (LPBF, 2006) because it can lead to algal blooms (extreme rates of phytoplankton growth), which results in anoxic conditions in the water and can lead to wide spread fish kills. Sources of nutrient contamination to surface waters in the northern Pontchartrain Basin include dairy farm wastes, agricultural fertilizer, and sewage outflow from overburdened sewage treatment plants and from poorly maintained, highly concentrated individual residential septic systems (LPBF, 2006; Fearnley *et al.*, 2006; Xu and Viosca, 2005).

In freshwater systems such as most rivers, the total inorganic nitrogen to total inorganic phosphorus (TIN:TIP) ratio is usually greater than 16:1, indicating that phosphorus is the limiting nutrient to phytoplankton growth (Turner *et al.*, 2003 and Kocum *et al.*, 2002). In marine and estuarine systems such as sea water in the Gulf of Mexico or the Lake Pontchartrain Estuary; the TIN:TIP ratio is usually less than 16:1, indicating that nitrogen is the limiting nutrient (Turner *et al.*, 2003 and Kocum *et al.*, 2002). Optimal phytoplankton growth will occur when the ratio of TIN:TIP is exactly 16:1 (Turner *et al.*, 2003).

The objective of this study was to monitor nutrient concentrations in two rivers and four bayous on the Northshore of Lake Pontchartrain to assess the limiting nutrient to phytoplankton growth in these water bodies that drain directly into Lake Pontchartrain.

#### **Methodology**

##### Sample Collection in the Field

Surface water samples from two rivers and four bayous on the north shore of Lake Pontchartrain (Figure 1) were sampled a total of nine times during a one year period from March 2007 to February 2008. Each waterway was sampled at three locations along its course; at the head waters, mid point, and discharge point into Lake Pontchartrain for a total of 18 samples per sampling date. Surface water samples were collected using a fishing rod and reel attached to a sampling device engineered especially for this project (Figure 2).



Figure 1: The location of two rivers and four bayous on the north shore of Lake Pontchartrain included in this monitoring project.



Figure 2: (A) Surface water sampling device and (B) transferring the sample into bottles to take back to the Geochemistry Laboratory at the University of New Orleans.

### Laboratory Analysis

Samples were kept cool until they arrived at the University of New Orleans (UNO) Geochemistry Laboratory for analysis. Samples were filtered and alkalinity measured immediately using standard titration procedures with Hydrochloric acid (HCl). The filtered samples were split into three for measurement of total carbon and nitrogen using a Flash Elemental Analyzer, anions and cations using a Liquid ion Chromatograph (LC). Cation samples were preserved with one drop of concentrated HCl to prevent precipitation prior to analysis using the LC.

### Precipitation Data

Daily precipitation data from five locations in St. Tammany parish, Louisiana were downloaded from the website, <http://waterdata.usgs.gov/la/nwis/rt>, which is maintained by the U.S. Geological Survey (USGS). These data were then averaged to determine the amount of precipitation received in the area for the six week time interval between sampling dates and for six weeks prior to the first sampling date. The total average precipitation for each sampling date

was then determined using data from all five recording stations in St. Tammany parish and these data were plotted with the nutrient results to investigate the effect of precipitation on nutrient concentrations in the waterways.

## **Principal Findings and Significance**

### Correlation with Precipitation

The nutrient concentrations at all of the sites monitored are highly influenced by precipitation and other anthropogenic activities occurring nearby. Concentrations of ammonium ( $\text{NH}_4^+$ ) and nitrate ( $\text{NO}_3^-$ ) were highly correlated with precipitation (Figures 3 and 4). Concentrations of nitrite and phosphorus were very low at all sites monitored and therefore exhibited little variation to correlate with precipitation.

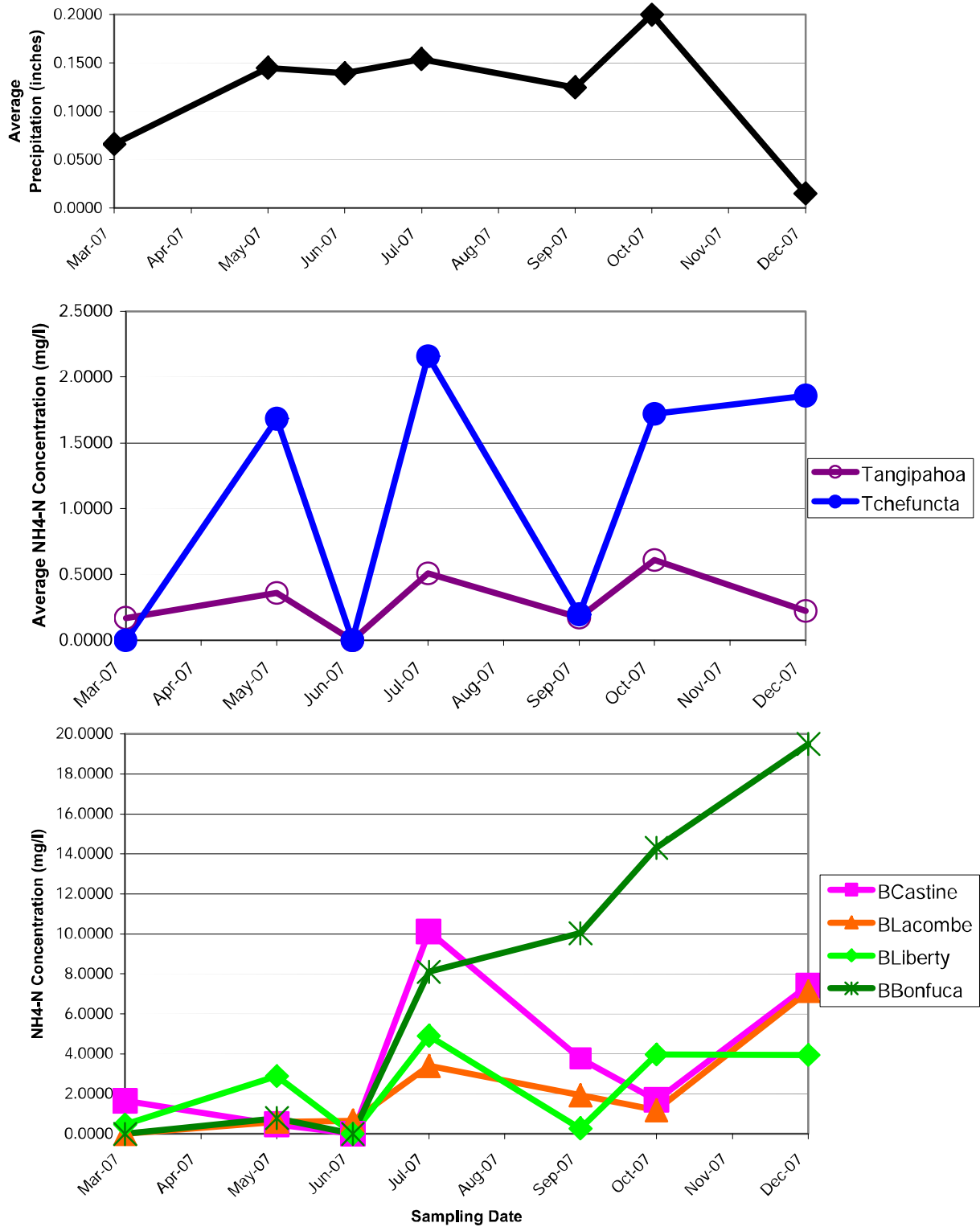


Figure 3: Variations in the average concentrations of ammonium in surface waters, which correlates with variation in precipitation amounts

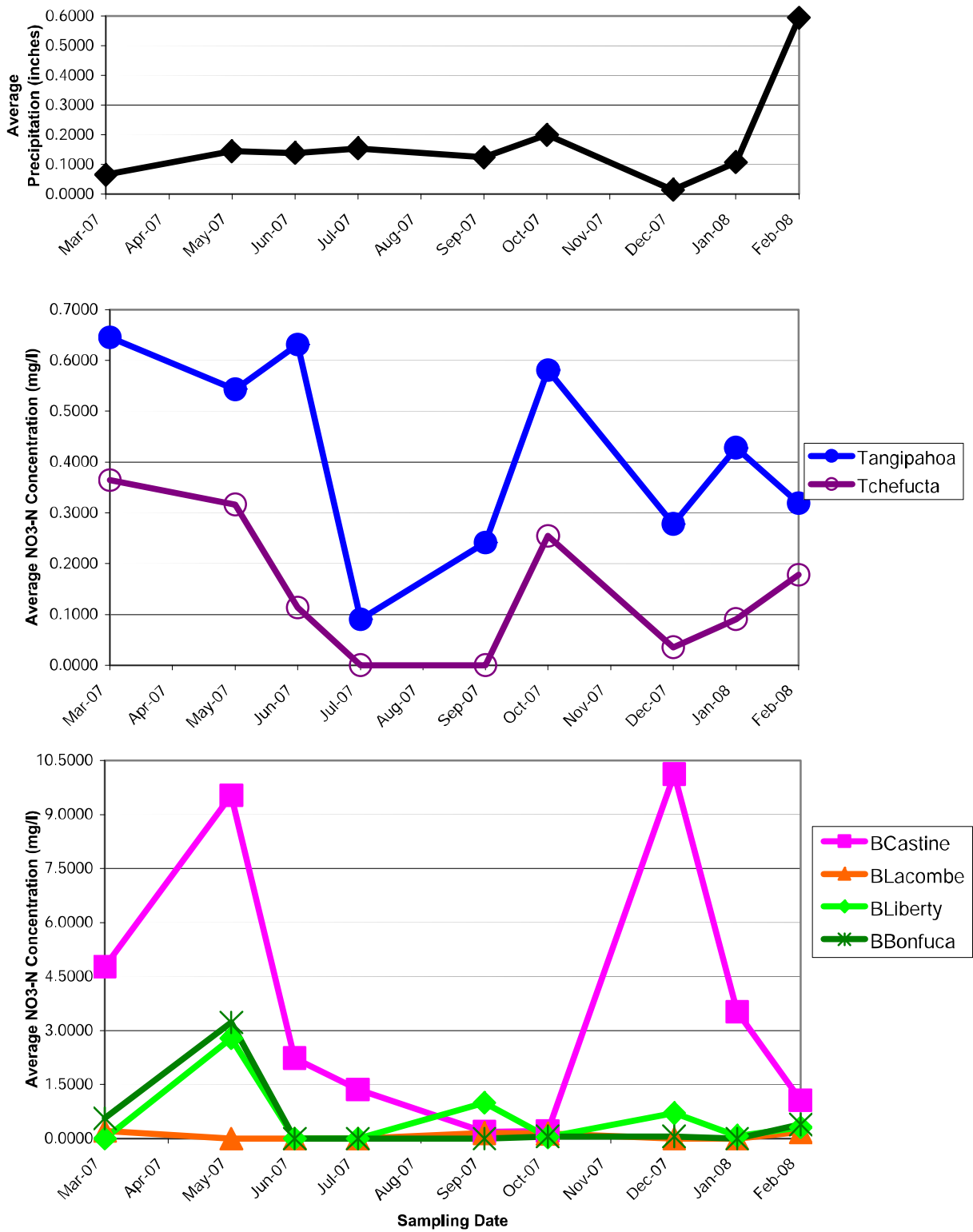


Figure 4: Variations in the average concentrations of nitrate in surface waters, which correlates with variation in precipitation amounts

The correlation of high concentrations of inorganic nitrogen with heavy precipitation indicates that the source of the nitrogen is likely outside of the waterbody's normal, daily drainage area and is being swept in during high rainfall events. In St. Tammany parish, roadside drainage ditches collect runoff from urban areas, as well as septic effluent in neighborhoods that employ individual residential septic systems, and drain into larger waterways, such as those monitored during this project, that eventually drain into Lake Pontchartrain. During high rainfall events two sources of nitrogen are evident. Nitrogen from urban non point sources is transferred with runoff into the roadside drainage ditches and then into the waterways. Nitrogen collecting in the ditches during low flow conditions is also transferred into the waterways during high flow events. Fearnley *et al.* (2006) established extremely high concentrations of nitrogen in roadside drainage ditches in St. Tammany parish, especially in neighborhoods employing individual residential septic systems.

Concentrations of phosphorus further substantiate that nutrient concentrations in the waterways are correlated with precipitation and thus urban sources from which nutrients are transferred to the waterway during high rainfall events. Phosphorus was detected in October at the northern Tangipahoa and Tchefuncta sites during a period of high precipitation. This was the only time phosphorus was detected in these waterways.

#### Limiting Nutrient to Phytoplankton Growth

All six of the waterways monitored are phosphorus limited at all times of the year. The Tangipahoa and Tchefuncta Rivers are large freshwater bodies and are expectedly low in phosphorus. The four bayous however, are tidally influenced and much more brackish especially at their southern sites near Lake Pontchartrain. Nitrogen is typically the limiting nutrient to growth in brackish and salt water environments such as Lake Pontchartrain (Turner *et al.*, 2003 and Kocum *et al.*, 2002). In the four bayous monitored, nitrogen has become so plentiful despite the brackish environment that growth has flourished until very little phosphorus remains in the environment. Nitrogen is still available and phosphorus has become the limiting nutrient to growth.



### Influence of nearby Urban Activities-Bayou Castine Example

Bayou Castine is a small bayou that runs through highly urbanized residential neighborhoods near the city of Mandeville in St. Tammany parish, Louisiana. The neighborhood surrounding the northern most sampling site is completely dependant on individual residential septic systems for sewage treatment. Effluent from the septic systems drains into the roadside ditches (Figure 5A), which empty into Bayou Castine via a long ditch beside a dirt trail and semi-wooded area (Figure 5B).

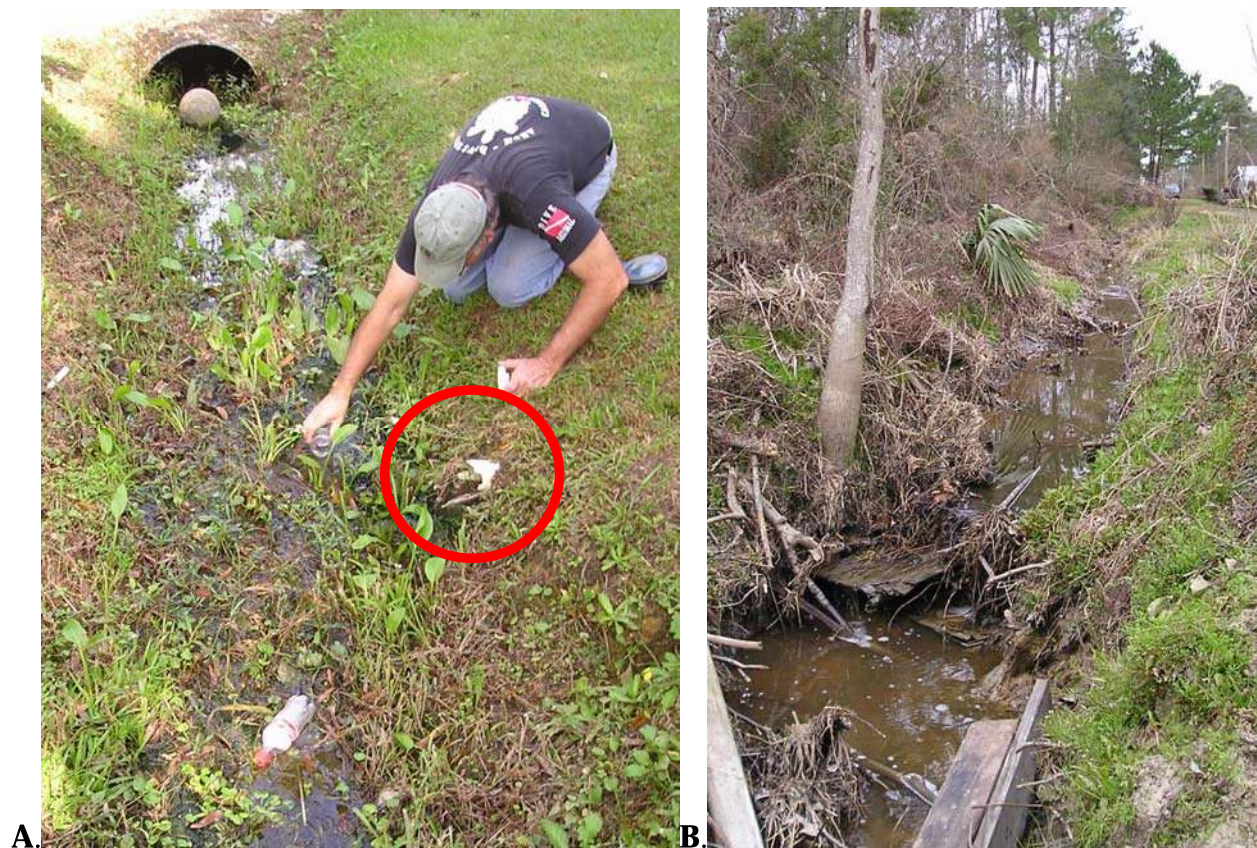


Figure 5: (A) A roadside drainage ditch in the nearby neighborhood depicting a pipe that transfers sewage effluent from the individual residential septic system on private property to the ditch and (B) the drainage ditch that transfers runoff from neighborhood roadside drainage ditches directly into Bayou Castine.

The St. Tammany parish government is responsible for maintaining the functionality of the ditch that drains runoff into Bayou Castine and had recently dredged the area to restore flow prior to the December sampling date. The concentrations of phosphorus,  $\text{NO}_3^-$ , and  $\text{NH}_4^+$  are elevated at

both the north and mid Bayou Castine sites during December and January and begin to return to previous concentrations by February. It is likely the high concentrations are the result of the dredging activity and subsequent increase in runoff received from the neighborhood. These results indicate that the recovery period for nutrient loading into Bayou Castine is approximately twelve weeks.

## References

- Fearnley, S., J. Willis, and M. Hester. 2006. Establishing best management practices for stormwater ditches in St. Tammany Parish to reduce nutrient and bacterial loads to Lake Pontchartrain. *Basics of the Basin 8<sup>th</sup> Biannual Research Symposium-Abstracts and Programs* **8**: 24-25.
- Kocum, E., D.B. Nedwell, and G.J. Underwood, 2002. Regulation of phytoplankton primary production along a hypereutrophic estuary. *Marine Ecology Progress Series* **231**: 13-22.
- Lake Pontchartrain Basin Foundation. 2006. Comprehensive Management Plan. [www.saveourlake.org], November 1, 2006.
- Turner, R.E., N.N. Rabalais, D. Justic, and Q. Dortch., 2003. Global patterns of dissolved N, P, and Si in large rivers. *Biogeochemistry* **64**: 297-317.
- Xu, Y.J. and A. Viosca, 2005. Surface Water Assessment of Three Louisiana Watersheds. *Watershed Update* **3 (2)**: 1-8.

# Information Transfer Program Introduction

One of the Institute's objectives is to make research results available to the general public and to interested researchers and institutions through publications and other information transfer activities. Although the information transfer component of the program budget of Section 104 funds is relatively small (10%), LWRI attempts to meet this goal in many ways which include actively participating in conferences and workshops, distributing summaries and other Institute information to the public and governmental agencies, maintaining internet access and web sites, and maintaining a library of water research materials. In addition to the program budget, LWRI was funded for project 2007LA52B – Information Transfer Symposium: Mitigation of Storm Surge Using Vegetation (Spring 2007) and Resilient Environmental Infrastructure for Coastal Communities (Fall 2007). The Institute requests that its investigators participate in reporting and information transfer activities such as publications in professional journals, workshops, and seminars.

The Institute's information transfer program is a subset of its administration program. Assisting with LWRI's information transfer activities is one undergraduate student worker, and two program coordinators (part-time LWRI support), and one research associate (half-time LWRI support). Two research associates are also available to assist in information transfer activities of the Institute. The Director, Dr. John Pardue, attends the annual National Institutes of Water Resources meetings in Washington, D.C., to discuss Institute and Program activities.

Further assisting in information transfer, the Engineering Incubation Research Center (EIRC) has given LWRI access to image processing, GIS, and computing systems. This access provides the Institute with the necessary tools to transfer information in visual graphic format, utilize Internet resources, and develop state-of-the-art presentations. Because of the Institute's expanding development, more emphasis is being placed on updating the public and other organizations about activities and objectives using electronic media and presentation tools.

The Institute's staff continues to maintain emphasis on acquainting Louisiana's research community with the research-funding opportunities through the U.S. Geological Survey Section 104 research program. 104 G program announcements, Mississippi SE-TAC RFPs, and Section 104 RFPs were widely distributed: 250 email addresses, 250 regular mail addresses, and 150 email addresses on the user-subscribed list, totaling 650. We also distributed the RFP through the USGS newsletter and to Louisiana colleges and universities and to research organizations throughout the state. In addition, public announcements were made at professional and faculty meetings to encourage wide participation in the program. We send out notifications of meeting and events for the American Water Resources Association, The Capital Area Ground Water Conservation Committee, and the Louisiana Rural Water Association.

**Research grants FY 2007–08 technical transfer.** *Project 2007LA51B*, Fearnley – Results from this project will be incorporated with other St. Tammany parish water quality data, unpublished and collected by the primary investigator and transferred to both the St. Tammany Parish Government and the greater scientific community. The Parish will receive an easy to understand brochure that can be used to inform the public of pressing water quality issues in their area. The scientific community will be informed through publication of these data in a scientific journal, such as *Water, Air, and Soil Pollution*. A manuscript for submission is currently being prepared by the primary investigator. The local scientific community will be further informed through the completion of Mr. Bohling's MS thesis and defense. *Project 200750B*, Deng – The VART model along with the findings and methods for estimation of nitrogen removal rate and other parameters will be transferred to the Louisiana Department of Environmental Quality for applications in TMDL developments and stream restoration.

## Other Information Dissemination Activities

1. Dissemination of Requests for Proposals for the following Programs:

- ◆ CREST Request for Proposal
- ◆ Request for Proposal for the Southeastern
- ◆ Regional Small Public Water Systems

2. Technical Assistance Center (SE TAC)

- ◆ BTNEP Mini Grants Program Request for Proposal

3. Dissemination of Information:

- ◆ Breaux Act Newsflash
- ◆ LWRRI PEER REVIEWED PUBLICATIONS

• LWRRI Digital Water Resources Archive • LSU Hurricane Center Seminars • Wiki for research collaboration

**Collaboration with major university research initiatives.** LWRRI have collaborated extensively with other campus research centers during this cycle. These have led to other funded centers and center proposals. Through these activities we have continued to leverage our resources by collaborating with other faculty. These collaborations include a Biotechnology Center (funding from Governor's Biotechnology initiative) within HSRC (use of molecular techniques for microbial community structure analysis), the Heath Excellence Fund Public Health Effects of Hurricanes center (chemical transport following a major hurricane), LSU School of the Coast and the LSU Department of Geography & Anthropology with ConRuhr (Transatlantic Water Symposium), and the LSU Hurricane Center (Louisiana Levee School initiative with LA DNR & LA DOTD).

In addition, our organization is contacted regularly with various questions for the public and/or private sector concerning water issues; we try to connect these people with the proper experts within our organization and the broader academic community. We have built a comprehensive web portal LAWATER.com in conjunction with the LWRRI web site to help facilitate this effort.

**LAWATER and electronic publication project.** Two outreach projects that we would particularly like to highlight is the development of the LAWATER web portal for Louisiana water issues ([www.lawater.lsu.edu](http://www.lawater.lsu.edu)) and the digital document library within LWRRI. The web portal LAWATER was designed as a comprehensive collection of web-based information on water issues within Louisiana. It captures information not only from the Institute but collects the rich content developed by USGS, EPA, DEQ, FEMA and others into one location. The portal is divided into several sections emphasizing 4 major issues: water quality, water supply, hazards and flooding and coastal restoration. While only in existence a little over two years, the web portal is being utilized in Louisiana's water community. In addition to LAWATER, we have been active archiving our past research products. LWRRI is one of the oldest research institutes on campus (founded in 1964). The collection of research products funded by the Institute date is in paper versions that are vulnerable to age and not accessible to the public. We have been scanning all of the documents produced by the institute into electronic archived versions for preservation and for any interested researchers to access (<http://www.lwrri.lsu.edu/dwaterlibrary.htm>).

Under the direction of our director, the Institute has developed a branding symbol for all of the information transfer activities and publications and is reconstituting the newsletter. Our annual report is housed at the Louisiana State Archives, Hill Memorial Library at LSU, and is available online at the Institute's web site.

In response to the focused RFP for the 2007–2008 solicitations, we received 7 new proposals and funded 3 of those after advisory board review. The theme, selected in consultation with faculty and advisory board members, is focused on resiliency of community water supplies in Louisiana's coastal zone, storm surge in the Louisiana coastal zone, adaptive management of Louisiana's water resources, total maximum daily load (TMDL) calculations in Louisiana water bodies, and scale-dependent behavior of hydrologic and water quality parameters. Also one has been continued until 2009 for the 104G program; which focuses on

groundwater flow and transport.

**NIWR–USGS Student Internship Program**

The Louisiana Water Resources Research Institute did not have any students in the formal NIWR–USGS Intern Program during this reporting period. The Institute maintains both formal and informal relationships with the Baton Rouge office through part time employment of students not in the intern program, and the USGS District Chief serves on the Institute Advisory Board.