Research Results – Ground water Baton Rouge, LA

Search Strategy

Scopus.com, OhioLink, Agricola, and Worldcat were searched for publications on the topic of ground water in Baton Rouge and surrounding area. Some ground water usage studies were included. Results are listed below in date order with the newest citations listed first.

("Baton Rouge" OR "West Feliciana" OR "East Feliciana" OR Helena OR Tangiphahoa OR Washington OR "Pointe Coupee" OR Livingston OR Tammany OR Baptist OR Orleans OR "New Orleans" OR Bernard OR Jefferson OR Plaquemines OR Lafourche OR terrebonne OR Ascension OR assumption OR iberville OR iberia OR Louisiana) AND (groundwater OR "ground water" OR “ground-water”)

Search Results

McCoy CA, Corbett DR. Review of submarine groundwater discharge (SGD) in coastal zones of the Southeast and Gulf Coast regions of the United States with management implications. Journal of Environmental Management 2009;90(1):644-51.

Groundwater serves as the primary drinking water source for over half of the coastal populations of the Southeast and Gulf Coast regions, two of the fastest growing regions in the United States. Increased demand for this resource has exceeded sustainable yields in many areas and induced saltwater intrusion of coastal aquifers. A process associated with coastal groundwater, submarine groundwater discharge (SGD), has been documented as a source of subsurface fluids to coastal ocean environments throughout the Southeast and Gulf Coast regions and is potentially a significant contributor to nearshore water and geochemical budgets (i.e., nutrients, carbon, trace metals) in many coastal regions. The importance of groundwater as a drinking water source for coastal populations and the influences of submarine groundwater discharge to the coastal ocean warrant increased research and management of this resource. This paper highlights findings from recent SGD studies on three hydrogeologically different continental margins (Onslow Bay, NC, southern Florida, and the Louisiana margin), provides background on the common methods of assessing SGD, and suggests a regional management plan for coastal groundwater resources. Suggested strategies call for assessments of SGD in areas of potentially significant discharge, development of new monitoring networks, and the incorporation of a regional coastal groundwater resources council.

Tsai FTC, Li X. Inverse groundwater modeling for hydraulic conductivity estimation using Bayesian model averaging and variance window. Water Resources Research 2008;44(9).

This study proposes a Bayesian model averaging (BMA) method to address parameter estimation uncertainty arising from nonuniqueness in parameterization methods. BMA is able to incorporate multiple parameterization methods for prediction through the law of total probability and to obtain an ensemble average of hydraulic conductivity estimates. Two major issues in applying BMA to hydraulic conductivity estimation are discussed. The first problem is using Occam's window in usual BMA applications to measure approximated posterior model probabilities. Occam's window only accepts models in a very narrow range, tending to single out the best method and discard other good methods. We propose a variance window to replace Occam's window to cope with this problem. The second problem is the Kashyap information criterion (KIC) in the approximated posterior model probabilities, which tends to prefer highly uncertain parameterization methods by considering the Fisher information matrix. With

sufficient amounts of observation data, the Bayesian information criterion (BIC) is a good approximation and is able to avoid controversial results from using KIC. This study adopts multiple generalized parameterization (GP) methods such as the BMA models to estimate spatially correlated hydraulic conductivity. Numerical examples illustrate the issues of using KIC and Occam's window and show the advantages of using BIC and the variance window in BMA application. Finally, we apply BMA to the hydraulic conductivity estimation of the "1500-foot" sand in East Baton Rouge Parish, Louisiana. Copyright 2008 by the American Geophysical Union.

Elucidating marine pore water exchange and fresh aquifer sources in estimates of submarine groundwater discharge to a coastal lagoon. Louisiana State University, 2008. (Accessed at http://etd.lsu.edu/docs/available/etd-07022008-050958/)

Rahman A, Tsai FTC, White CD, Willson CS. Coupled semivariogram uncertainty of hydrogeological and geophysical data on capture zone uncertainty analysis. Journal of Hydrologic Engineering 2008;13(10):915-25.

This study investigates capture zone uncertainty that relates to the coupled semivariogram uncertainty of hydrogeological and geophysical data. Semivariogram uncertainty is represented by the uncertainty in structural parameters (range, sill, and nugget). We used the beta distribution function to derive the prior distributions of structural parameters. The probability distributions of structural parameters were further updated through the Bayesian approach with the Gaussian likelihood functions. Cokriging of noncollocated pumping test data and electrical resistivity data was conducted to better estimate hydraulic conductivity through autosemivariograms and pseudo-cross-semivariogram. Sensitivities of capture zone variability with respect to the spatial variability of hydraulic conductivity, porosity and aquifer thickness were analyzed using ANOVA. The proposed methodology was applied to the analysis of capture zone uncertainty at the Chicot aquifer in Southwestern Louisiana, where a regional groundwater flow model was developed. MODFLOW-MODPATH was adopted to delineate the capture zone. The ANOVA results showed that both capture zone area and compactness were sensitive to hydraulic conductivity variation. We concluded that the capture zone uncertainty due to the semivariogram uncertainty is much higher than that due to the kriging uncertainty for given semivariograms. In other words, the sole use of conditional variances of kriging may greatly underestimate the flow response uncertainty. Semivariogram uncertainty should also be taken into account in the uncertainty analysis. © 2008 ASCE.

Rahman A, Tsai FTC, White CD, Carlson DA, Willson CS. Geophysical data integration, stochastic simulation and significance analysis of groundwater responses using ANOVA in the Chicot Aquifer system, Louisiana, USA. Hydrogeology Journal 2008;16(4):749-64.

Data integration is challenging where there are different levels of support between primary and secondary data that need to be correlated in various ways. A geostatistical method is described, which integrates the hydraulic conductivity (K) measurements and electrical resistivity data to better estimate the K distribution in the Upper Chicot Aquifer of southwestern Louisiana, USA. The K measurements were obtained from pumping tests and represent the primary (hard) data. Borehole electrical resistivity data from electrical logs were regarded as the secondary (soft) data, and were used to infer K values through Archie's law and the Kozeny-Carman equation. A pseudo cross-semivariogram was developed to cope with the resistivity data non-collocation. Uncertainties in the auto-semivariograms and pseudo cross-semivariogram were quantified. The groundwater flow model responses by the regionalized and coregionalized models of K were compared using analysis of variance (ANOVA). The results indicate that non-collocated secondary data may improve estimates of K and affect groundwater flow responses of practical interest, including specific capacity and drawdown. © Springer-Verlag 2007.

Meckel TA. An attempt to reconcile subsidence rates determined from various techniques in southern Louisiana. Quaternary Science Reviews 2008;27(15-16):1517-22.

Subsidence rates determined from geodetic releveling observations since 1920 in southern Louisiana are consistently higher than subsidence rates determined from radiocarbon data in the same region over Holocene timescales. Radiocarbon-based subsidence rates are similar to numerically modeled shallow sedimentary compaction rates at similar timescales, while recent geodetic observations are an order of magnitude higher. Possible explanations for the dramatic recent increase in regional subsidence rates suggested by the geodetic data that are considered here include: (1) a recent increase in regional contributions from faulting; (2) the recent contribution of a regional, high-impact process such as fluid withdrawal; (3) accuracy in one or more of the datasets; and (4) a strong dependence of subsidence rates upon the time frame over which different techniques are used. Faulting and regional groundwater withdrawals appear insufficient to explain the high regional geodetic rates. The contribution of regional depressurization from deep fluid withdrawals remains unknown. Estimate errors are likely smaller than the magnitude of the discrepancies between rates from different datasets. Observations of subsidence rates may be biased by measurement duration.

McClain WR, Romaire RP. Water budgets for a rice-crawfish aquaculture system. North American Journal of Aquaculture 2008;70(3):296-304.

Red swamp crawfish Procambarus clarkii and white river crawfish P. zonangulus are raised mostly in southern Louisiana, usually in association with commercial rice cultivation. Shallow ponds (fields) are flooded in the fall after the rice harvest (usually in October) and drained at the end of the crawfish production cycle the following spring-summer (usually in May-July). The water use and effluent volume associated with crawfish aquaculture have not been quantified. This study was conducted to determine water use and effluent release in crawfish aquaculture under simulated commercial conditions. Water inflow and outflow were measured in experimental crawfish ponds from 1999 to 2002 (three consecutive crawfish production seasons) that simulated rice-crawfish rotational production practices. The mean water inflow from groundwater pumping and precipitation was 228 cm per production season (range, 223-233 cm). Total water use (groundwater plus precipitation) and groundwater consumption averaged 21.5 and 15.2 m3 per kilogram of crawfish harvested, respectively. The amount of groundwater used for filling ponds, replacing losses from evaporation-evapotranspiration and seepage, and flushing ponds to maintain satisfactory dissolved oxygen levels averaged 139 cm (range, 97-165 cm). The contribution from precipitation averaged 90 cm. Effluent discharge averaged 59.5 cm. Of this, 36.9% was accounted for by pond drainage at the end of the production season, 29.4% by precipitation overflow and temporary levee failures, 22.1% by lateral seepage and minor leaks of the perimeter levees, and 11.6% by intentional flushing to maintain an acceptable concentration of dissolved oxygen. On average, 74% (172.5 cm) of the water input was lost as a result of evaporation, evapotranspiration, and percolation through the pond-bottom sediments.

Hyfield ECG, Day JW, Cable JE, Justic D. The impacts of re-introducing Mississippi River water on the hydrologic budget and nutrient inputs of a deltaic estuary. Ecological Engineering 2008;32(4):347-59.

Most wetlands of the Mississippi deltaic plain are isolated from riverine input due to flood control levees along the Mississippi River. These levees have altered hydrology and ecology and are a primary cause of massive wetland loss in the delta. River water is being re-introduced into coastal basins as part of a large-scale ecological engineering effort to restore the delta. We quantified freshwater, nitrogen, and phosphorus inputs to the Breton Sound Estuary for three climatically different years (2000, 2001, and 2002). Water budgets included precipitation, potential evapotranspiration, the diversion, stormwater pumps, and groundwater. Precipitation contributed 48-57% of freshwater input, while the diversion accounted for 33-48%. Net groundwater input accounted for less than 0.05% of freshwater inputs. Inputs of ammonium (NH4-N), nitrate (NO3-N), total nitrogen (TN), and total phosphorus (TP) were determined for each of the water sources. Atmospheric deposition was the most important input of NH4-N (57-62% or 1.44 Ã— 105-2.32 Ã— 105 kg yr-1) followed by the diversion. The diversion was the greatest source of NO3-N (67-83%, 7.78 Ã— 105-1.64 Ã— 106 kg yr-1) and TN (60-71%). The diversion contributed 41-60% of TP input (1.17 Ã— 105-2.32 Ã— 105 kg yr-1). Annual loading rates of NH4-N and NO3-N were

0.17-0.27 and 1.2-2.3 g N m-2 yr-1, respectively, for the total basin indicating strong retention of nitrogen in the basin. Nitrogen retention through denitrification and burial was estimated for the upper basin. © 2008 Elsevier B.V. All rights reserved.

Dunbar JB, Britsch Iii LD. Geology of the New Orleans area and the canal levee failures. Journal of Geotechnical and Geoenvironmental Engineering 2008;134(5):566-82.

The geologic history of the New Orleans area significantly influences the engineering properties of the foundation soils beneath the levees. Geologic and engineering data gathered from the levee breaches identify a spatially complex geomorphic landscape, caused by Holocene sea level rise, lateral changes in depositional environments, development of Mississippi River delta lobes, and the distributary channels associated with delta development. Overlying the Pleistocene surface beneath New Orleans are predominantly fine-grained, shallow water sediments associated with bay sound (or estuarine), nearshore-gulf, sandy beach, lacustrine, interdistributary, and paludal (marsh and swamp) environments. These environments define the New Orleans area history during the Holocene and comprise the levee foundation beneath the failure areas. A barrier beach ridge is present in the subsurface along the southern shore of Lake Ponchartrain, which blocked the filling of the lake with fluvial-deltaic sediments. This buried beach impacted the supply and texture of sediment being deposited by advancing distributary channels and influenced the engineering properties of these soils. Marsh and swamp soils beneath the failure area at the 17th Street Canal are much thicker in comparison to those beneath the London Avenue Canal failures because of the influence of the beach complex, and are thickest in the Industrial Canal area. Additionally, human activities in the New Orleans area during historic time contributed to the spatial complexity and affected the engineering properties of the foundation soils. These activities include construction of drainage and navigation canals, groundwater pumping, hydraulic filling of the Lake Ponchartrain lake front, and construction of levees to prevent river flooding. Human activities, combined with the geologic setting and subsidence in this region, are responsible for the unique landscape that was impacted by Hurricane Katrina. © 2008 ASCE.

Carlson DA, Van Biersel TP, Milner LR. Storm-damaged saline-contaminated boreholes as a means of aquifer contamination. Ground Water 2008;46(1):69-79.

Saline water from a storm surge can flow down storm-damaged submerged water supply wells and contaminate boreholes and surrounding aquifers. Using data from conventional purging techniques, aquifer test response analysis, chemical analysis, and regression analysis of chloride/silica (Cl/Si) ratio, equations were derived to estimate the volume of saline water intrusion into a well and a porous media aquifer, the volume of water needed to purge a well shortly following an intrusion event, and the volume of water needed after delay of several or more months, when the saline plume has expanded. Purging time required is a function of volume of water and pumping rate. The study site well is located within a shoreline community of Lake Pontchartrain, St. Tammany Parish, in southeastern Louisiana, United States, which was impacted by two hurricane storm surges and had neither been rehabilitated nor chlorinated prior to our study. Chemical analysis of water samples in fall 2005 and purging of well and aquifer in June 6, 2006, indicated saline water had intruded the well in 2005 and the well and aquifer in 2006. The volume of water needed to purge the study well was approximately 200 casing volumes, which is significantly greater than conventionally used during collection of water samples for water quality analyses. © 2007 National Ground Water Association.

Van Biersel TP, Carlson DA, Milner LR. Impact of hurricanes storm surges on the groundwater resources. Environmental Geology 2007;53(4):813-26.

Ocean surges onto coastal lowlands caused by tropical and extra tropical storms, tsunamis, and sea level rise affect all coastal lowlands and present a threat to drinking water resources of many coastal residents. In 2005, two such storms, Hurricanes Katrina and Rita struck the Gulf Coast of the US. Since September 2005, water samples have been collected from water wells impacted by the hurricanes' storm surges

along the north shore of Lake Pontchartrain in southeastern Louisiana. The private and public water wells tested were submerged by 0.6-4.5 m of surging saltwater for several hours. The wells' casing and/or the associated plumbing were severely damaged. Water samples were collected to determine if storm surge water inundated the well casing and, if so, its effect on water quality within the shallow aquifers of the Southern Hills Aquifer System. In addition, the samples were used to determine if the impact on water quality may have long-term implication for public health. Laboratory testing for several indicator parameters (Ca/Mg, Cl/Si, chloride, boron, specific conductance and bacteria) indicates that surge water entered water wells' casing and the screened aquifer. Analysis of the groundwater shows a decrease in the Ca/Mg ratio right after the storm and then a return toward pre-Katrina values. Chloride concentrations were elevated right after Katrina and Rita, and then decreased downward toward pre-Katrina values. From September 2005 to June 2006, the wells showed improvement in all the saltwater intrusion indicators. © 2007 Springer-Verlag.

Thompson C, Smith L, Maji R. Hydrogeological modeling of submarine groundwater discharge on the continental shelf of Louisiana. Journal of Geophysical Research C: Oceans 2007;112(3).

A regional scale hydrogeologic model has been developed to estimate the magnitude of submarine groundwater discharge to the coastal waters of southeastern Louisiana. The model domain incorporates both the onshore recharge area of terrestrially derived freshwater, and fluid circulation within the sediments on the continental shelf. The hydrogeologic properties of these sediments, which form part of the Coastal Lowlands Aquifer System, have been well-characterized in earlier studies. The low topographic relief of the coastal plain and an extensive zone of seawater intrusion are key features of the groundwater flow system. Model calculations suggest that no water containing a substantial component of terrestrial origin discharges on the continental shelf. Rather the near-shore coastal zone serves as a groundwater recharge area of saline water that then forms the seawater recirculation system beneath the coastal plain. The modeling results are consistent with interpretations of the rates of submarine groundwater discharge derived from geochemical tracers, presented in a companion paper by McCoy et al. (2007). Copyright 2007 by the American Geophysical Union.

Prakken LB, Louisiana. Office of Public Works and Intermodal T, Geological S. Chloride concentrations in the Southern Hills regional aquifer system in Livingston, southern Tangipahoa and St. Tammany Parishes, Louisiana, 2005. Baton Rouge, La.: Louisiana Dept. of Transportation and Development; 2007.

Polomski RF, Bielenberg DG, Whitwell T, Taylor MD, Bridges WC, Klaine SJ. Nutrient recovery by seven aquatic garden plants in a laboratory-scale subsurface-constructed wetland. HortScience 2007;42(7):1674-80.

Commercial nurseries use large amounts of water and nutrients to produce container-grown plants. The large volume of runoff containing nitrogen (N) and phosphorus (P) that leaves nurseries can contaminate surface and groundwater. Subsurface flow-constructed wetlands have been shown to effectively treat agricultural, industrial, and residential wastewater and to be well-suited for growers with limited production space. We investigated the possibility of using commercially available aquatic garden plants in subsurface-constructed wetlands to remove nutrients in a laboratory scale, gravel-based system. Seven popular aquatic garden plants received N and P from Hoagland's nutrient solution every 2 days for 8 weeks. These rates (0.39 to 36.81 mg·L-1 of N and 0.07 to 6.77 mg·L-1 P, respectively) encompassed low to high rates of nutrients found at various points between the discharge and inflow points of other constructed wetland systems currently in use at commercial nurseries. Plant biomass, nutrient recovery, and tissue nutrient concentration and content were measured. Whole plant dry weight positively correlated with total N and P supplied. Louisiana Iris hybrid 'Full Eclipse', Canna X generalis Bailey (pro sp.) 'Bengal Tiger', Canna X generalis Bailey (pro sp.) 'Yellow King Humbert', Colocasia esculenta (L.) Schott 'Illustris', Peltandra virginica (L.) Schott, and Pontederia cordata L. 'Singapore Pink' had the greatest N recovery rates. The P recovery rates were similar for the cannas, Colocasia esculenta 'Illustris', Louisiana Iris 'Full Eclipse', Pe. virginica, and Po. cordata 'Singapore Pink'. The potential exists

for creating a sustainable nursery and greenhouse production system that incorporates a subsurface-constructed wetland planted with marketable horticultural crops that provide remediation and revenue.

Oostrom M, Truex MJ, Thorne PD, Wietsma TW. Three-dimensional multifluid flow and transport at the Brooklawn Site near Baton Rouge, LA: A case study. Soil and Sediment Contamination 2007;16(2):109-41.

Disposal quantities of organic wastes at the Brooklawn Site in Louisiana are suspected to equal nearly 1.45 Ã— 108Kg, making this site one of the most contaminated dense nonaqueous phase liquid (DNAPL) sites in the world. Remedial activities at the site include groundwater and DNAPL extraction from recovery wells. DNAPL recovery has markedly declined in recent years, with many of the peripheral wells showing negligible recovery of organic liquids. Three-dimensional simulations of DNAPL movement in the subsurface were conducted using the STOMP simulator, including a new coupled-well model. The objectives of this modeling effort were to (1) determine the fate and transport of infiltrated DNAPL, and (2) measure the effects of active recovery through DNAPL pumping. A detailed three-dimensional geologic model of the Brooklawn primary DNAPL disposal area was developed and used as the framework for DNAPL simulations. Additionally, site-specific data were obtained to determine the most important hydraulic properties of the subsurface related to DNAPL movement and formation of entrapped DNAPL in the laboratory. In addition to a simulation using the best available subsurface information, several sensitivity simulations were conducted to assess the effects on DNAPL migration. These simulations include DNAPL pumping, well screen extension, an alternative geology, increased DNAPL density, lower DNAPL viscosity, and more-permeable sand and silt deposits. Results of the simulations were compared to field data that define the extent of DNAPL movement based on where DNAPL has been extracted in the site recovery wells. The model simulations show that pumping has a negligible effect on subsurface DNAPL saturations and movement. Pumped DNAPL volumes diminish rapidly due to the limited radius of influence of the wells and movement of the DNAPL out of the zone of influence of the wells with a maximum radius of influence of about 6 m. The numerical analysis also demonstrates that it is impractical to extend existing wells or install new wells to retrieve enough DNAPL to affect the overall extent of DNAPL movement.

McCoy CA, Corbett DR, McKee BA, Top Z. An evaluation of submarine groundwater discharge along the continental shelf of Louisiana using a multiple tracer approach. Journal of Geophysical Research C: Oceans 2007;112(3).

Natural geochemical tracers (222Rn, 3H, 3He, and 4He) were used to assess submarine groundwater discharge (SGD) along the continental shelf west of the Mississippi River. In order to assess SGD, groundwater, surface water, and sediment samples were collected on land and during six 4-day cruises aboard the R/V Pelican between Match 2003 and May 2004. A box model approach was used to quantify sources and sinks of 222Rn in the study area and to calculate SGD rates. SGD estimates were we based on two end member values for the potential advecting fluids: (1) that supported by 226Ra in the sediments; and (2) groundwater activities measured in monitoring wells. Calculated 222Rn SGD rates based on sediment supported activities ranged from 0.04 to 0.14 cm d-1, and estimates based on monitoring well activities ranged from 0.01 to 0.07 cm d-1 and corresponds to 1.41 km3 yr-1 of discharged water over our study area, equivalent to <1% of the Mississippi River during the same time frame. 3He and 4He, longer-lived tracers, exhibited significantly greater anomalies in the eastern portion of the study area which corresponds with greater oil and gas extraction and the release of formation water into the water column in this region. While the total SGD was relatively minor, potential sources of SGD are many and we suggest formation water associated with oil and gas extraction, geothermal convection, and seawater recirculation are the primary sources with a minimal contribution from terrestrially derived topography driven flow.

Chloride concentrations in ground water in East and West Baton Rouge Parishes, Louisiana, 2004-05. U.S. Dept. of the Interior, U.S. Geological Survey, 2007.(Accessed at http://pubs.usgs.gov/sir/2007/5069/)

Hanor JS. The Dunbar-Hunter expedition (1804-1805): early analyses of spring waters in the Louisiana Purchase. Ground Water 2007;45(6):803-7.

Hanor JS. Variation in the composition and partitioning of adsorbed cations at a brine-contaminated crude oil production facility in southeastern Louisiana, USA. Applied Geochemistry 2007;22(10):2115-24.

The first geological materials impacted by oil field wastes released into near-surface environments in southern Louisiana, USA, are typically clays and silts. Clay minerals within these siliciclastic sediments have the potential for altering the composition of produced water wastes through cation exchange. The general relations between the composition of adsorbed cations and interstitial water salinity in brine-contaminated samples from a site in southeastern Louisiana are consistent with previous studies of multicomponent exchange in groundwater systems of varying salinity. The divalent cations Ca and Mg dominate as adsorbed cations at low salinities (<1200 mg/L), but Na is dominant at moderate to high salinities (up to 53,000 mg/L). The change in the proportions of adsorbed cations is a non-linear function of salinity, and the transition from Ca-dominated adsorption to Na-dominated adsorption occurs over a narrow range of salinities. Calculated interstitial water compositions, assuming exchange equilibrium, are consistent with the source of contamination being produced waters having Na as the dominant dissolved cation, followed by Ca, rather than some other type of saline waste. The calculated partitioning for Ba indicates that in low to moderate salinity pore waters, Ba, and by extension Ra, are nearly quantitatively adsorbed on the clays and would be of low mobility in a physically active groundwater system. However, at the elevated salinities typical of many produced waters, Ba and Ra are not preferentially adsorbed.

Griffith JM, Louisiana. Office of Public Works and Intermodal T, Geological S. Fluoride concentrations in freshwater aquifers in Louisiana, 1931-2006. Baton Rouge: Louisiana Dept. of Transportation and Development; 2007.

Fendick RB, Louisiana. Office of Public Works and Intermodal T, Geological S. Louisiana ground-water map no. 22: generalized potentiometric surface of the Amite Aquifer and the "2,800-Foot" sand of the Baton Rouge area in southeastern Louisiana, June-August 2006. Reston, Va.: U.S. Geological Survey, 2007.

Boutwell GP. Geotechnical engineering difficulties and soil conditions in Southeast Louisiana. Geotechnical Special Publication 2007(161).

Geotechnical engineering in Southeast Louisiana is far more complex than the "let's drive piles to rock" approach common in more geologically fortunate regions. This area is the delta of the Mississippi River, where Pleistocene-age erosion up to hundreds of meters deep has been refilled with normally- or even underconsolidated deposits, predominately clays. It thus shares geotechnical difficulties with similar deltaic areas around the world. The groundwater levels are high. Away from major rivers, the normal groundwater level is essentially at the ground surface. Near rivers or flooded canals, the potentiometric level can approach river/canal level, i.e., be well above the ground surface. Geologic subsidence is a long established phenomenon throughout the region, with subsidence rates of 0.5 to 1.5m per century. A big geotechnical problem here is evaluation of shear strength; sample disturbance in soft materials or those from great depths affects laboratory test results. Therefore, common practice today is to avoid unconfined compression tests for such materials in favor of triaxial or direct simple shear tests in the laboratory. In-situ vane shear testing has been used here for decades, but the cone penetrometer is becoming the preferred field strength determination procedure. Many projects such as levees, landfills, or large storage tanks are feasible only by using strength gain with consolidation techniques. This procedure was used by the Corps of Engineers to attain the levee heights they did achieve along the MRGO, Atchafalaya River, etc. Several landfills in the New Orleans area have reached heights twice those which would have caused failure without strength gain over time. Excavating can be difficult because of the combination of soft soils and high groundwater; hydrostatic bottom heave is often a concern. For levees adjacent to hurricane- or river-impacted water bodies, hydrostatic heave at the land side is a problem.

Bae HS, Rash BA, Rainey FA, et al. Description of Azospira restricta sp. nov., a nitrogen-fixing bacterium isolated from groundwater. Int J Syst Evol Microbiol 2007;57(Pt 7):1521-6.

A novel, Gram-negative bacterial strain, SUA2(T), isolated from groundwater, was characterized using a polyphasic approach. Cells are Gram-negative, non-spore-forming, straight to curved rods with a single polar flagellum. Strain SUA2(T) is oxidase- and catalase-positive and is able to fix nitrogen. Poly-beta-hydroxybutyrate storage granules are produced. Dominant fatty acids when grown in R2A and VM ethanol media for 72 h at 37 degrees C are C(16 : 0), C(16 : 1)omega7c, C(17 : 0) cyclo, C(10 : 0) 3-OH, C(18 : 1) omega 7c, C(12 : 0) and C(15 : 0). DNA G+C content is 67.9 mol%. Phenotypic and phylogenetic data indicate that strain SUA2(T) is related to, but clearly differentiated from Azospira oryzae. Strain SUA2(T) is thus proposed as a novel species of the genus Azospira with the name Azospira restricta sp. nov. The description of the genus Azospira is emended to include the characteristics of this novel species. The type strain of Azospira restricta is SUA2(T) (=NRRL B-41660(T)=DSM 18626(T)=LMG 23819(T)).

Yu K, DeLaune RD, Boeckx P. Direct measurement of denitrification activity in a Gulf coast freshwater marsh receiving diverted Mississippi River water. Chemosphere 2006;65(11):2449-55.

Wetland loss along the Louisiana Gulf coast and excessive nitrate loading into the Gulf of Mexico are interrelated environmental problems. Nitrate removal by soil denitrification activity was studied in a ponded freshwater marsh receiving diverted Mississippi River water for the purpose of reversing or slowing wetland loss. Labeled (15)N-nitrate was applied at 3.8 g N m(-2) into four replicate study plots after removing above ground vegetation. Nitrogen gas (N(2)) and nitrous oxide (N(2)O) emissions from the plots were determined by isotope ratio mass spectrometry (IRMS). Nitrous oxide emissions were also compared with the results determined by gas chromatograph (GC). Results showed that it took 2 weeks to remove the added nitrate with N(2)O emission occurring over a period of 4d. The apparent denitrification dynamics were assumed to follow the Michaelis-Menten equation. The maximum denitrification rate and K(m) value were determined as 12.6 mg N m(-2)h(-1), and 6.5 mg Nl(-1), respectively. Therefore the maximum capacity for nitrate removal by the marsh soil would be equivalent to 110 g N m(-2)yr(-1), with more than 30% of nitrogen gas evolved as N(2)O. For typical nitrate concentrations in Mississippi River water of about 1 mg N l(-1), nitrate would be removed at a rate of 14.7 g N m(-2)yr(-1) with N(2)O emission about 1.5%. A denitrification dynamic model showed that the efficiency of nitrate removal would largely depend on the water discharge rate into the ponded wetland. Higher discharge rate will result in less retention time for the water in the marsh where nitrate is denitrified.

Ramos JA. Exponential data fitting applied to infiltration, hydrograph separation, and variogram fitting. Stochastic Environmental Research and Risk Assessment 2006;20(1-2):33-52.

Most lumped rainfall-runoff models separate the interflow and groundwater components from the measured runoff hydrograph in an attempt to model these as hydrologic reservoir units. Similarly, rainfall losses due to infiltration as well as other abstractions are separated from the measured rainfall hyetograph, which are then used as inputs to the various hydrologic reservoir units. This data pre-processing is necessary in order to use the linear unit hydrograph theory, as well as for maintaining a hydrologic budget between the surface and subsurface flow processes. Since infiltration determines the shape of the runoff hydrograph, it must be estimated as accurately as possible. When measured infiltration data is available, Horton's exponential infiltration model is preferable due to its simplicity. However, estimating the parameters from Horton's model constitutes a nonlinear least squares fitting problem. Hence, an iterative procedure that requires initialization is subject to convergence. In a similar context, the separation of direct runoff, interflow, and baseflow from the total hydrograph is typically done in an ad hoc manner. However, many practitioners use exponential models in a rather "layer peeling" fashion to perform this separation. In essence, this also constitutes an exponential data fitting problem. Likewise, certain variogram functions can be fitted using exponential data fitting techniques. In this paper we show that fitting a Hortonian model to experimental data, as well as performing hydrograph

separation, and total hydrograph and variogram fitting can all be formulated as a system identification problem using Hankel-based realization algorithms. The main advantage is that the parameters can be estimated in a noniterative fashion, using robust numerical linear algebra techniques. As such, the system identification algorithms overcome the problem of convergence inherent in iterative techniques. In addition, the algorithms are robust to noise in the data since they optimally separate the signal and noise subspaces from the observed noisy data. The algorithms are tested with real data from field experiments performed in Surinam, as well as with real hydrograph data from a watershed in Louisiana. The system identification techniques presented herein can also be used with any other type of exponential data such as exponential decays from nuclear experiments, tracer studies, and compartmental analysis studies. © Springer-Verlag 2005.

Keim RF, Blanford WJ. Hurricanes create a crossroads for hydrological management of the Mississippi River delta. Ground Water 2006;44(2):123-4.

Griffith JM, Geological S, Capital Area Ground Water Conservation C. Hydrogeologic maps and sections of the "400-foot", "600-foot", and "800-foot" sands of the Baton Rouge area and adjacent aquifers in East and West Baton Rouge, East and West Feliciana, and Pointe Coupee Parishes, Louisiana. Denver, CO: U.S. Geological Survey, 2006.

Dokka RK. Modern-day tectonic subsidence in coastal Louisiana. Geology 2006;34(4):281-4.

Subsidence is leading to the slow inundation of communities and wetlands of Louisiana, Mississippi, Texas, and Alabama (United States) by the Gulf of Mexico. The prevailing paradigm considers subsidence to be the result of young sediment compaction and/or consolidation and human activities. This paper describes the results of a test of this theory based on an examination of historic motions of benchmark in the Michoud area of Orleans Parish, Louisiana. This methodology allowed for an assessment of vertical change at different levels over time relative to a precise vertical datum (North American Vertical Datum of 1988, NAVD88). Data do not support the current theory on the origins of subsidence; they demonstrate that tectonic causes dominate in the study area. During 1969-1971 and 1971-1977, tectonism was responsible for -16.9 mm/yr and -7.1 mm/yr of subsidence, respectively. These contributions account for 73% and 50% of the total subsidence during these intervals. The change in deep subsidence is attributed to renewed motion along a large normal fault (Michoud fault). Over the same time intervals, intermediate depth subsidence due to compaction of Pleistocene to middle Miocene strata was constant (-4.6 mm/yr). Similarly, subsidence due to shallow processes, i.e., sediment compaction and groundwater offtake, was -1.5 mm/yr and -2.5 mm/yr. Subsidence associated with petroleum extraction was not a factor due to the lack of local production. © 2006 Geological Society of America.

Dinglasan-Panlilio MJ, Dworatzek S, Mabury S, Edwards E. Microbial oxidation of 1,2-dichloroethane under anoxic conditions with nitrate as electron acceptor in mixed and pure cultures. FEMS Microbiology Ecology 2006;56(3):355-64.

Many organisms have been found to readily oxidize the prevalent contaminant 1,2-dichloroethane (1,2-DCA) to CO2 under aerobic conditions. Some organisms have also been isolated that can reduce 1,2-DCA to ethene via dihaloelimination under anaerobic, fermentative conditions. However, none have been described that can metabolize 1,2-DCA under anoxic, nitrate-reducing conditions. In microcosms prepared from aquifer material and groundwater samples from a contaminated site in eastern Louisiana, USA, 1,2-DCA was observed to degrade with nitrate as the terminal electron acceptor. Nitrate-dependent enrichment cultures were developed from these microcosms that sustained rapid 1,2-DCA degradation rates of up to 500 Î¼M day-1. This degradation was tightly coupled to complete reduction of nitrate via nitrite to nitrogen gas. A novel 1,2-DCA-degrading organism belonging to the Betaproteobacteria (affiliated with the genus Thauera) was isolated from this enrichment culture. However, degradation rates were much slower in cultures of the isolate than observed in the parent mixed culture. Complete mineralization of 1,2-DCA to CO2 was linked to cell growth and to nitrate reduction in both enrichment

and isolated cultures. Monochloroacetate, a putative metabolite of 1,2-DCA degradation, could also be mineralized by these cultures.

Bunnell JE, Tatu CA, Bushon RN, et al. Possible linkages between lignite aquifers, pathogenic microbes, and renal pelvic cancer in northwestern Louisiana, USA. Environmental Geochemistry and Health 2006;28(6):577-87.

In May and September, 2002, 14 private residential drinking water wells, one dewatering well at a lignite mine, eight surface water sites, and lignite from an active coal mine were sampled in five Parishes of northwestern Louisiana, USA. Using a geographic information system (GIS), wells were selected that were likely to draw water that had been in contact with lignite; control wells were located in areas devoid of lignite deposits. Well water samples were analyzed for pH, conductivity, organic compounds, and nutrient and anion concentrations. All samples were further tested for presence of fungi (cultures maintained for up to 28 days and colonies counted and identified microscopically) and for metal and trace element concentration by inductively-coupled plasma mass spectrometry and atomic emission spectrometry. Surface water samples were tested for dissolved oxygen and presence of pathogenic leptospiral bacteria. The Spearman correlation method was used to assess the association between the endpoints for these field/laboratory analyses and incidence of cancer of the renal pelvis (RPC) based on data obtained from the Louisiana Tumor Registry for the five Parishes included in the study. Significant associations were revealed between the cancer rate and the presence in drinking water of organic compounds, the fungi Zygomycetes, the nutrients PO4 and NH3, and 13 chemical elements. Presence of human pathogenic leptospires was detected in four out of eight (50%) of the surface water sites sampled. The present study of a stable rural population examined possible linkages between aquifers containing chemically reactive lignite deposits, hydrologic conditions favorable to the leaching and transport of toxic organic compounds from the lignite into the groundwater, possible microbial contamination, and RPC risk.

Bowman KS, Moe WM, Rash BA, Bae HS, Rainey FA. Bacterial diversity of an acidic Louisiana groundwater contaminated by dense nonaqueous-phase liquid containing chloroethanes and other solvents. FEMS Microbiol Ecol 2006;58(1):120-33.

Bacterial concentration and diversity was assessed in a moderately acidic (pH 5.1) anaerobic groundwater contaminated by chlorosolvent-containing DNAPL at a Superfund site located near Baton Rouge, Louisiana. Groundwater analysis revealed a total aqueous-phase chlorosolvent concentration exceeding 1000 mg L(-1), including chloroethanes, vinyl chloride, 1,2-dichloropropane, and hexachloro-1,3-butadiene as the primary contaminants. Direct counting of stained cells revealed more than 3 x 10(7) cells mL(-1) in the groundwater, with 58% intact and potentially viable. Universal and 'Dehalococcoides'-specific 16S rRNA gene libraries were created and analyzed. Universal clones were grouped into 18 operational taxonomic units (OTUs), which were dominated by low-G+C Gram-positive bacteria (62%) and included several as yet uncultured or undescribed organisms. Several unique 16S rRNA gene sequences closely related to Dehalococcoides ethenogenes were detected. Anaerobically grown isolates (168 in total) were also sequenced. These were phylogenetically grouped into 18 OTUs, of which only three were represented in the clone library. Phylogenetic analysis of isolates and the clone sequences revealed close relationships with dechlorinators, fermenters, and hydrogen producers. Despite acidic conditions and saturation or near-saturation chlorosolvent concentrations, the data presented here demonstrate that large numbers of novel bacteria are present in groundwater within the DNAPL source zone, and the population appears to contain bacterial components necessary to carry out reductive dechlorination.

Wu K, Xu YJ. Applicability of swat for three coastal watersheds in Louisiana. In: Proceedings of the 3rd Conference on Watershed Management to Meet Water Quality Standards and Emerging TMDL; 2005; 2005. p. 489-99.

The Soil & Water Assessment Tool (SWAT) has been widely used for spatial hydrologic analyses at various watershed scales. However, little is known about the model's behaviors in coastal watersheds that have gentle topography and high drainage density. In this study we evaluated the SWAT model for its ability to predict hydrologic components in three coastal lowland watersheds in size from 1896 to 4822 km2. The model was calibrated and validated with daily discharge data from 1976 to 1977 and from 1979 to 1999, respectively. Deviation of mean discharge and the Nash-Sutcliffe efficiency were used to evaluate the model's performance. The study found that Manning's roughness coefficient for main channel (CH_N(2)), SCS curve number (CN), soil evaporation compensation factor (ESCO), deep aquifer percolation fraction (RCHRG_DP), groundwater delay (GW_DELAY), and maximum canopy storage (CANMX) were the most sensitive model parameters for these coastal watersheds. CH_N(2) showed the greatest effect on the surface runoff response time in hydrograph, indicating its critical role in hydrologic routing processes for the lowland watersheds with a flat topography. The SWAT model showed an excellent performance with a Nash-Sutcliffe model efficiency of 0.935, 0.940 and 0.960 for the calibration period and of 0.851, 0.811 and 0.867 for the validation period for the three watersheds. The estimation errors in annual average runoff were below 5.6%. In addition to discharge, SWAT produced reasonable estimates for other relevant components such as evapotranspiration, soil moisture, and groundwater flow. These results demonstrate that SWAT is capable to simulate hydrologic processes for medium to large scale lowland coastal watersheds.

Nyman DJ, Louisiana. Dept. of Transportation and Development. Water Resources S, Nyman and A. Simulation of groundwater flow and transport in the Kisatchie Well Field near Alexandria, Louisiana. Baton Rouge, La.: Nyman and Associates; 2005.

Spatial and temporal estimation of pumping and recharge in groundwater system analysis. Louisiana State University, 2005.(Accessed at http://etd.lsu.edu/docs/available/etd-08312005-151603/)

Fendick RB. Louisiana ground-water map no. 21 [electronic resource] : generalized potentiometric surface of the Evangeline Aquifer in south-central Louisiana, January-March 2004 / by Robert B. Fendick, Jr. ; prepared in cooperation with the Louisiana Department of Transportation and Development, Office of Public Works and Intermodal, Public Works and Water Resources Division. Denver, CO.: U.S. Dept. of the Interior, U.S. Geological Survey; 2005.

Carlson D. Louisiana's ground-water resources / Douglas Carlson. Baton Rouge: Louisiana Geological Survey; 2005.

Water industry responds to hurricane disasters. Journal / American Water Works Association 2005;97(11):48-9.

In response to the hurricanes, AWWA and the National Ground Water Association are both encouraging their members who want to volunteer professional expertise to register with the National Emergency Resource Registry. The Water and Wastewater Equipment Manufacturers Association (WWEMA) is identifying ways in which the federal government can assist the water and wastewater equipment manufacturing community in ensuring that it remains competitive following Hurricane Katrina. ZENON Environmental has donated 40 of its Homespring central water filtration systems to aid in relief efforts in Mississippi and Louisiana, and Maytag. Bentley Systems Inc. is providing design assistance to architectural and construction firms that are displaced by Katrina.

Tomaszewski DJ, Accardo D, Geological S, Capital Area Ground Water Conservation C. Louisiana ground-water map no.19, potentiometric surface of the "2,400-foot" sand of the Baton Rouge area, Louisiana, May-June 2002. Denver, CO: U.S. Geological Survey, 2004.

Tomaszewski DJ, Accardo D, Geological S, Capital Area Ground Water Conservation C. Louisiana ground-water map no.20, potentiometric surface of the "2,000-foot" sand of the Baton Rouge area, Louisiana, May 2002. Denver, CO: U.S. Geological Survey, 2004.

Quality of water in domestic wells in the Chicot and Chicot equivalent aquifer systems, southern Louisiana and southwestern Mississippi, 2000-2001. U.S. Dept. of the Interior, U.S. Geological Survey, 2004.(Accessed at http://purl.access.gpo.gov/GPO/LPS98469)

Quality of water from shallow wells in the rice-growing area in southwestern Louisiana, 1999 through 2001. U.S. Dept. of the Interior, U.S. Geological Survey, 2004.(Accessed at http://purl.access.gpo.gov/GPO/LPS98759)

Reyes MR, Skaggs RW, Bengtson RL. GLEAMS-SWT with nutrients. Transactions of the American Society of Agricultural Engineers 2004;47(1):129-32.

This article introduces the Groundwater Loading Effects of Agricultural Management Systems with Subsurface drainage and Water Table (GLEAMS-SWT) with nutrients model. This version contains GLEAMS' nutrient component and additional routines to predict nitrogen loss from subsurface drainage. Comparisons of GLEAMS-SWT and GLEAMS nitrogen and phosphorus loss predictions with six years of measured nitrogen and phosphorus losses from nonsubsurface and subsurface drained plots located at Ben Hur Research Farm in Baton Rouge, Louisiana, showed that: (1) GLEAMS-SWT overpredicted total (ammonia and nitrate both in solution and solids) surface nitrogen (TSN) loss by 10%, and GLEAMS underpredicted TSN loss by 38% for the nonsubsurface drained plot; (2) GLEAMS-SWT overpredicted TSN loss by 31%, and GLEAMS overpredicted it by 7% for the subsurface drained plot; (3) both models severely underpredicted total (solution and solids) surface phosphorus losses for the nonsubsurface and subsurface drained plots; and (4) GLEAMS-SWT overpredicted total nitrogen loss in subsurface drainage nearly 7-fold.

Ramos JA. Exponential data fitting applied to environmental data. In: Proceedings of the IEEE Conference on Decision and Control; 2004; 2004. p. 4169-74.

Most lumped rainfall-runoff models separate the interflow and groundwater components from the measured runoff Hydrograph in an attempt to model these as hydrologic reservoir units. Similarly, rainfall losses due to infiltration as well as other abstractions are separated from the measured rainfall hyetograph, which serve as inputs to the various hydrologic reservoir units. When measured infiltration data is available, Horton's exponential infiltration model is preferable due to its simplicity. However, estimating the parameters from Horton's model constitutes a nonlinear least squares fitting problem. In a similar context, the separation of direct runoff, interflow, and baseflow from the total hydrograph is typically done using exponential models in a rather "layer peeling" fashion, which in essence also constitutes an exponential data fitting problem. In this paper we show that fitting a Hortonian model to experimental data, as well as performing hydrograph separation can be formulated as a system identification problem in the state-space domain. The main advantage is that the parameters can be estimated in a non iterative fashion, using robust numerical linear algebra techniques. The algorithms are tested with real data from field experiments performed in Surinam, as well as with real hydrograph data from a watershed in Louisiana.

Prakken LB, Geological S, Louisiana. Office of Public W, Louisiana. Dept. of Transportation and Development. Water Resources S. Louisiana ground-water map no. 17 : generalized potentiometric surface of the Kentwood Aquifer system and the "1,500-foot" and "1,700-foot" sands of the Baton Rouge area in Southeastern Louisiana, March-April 2003. Denver, Colo.: U.S. Geological Survey, 2004.

Otvos EG, Giardino MJ. Interlinked barrier chain and delta lobe development, northern Gulf of Mexico. Sedimentary Geology 2004;169(1-2):47-73.

A wealth of new data provides a well-constrained chronology of mid- to late Holocene coastal development in the Louisiana-Mississippi borderland that may also be utilized in a globally applicable sedimentation model. Barrier sand and deltaic mud sequences illustrate a process by which potential ground water and hydrocarbon reservoir rocks accumulated unusually rapidly and were preserved. Set against decelerating Holocene sea-level rise and locally variable subsidence rates, the study provides an example of the interplay between an emerging, prograding, and partially stranded barrier island chain, a sizable estuary, and several extensive delta lobes. Utilizing microfossil fauna-based depositional facies information and archaeological data, absolute dates helped to reconstruct the history of the Alabama-Louisiana barrier chain and deltas between ca. 5.7 and ca. 1.5 14C ka BP. Protected by the substantial dune cover that prevented island submersion, the regional eustastic transgression paradoxically was synchronous with significant progradational barrier and deltaic regression. The earliest barrier islands emerged ca. 4.6-4.4 14C ka BP (ca. 5.7-5.0 cal years) when sea level stood at ca. -1.0 to -1.5 m. These islands isolated Mississippi Sound from the greater Gulf of Mexico. The absence of a lagoonal-inshore sediment interval beneath the islands and the 3-15 m thick basal nearshore marine muddy-sandy unit that blankets the Pleistocene surface refutes the transgressive history of barrier initiation. The islands aggraded on a 3.0-16.5 m thick fine sandy shallow-marine regressive platform lithosome that, in turn, overlies a transgressive muddy-sandy nearshore marine lower sediment interval. Avulsion of the Mississippi River had abruptly reduced nearshore salinities by ca. 3.9-3.7 ka 14C BP. Renewed Mississippi delta growth induced rapid aggradation and progradation on the opposite Pearl River delta-mainland shore as well. Gulf influences have rapidly diminished in areas so affected. A new absolute chronology of the Mississippi-St. Bernard delta lobes constrains these events. Delta growth and mainland progradation first isolated, then severely constricted the Lake Borgne embayment. Accompanied by ongoing subsidence, the western barriers were stranded, then buried. Shoaling, related to St. Bernard delta progradation, interfered with westward littoral drift to maintain Cat Island. Archaeology provided important supplementary data for dating environmental changes. Refuting earlier suggestions that Native colonization rapidly followed delta complex formation, the earliest known Indian sites postdated the start of the associated St. Bernard delta lobe by 1.9-3.1 14C ka. © 2004 Published by Elsevier B.V.

Moore WS, Krest J. Distribution of 223Ra and 224Ra in the plumes of the Mississippi and Atchafalaya Rivers and the Gulf of Mexico. Marine Chemistry 2004;86(3-4):105-19.

Two naturally occurring, short-lived radium isotopes (223Ra and 224Ra) provide unique tracers of riverine plumes as they mix into the ocean. Here, we apply these isotopes to studies conducted at the mouths of the Mississippi and Atchafalaya Rivers in November 1993 and May 1994. During each study, plume waters contained unsupported activities of short-lived radium isotopes for distances of over 75 km from the Mississippi River mouth. These isotopes may be used to calculate apparent ages of the plume since the water was last in contact with sediments at the river mouth. The ages provide a unique time history of water in the plume. Plume ages derived from the isotope ratios indicate that the plume moved considerably faster in May compared to November. During May 1994, there were significant enrichments of all radium isotopes in the bottom waters near the Mississippi mouth. The suspected source of these enrichments is the discharge of salty groundwater into the bottom water. Besides supplying radium isotopes, these discharges may provide significant inputs of nutrients and other materials. © 2004 Elsevier B.V. All rights reserved.

Michel RL. Tritium hydrology of the Mississippi River basin. Hydrological Processes 2004;18(7):1255-69.

In the early 1960s, the US Geological Survey began routinely analysing river water samples for tritium concentrations at locations within the Mississippi River basin. The sites included the main stem of the Mississippi River (at Luling Ferry, Louisiana), and three of its major tributaries, the Ohio River (at Markland Dam, Kentucky), the upper Missouri River (at Nebraska City, Nebraska) and the Arkansas River (near Van Buren, Arkansas). The measurements cover the period during the peak of the bomb-produced tritium transient when tritium concentrations in precipitation rose above natural levels by two to three orders of magnitude. Using measurements of tritium concentrations in precipitation, a tritium input function was established for the river basins above the Ohio River, Missouri River and Arkansas River

sampling locations. Owing to the extent of the basin above the Luling Ferry site, no input function was developed for that location. The input functions for the Ohio and Missouri Rivers were then used in a two-component mixing model to estimate residence times of water within these two basins. (The Arkansas River was not modelled because of extremely large yearly variations in flow during the peak of the tritium transient.) The two components used were: (i) recent precipitation (prompt outflow) and (ii) waters derived from the long-term groundwater reservoir of the basin. The tritium concentration of the second component is a function of the atmospheric input and the residence times of the groundwaters within the basin. Using yearly time periods, the parameters of the model were varied until a best fit was obtained between modelled and measured tritium data. The results from the model indicate that about 40% of the flow in the Ohio River was from prompt outflow, as compared with 10% for the Missouri River. Mean residence times of 10 years were calculated for the groundwater component of the Ohio River versus 4 years for the Missouri River. The mass flux of tritium through the Mississippi Basin and its tributaries was calculated during the years that tritium measurements were made. The cumulative fluxes, calculated in grams of 3II were: (i) 160 g for the Ohio (1961-1986), (ii) 98 g for the upper Missouri (1963-1997), (iii) 30 g for the Arkansas (1961-1997) and (iv) 780 g for the Mississippi (1961-1997). Published in 2004 by John Wiley and Sons, Ltd.

Fendick RB. Quality of water from shallow wells in urban residential and light commercial areas in Lafayette Parish, Louisiana, 2001 through 2002 / by Robert B. Fendick, Jr., and Roland W. Tollett. Baton Rouge, LA : Denver, CO: U.S. Dept. of the Interior, U.S. Geological Survey, 2004.

Tomaszewski DJ, Louisiana. Dept. of Transportation and Development, Geological Survey. Ground-water resources along the lower Mississippi River, southeastern Louisiana. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 2003.

Rahman A, Hartono S, Carlson D, Willson CS. Incorporating uncertainty into high-resolution groundwater supply models. In: Groundwater Quality Modeling and Management Under Uncertinity; 2003; 2003. p. 122-30.

Groundwater modeling is a useful tool for evaluating whether an acquifer system is capable of supporting groundwater withdrawals over long periods of time and what effect, if any, such activity will have on the regional flow dynamics as well as on specific public water, agricultural and industrial supplies. An overview is given of an ongoing groundwater modeling study of the Chicot Aquifer in southwestern Louisiana where a low-resolution groundwater model is being used to study the regional flow in the Chicot acquifer and to provide boundary conditions for higher-resolution inset models created using telescopic mesh refinement (TMR).

Mora G, Jahren AH. Isotopic evidence for the role of plant development on transpiration in deciduous forests of southern United States. Global Biogeochemical Cycles 2003;17(2):13-1.

We evaluated D/H ratios of soil- and plant-extracted water during the 1997 growing season to assess the influence of temperature, humidity, and rainfall on water distribution in deciduous forests. Three state parks (Chicot in Arkansas; Natchez in Mississippi, and St. Bernard in Louisiana) were identified along a 13.5-cm precipitation gradient established during the studied growing season within the Mississippi River basin. Samples were collected for isotopic determinations from five to six species at each site early (March) and late (June) in the growing season. To capture the isotopic variability in water sources, samples of rainwater, groundwater, and soil water were collected. Isotopic results for rainwater showed an average increase of 4€° from March to June. This increase did not transfer to soil water: soil water Î´D values throughout the growing season showed values close to those measured for March rainwater. In contrast, leaf water showed Î´D values that were 15€° to 20€° higher in March compared to June Î´D values. Elevated March Î´D values in leaf water were observed in virtually all species at the three sites. Change in leaf water Î´D value during the growing season was not correlated with precipitation rate, temperature, humidity, or changes in atmospheric water vapor isotopic composition. We propose that this widespread March isotopic enrichment resulted from enhanced evaporative demand induced by

accelerated plant growth early in the growing season. This suggestion implies a decoupling of environmental factors and plant response, pointing to the important role of plant developmental timing in ecosystem functioning.

McCulloh RP. The stream net as an indicator of cryptic systematic fracturing in Louisiana. Southeastern Geology 2003;42(1):1-17.

The stream net in many parts of Louisiana includes straight reaches with preferred alignment in a few directions, with some examples spanning tens of kilometers. In places the reaches form classic rectangular drainage patterns. These characteristics are obvious on maps at a variety of scales, and are recognizable on some portion of nearly every 7.5-minute quadrangle in the state, excepting those quadrangles situated entirely within the HoÅ‚ocene coastal marshes or the Holocene flood plains of the larger rivers. Such patterns of lineaments are reminiscent of patterns associated with systematic fracturing in other regions. In Louisiana, however, verification and measurement of fractures that may exist in the vicinity of rectilinear drainage anomalies is problematic because surface deposits are comparatively young and sparsely exposed, and tend, especially near waterways, to be heavily weathered and vegetated. An indirect approach to evaluating the potential influence on drainage by fracturing involves evaluating the frequency distribution of stream-course orientations based on its degree of similarity with that of the strikes of previously mapped or reported fractures (faults and/or joints). A rose diagram of orientation frequencies for the stream net of the entire state, created utilizing a publicly available line dataset processed into 100-m segments (N 290,000), shows a nonrandom distribution with three visually identifiable trends: the strongest, oriented essentially N-S; a subsidiary trend oriented N20°-30°W; and a weak trend oriented N80°-90°W. The entire population of orientations yields a mean direction of N17.5°W ± 4.2° with a probability of 95 percent. The strike frequencies of mapped faults show little correspondence with these trends. This suggests, if mapped faults are at least representative of actual faults, that insofar as apparent lineaments reflect structure and not the influence of a south-southeasterly regional drainage gradient, they predominantly reveal the influence of joints. These could reflect either a Quaternary stress regime, or propagation in young sediment of a structural pattern in underlying older strata. The data available at present do not compel either interpretation, though in south Louisiana at least, where reactivated early Tertiary growth faults have surface expression that in places is juxtaposed with differently oriented drainage lineaments, propagation of a preexisting pattern from depth appears plausible. Widespread systematic fracturing in this predominantly Quaternary coastal-plain setting could have important implications for groundwater flow and for other processes that depend substantially on permeability.

Louisiana Geological Survey, Louisiana State University Dept of Civil and Environmental Engineering, Louisiana Public Works and Water Resources Division. Evaluation of aquifer capacity to sustain short-, long-term ground water withdrawal from point sources in the Chicot aquifer for southwest Louisiana. Baton Rouge, La.: Louisiana Dept. of Transportation and Development; 2003.

Griffith JM, Lovelace JK, Geological Survey, Capital Area Ground Water Conservation. Louisiana ground-water map. no. 16, Potentiometric surface of the "1,500-foot" sand of the Baton Rouge area, Louisiana, Spring 2001. [Baton Rouge, LA]; Denver, CO: U.S. Geological Survey, 2003.

Griffith JM, Lovelace JK, Geological S, Capital Area Ground Water Conservation C. Louisiana ground-water map. no. 15, Potentiometric surface of the "1,200-foot" sand of the Baton Rouge area, Louisiana, Spring, 2001. [Baton Rouge, LA]; Denver, CO: U.S. Geological Survey, 2003.

Truex MJ, Johnson CD, Spencer JR, Clement TP. Evaluating natural attenuation of chlorinated solvents at a complex site. In: Proceedings of the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds; 2002; 2002. p. 1535-42.

The EPA's Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (EPA/600/R-98/128) was applied for the Petro Processors Inc. Brooklawn site near Baton Rouge,

Louisiana. This site consists of a mixed non-aqueous phase (NAPL) source area creating a dissolved groundwater contamination plume in alluvial material near the Mississippi River. The hydraulic gradient of the groundwater varies seasonally with changes in the river stage. Due to this transient nature of the hydraulic gradient, direct field measurements could not be used to estimate natural attenuation rates. Instead, laboratory microcosm tests and geochemical data were used to estimate attenuation rates. Fate and transport of contaminants was then modeled using the Reactive Transport in Three Dimensions (RT3D) numerical code. These data and model results were evaluated within the framework of the EPA protocol where it was determined that monitored natural attenuation (MNA) has the potential to meet the site dissolved plume remediation goals and the requirements of the EPA OSWER Directive 9200.4-17. Based on this evaluation, MNA has been approved as the remedial action for the dissolved plume at the site.

Tomaszewski DJ, Lovelace JK, Ensminger PA, Louisiana. Dept. of Transportation and Development. Water Resources S, Geological S. Water withdrawals and trends in ground-water levels and stream discharge in Louisiana. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 2002.

Spencer JR, Johnson CD, Truex MJ, Clement TP. Modeling biological transformation of chlorinated ethanes and ethenes in support of natural attenuation. In: Proceedings of the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds; 2002; 2002. p. 1557-63.

As part of an evaluation of monitored natural attenuation, a reactive flow and transport model was developed to predict the fate and transport of chlorinated ethanes and ethenes at a complex site near Baton Rouge, Louisiana. Complexities at the site included highly variable geology, transient flow conditions, and a large number of waste components. Calibration of the flow model was achieved for the transient flow conditions. The Reactive Transport in 3-Dimensions (RT3D) code was used for simulating contaminant fate and transport. Reactive transport simulations incorporated a 10 species site-specific (user-defined) RT3D reaction module that was developed based on laboratory microcosm results. Calibration of the transport model considered matching of simulation results and measured constituent data along transects down-gradient of the contaminant source area and at plume boundaries. Simulations were conducted to predict the fate of the plume in the scenario where hydraulic containment activities (currently being used at the site) were discontinued. The predictive simulations indicated that the plume would reach a steady-state condition and cease migration down-gradient prior to reaching the receptors of concern. These results, in combination with other lines of evidence, have led to regulatory acceptance of MNA as a remedial action at this site.

Ryder PD, Ardis AF. Hydrology of the Texas Gulf coast aquifer systems. US Geological Survey Professional Paper 2002(1416 E).

A complex, multilayered ground-water flow system exists in the Coastal Plain sediments of Texas. The Tertiary and Quaternary clastic deposits have an areal extent of 114,000 square miles onshore and in the Gulf of Mexico. Two distinct aquifer systems are recognized within the sediments, which range in thickness from a few feet to more than 12,000 feet. The older system, the Texas coastal uplands aquifer system, consists of four aquifers and two confining units in the Claiborne and Wilcox Groups. It is underlain by the practically impermeable Midway confining unit or by the top of the geopressured zone. It is overlain by the nearly impermeable Vicksburg-Jackson confining unit, which separates it from the younger coastal lowlands aquifer system. The coastal lowlands aquifer system consists of five permeable zones and two confining units that range in age from Oligocene to Holocene. The hydrogeologic units of both systems are exposed in bands that parallel the coastline. The units dip and thicken toward the Gulf. The quality of water in the aquifer systems is highly variable, with content of dissolved solids ranging from less than 500 to 150,000 milligrams per liter. Substantial withdrawal from the aquifer systems began in the early 1900's and increased nearly continuously into the 1970's. The increase in withdrawal was relatively rapid from about 1940 to 1970, Adverse hydrologic effects, such as saltwater encroachment in coastal areas, land-surface subsidence in the Houston-Galveston area, and long-term dewatering in the Winter Garden area, were among the factors that caused pumping increases to slow or to cease in the

1970's and 1980's. Ground-water withdrawals in the study area in 1980 were about 1.7 billion gallons per day. Nearly all of the withdrawal was from four units: Permeable zones A, B, and C of Miocene age and younger, and the lower Claiborne-upper Wilcox aquifer. Ground-water levels have declined hundreds of feet in the intensively pumped areas of Houston-Galveston, Kingsville, Winter Garden, and Lufkin-Nacogdoches. Water-level declines have caused inelastic compaction of clays which, in turn, has resulted in land-surface subsidence of more than 1 foot in an area of about 2,000 square miles. Maximum subsidence of nearly 10 feet occurs in the Pasadena area east of Houston. A three-dimensional, variable-density digital model was developed to simulate predevelopment and transient flow in the aquifer systems. The modeled area is larger than the study area and includes adjacent parts of Louisiana and Mexico. The transient-model calibration period was from 1910 (predevelopment to 1982. Model-generated head distributions, water-level hydrographs, and land-surface subsidence were matched to measured data in selected, intensively pumped areas. For the study area, mean horizontal hydraulic conductivity in the calibrated model rages from 10 feet per day for the middle Wilcox aquifer to 25 feet per day for permeable zone A. Mean transmissivity ranges from about 4,600 feet squared per day for the middle Claiborne aquifer to about 10,400 feet squared per day for permeable zone D. Mean vertical hydraulic conductivity ranges from 1.1Ã—10-5 feet per day for the Vicksburg-Jackson confining unit, to 3.8Ã—10-3 feet per day for permeable zone A. Mean values of calibrated storage coefficient range from 5.2Ã—10-4 for the middle Claiborne aquifer to 1.7Ã—10-3 for the middle Wilcox aquifer and permeable zone C. Calibrated inelastic specific storage values for clay beds in permeable zones A, B, and C in the Houston-Galveston area are 8.5Ã—10-5, 8.0Ã—10-5, and 8.0Ã—10-6 per foot, respectively. Recharge rates were mapped for predevelopment conditions as determined from a steady-state model calibration. A maximum rate of 3 inches per year was simulated in small areas, and the average rate for the study area was 0.34 inch per year. Total simulated recharge was 85 million cubic feet per day in the outcrop area. Recharge was equal to discharge in outcrop areas (79 million cubic feet per day) plus net lateral flow o t of the study area (6 million cubic feet per day). Rates of inflow and outflow to the ground-water system have nearly tripled from predevelopment to 1982 (85 to 276 million cubic feet per day) based on model simulation Withdrawal of 231 million cubic feet per day was supplied principally by an increase in outcrop recharge and, to a lesser extent, from a decrease in natural discharge and release of water from storage in aquifers and compacting clay beds. The average simulated 1982 recharge rate for the study area was 0.52 inch per year, with a maximum simulated rate of 6 inches per year in Jackson and Wharton Counties. Because withdrawal has caused problems such as saltwater intrusion, land-surface subsidence, and aquifer dewatering, the Texas Department of Water Resources has projected that ground-water use will decline substantially in most of the study area by the year 2030. Some areas remain favorable for development of additional ground-water supplies. Pumping from older units that are farther inland and in areas where potential recharge is greater will minimize adverse hydrologic effects.

Louisiana Ground Water Management Commission. Advisory task force. Baton Rouge, La.: Louisiana Ground Water Management Commission, 2002.

Kim JH, Feagley SE. Leaching of trifluralin, metolachlor, and metribuzin in a clay loam soil of Louisiana. Journal of Environmental Science and Health - Part B Pesticides, Food Contaminants, and Agricultural Wastes 2002;37(5):393-403.

Trifluralin[2,6-dinitro-N,N-dipropyl-4-(trifluormethyl)benzenamine], metolachlor[2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) acetamide], and metribuzin[4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2, 4-triazin-5(4H)one] were applied in field plots located on a Commerce clay loam soil near Baton Rouge, Louisiana at the rate of 1683 g/ha, 2759 g/ha and 609 g/ha, respectively. The half-lives of trifluralin, metolachlor, and metribuzin in the top 0-15 cm soil depth were found to be 54.7 days, 35.8 days and 29.8 days, respectively. The proportion of trifluralin, metolachlor, and metribuzin in the top 0-15 cm soil depth was 94.7%, 86.6%, and 75.4%, respectively of that found in the top 0-60 cm soil depth 30 days after application. Trifluralin concentrations were within a range of 0.026 ng/mL to 0.058 ng/mL in 1 m deep well water, and between 0.007 ng/mL and 0.039 ng/mL in 2 m deep well water over a 62 day period after application. Metolachlor concentrations in the 1 m and 2 m wells ranged from 3.62 ng/mL to 82.32 ng/mL and 8.44 ng/mL to 15.53 ng/mL, respectively. Whereas metribuzin concentrations in the 1 m and 2

m wells ranged from 0.70 ng/mL to 27.75 ng/mL and 1.71 ng/mL to 3.83 ng/mL, respectively. Accordingly, trifluralin was found to be strongly adsorbed on the soil and showed negligible leaching. Although metolachlor and metribuzin were also both readily adsorbed on the soil, their leaching potential was high. As a result, in the clay loam soil studied, metribuzin concentration in groundwater with shallow aquifers is likely to exceed the 10 mg/L US Environmental Protection Agency (EPA) advisory level for drinking water early in the application season, whereas trifluralin and metolachlor concentrations are expected to remain substantially lower than their respective 2 ng/mL and 175 ng/mL EPA advisory levels.

Scientific and management perspectives in wetland groundwater hydrology. Louisiana State University, 2002.(Accessed at http://etd.lsu.edu:8085/docs/available/etd-0408102-073903/)

Clement TP, Truex MJ, Lee P. A case study for demonstrating the application of U.S. EPA's monitored natural attenuation screening protocol at a hazardous waste site. Journal of Contaminant Hydrology 2002;59(1-2):133-62.

Natural attenuation assessment data, collected at a Superfund site located in Louisiana, USA, are presented. The study site is contaminated with large quantities of DNAPL waste products. Source characterization data indicated that chlorinated ethene and ethane compounds are the major contaminants of concern. This case study illustrates the steps involved in implementing the U.S. EPA's [U.S. EPA, 1998. Technical protocol for evaluating natural attenuation of chlorinated solvents in ground water, by Wiedmeier, T.H., Swnason, M.A., Moutoux, D.E., Gordon, E.K., Wilson, J.T., Wilson, B.H., Kampbell, D.H., Hass, P.E., Miller, R.N., Hansen, J. E., Chapelle, F.H., Office of Research and Development, EPA/600/R-98/128] monitored natural attenuation (MNA) screening protocol at this chlorinated solvent site. In the first stage of the MNA assessment process, the field data collected from four monitoring wells located in different parts of the plume were used to complete a biodegradation scoring analysis recommended by the protocol. The analysis indicates that the site has the potential for natural attenuation. In the second stage, a detailed conceptual model was developed to identify various contaminant transport pathways and exposure points. The U.S. EPA model and BIOCHLOR was used to assess whether the contaminants are attenuating at a reasonable rate along these transport paths so that MNA can be considered as a feasible remedial option for the site. The site data along with the modeling results indicate that the chlorinated ethene and chlorinated ethane plumes are degrading and will attenuate within 1000 ft down gradient from the source, well before reaching the identified exposure point. Therefore, MNA can be considered as one of the feasible remediation options for the site. Copyright © 2002 Elsevier Science B.V.

Williamson AK, Grubb HF. Ground-water flow in the Gulf Coast Aquifer systems, South-Central United States. US Geological Survey Professional Paper 2001(1616 F).

The gulf coast regional aquifer systems comprise one of the largest, most complicated, and interdependent aquifer systems in the United States. The Gulf Coast Regional Aquifer-System Analysis (Gulf Coast RASA) study area encompasses approximately 230,000 square miles onshore in parts of Alabama, Arkansas, Florida, Illinois, Kentucky, Mississippi, Missouri, Tennessee, Texas, and all of Louisiana. The aquifer systems (and the study area) extend offshore beneath the Gulf of Mexico to include an additional 60,000 square miles and are truncated at the edge of the Continental Shelf. The Gulf Coast RASA study is limited to coastal plain sediments mostly of Cenozoic age except for the northernmost part of the area, where it includes Late Cretaceous rocks. The thickness of the aquifer system increases toward the Gulf of Mexico and exceeds 17,000 feet near the coastline of southeastern Louisiana. The shallower parts of the aquifers contain freshwater, but the deeper and offshore parts contain mostly mineralized water or brine. Nearly 10 billion gallons per day of ground water was withdrawn from the aquifers in 1985; most of the water was for irrigation, but substantial quantities were used for municipal and industrial purposes. Three aquifer systems have been delineated in the Gulf Coast RASA study area: (1) the Mississippi embayment aquifer system, (2) the Texas coastal uplands aquifer system, and (3) the coastal lowlands aquifer system. Although all three aquifer systems are mixtures of fine- and coarse-grained clastic sediments deposited in continental and marine environments, the clay

and silt beds in the coastal lowlands aquifer system are generally thinner, dispersed vertically throughout the aquifers, and not areally as extensive as in the two other aquifer systems. The base of the gulf coast regional aquifer systems in the northern part of the area is at top of the Midway confining unit and in the southern part is at the transition zone into geopressured sediments. Faults are common, but fault throws generally are not great enough to entirely offset the regional hydrogeologic units described in this report, although individual beds could be offset. Many salt domes occur in several basins of the gulf coast. The gulf coast regional aquifer systems were divided into 10 aquifer and 5 regional confining units. Each of the aquifers was simulated as a separate layer in a three-dimensional, variable density, finite-difference ground-water flow model with 10-mile-grid spacing. The model accounted for inelastic compaction of fine-grained beds, resulting in more water being released from storage than would be released from coarse-grained sediments alone, and also resulting in land subsidence. Many of the aquifer characteristics, such as thickness, sand percentage, water density (based on concentration of dissolved solids), temperature, and pressure, were derived from a computerized file of 989 geophysical logs. The factors that controlled regional ground-water flow in the aquifer systems under predevelopment conditions (before 1925) are, in order of importance: (1) topography; (2) outcrop and subcrop pattern and geometry of aquifers, permeable zones, and confining units; (3) variation of hydraulic properties of aquifers, permeable zones, and confining units; (4) distribution of density and brines; and (5) downdip limits of geohydrologic units and geologic structure. Topography is the most significant factor controlling ground-water flow because the relatively humid climate maintains the aquifer systems generally full to overflowing with ground water. Therefore, the amount and distribution of regional recharge and discharge is generally proportional to the topographic gradient and aquifer conductivity rather than being controlled by precipitation or other factors. The major variations in subsurface permeability have been accounted for by delineation of aquifers and confining units. Hydraulic conductivity of sand beds increases from the western side of the study area toward the eastern side. Effective hydraulic conductivity varie as a power function of sand percentage because as the sand percentage decreases, the degree of hydraulic connection among sand beds also decreases. Hydraulic conductivity also decreases with depth due to compaction. Predevelopment net regional recharge was occuring in 41 percent of the aquifer system at the average rate of about 0.48 inch per year. The highest predevelopment net recharge rate was about 6 inches per year in southwestern Mississippi. Predevelopment net regional discharge was occurring in 59 percent of the area at the rate of about 0.35 inch per year. The largest net regional discharge was in the Mississippi River Valley alluvial aquifer at about 4 inches per year. The distribution of freshwater (dissolved-solids concentration less than 10,000 milligrams per liter) thickness correlated well with the simulated net regional recharge and discharge, indicating that the regional flow has flushed saline water (dissolved-solids concentration greater than 10,000 milligrams per liter) out of the sediments, creating a thicker section of freshwater. Some ground water flows offshore and is discharged to the ocean, but most is discharged before it reaches the coastline. Major changes have occured in the gulf coast regional aquifer systems in response to large-scale development of ground water throughout much of the study area. Development has led to lowering of hydraulic heads, changes in recharge and discharge, changes in flow and velocity both in direction and magnitude, land subsidence, and changes in water quality. Total pumpage increased by a factor of 2.5 during 1960-80 but decreased by 7 percent from 1980 to 1985. Large-scale ground-water pumpage in the freshwater part of the aquifer systems has markedly changed flow patterns in the brine (dissolved-solids concentration greater than 35,000 milligrams per liter) part of the system and induced flow updip toward pumping areas. However, it will take decades or centuries for the brine water to reach these pumping areas because of the relatively slow ground-water velocities when compared to the long flow paths. Simulation indicates that there is great potential for continued further development of the ground-water resource. By carefully designing the pattern of pumping additions, doubling the pumpage to 20 billion gallons per day could be accomplished with minimal impacts (average of less than 60 feet of drawndown over the study area).

Lovelace JK. Louisiana ground-water map no. 12: potentiometric surface of the Chicot Aquifer system in southwestern Louisiana, June 2000 / by John K. Lovelace; prepared in cooperation with the Louisiana State University Agricultural Center, Cooperative Extension Service and the Louisiana Rice Research Board. [Reston, Va.] : Denver, CO.: U.S. Dept. of the Interior, U.S. Geological Survey, 2001.

Goolsby DA, Battaglin WA. Long-term changes in consentrations and flux fo nitrogen in the Mississippi River Basin, USA. Hydrological Processes 2001;15(7):1209-26.

Current and historical data show that nitrogen concentrations and flux in the Mississippi River Basin have increased significantly during the past 100 years. Most of the increase observed in the lower Mississippi River has occurred since the early 1970s and is due almost entirely to an increase in nitrate. The current (1980-99) average annual nitrogen (N) flux from the Mississippi Basin to the Gulf of Mexico is about 1 555 500 t year-1, of which about 62% is nitrate-N. The remaining 38% is organic nitrogen and a small amount of ammonium. The current (1980-99) average nitrate flux to the Gulf is almost three times larger than it was during 1955-70. This increased supply of nitrogen to the Gulf is believed to be partly responsible for the increasing size of a large hypoxic zone that develops along the Louisiana-Texas shelf each summer. This zone of oxygen-depleted water has doubled in areal extent since it was first measured in 1985. The increase in annual nitrate flux to the Gulf can be largely explained by three factors: Increased fertilizer use, annual variability in precipitation and increased streamflow, and the year-to-year variability in the amount of nitrogen available in the soil-ground water system for leaching to streams. The predominant source areas for the nitrogen transported to the Gulf of Mexico are basins draining southern Minnesota, Iowa, Illinois, Indiana, and Ohio. Basins in this region yield 1801 to 3050 kg N km-2 year-1 to streams, several times the N yield of basins outside this region.

Rowland MA. The evolution of water resource management systems: case studies of the Tampa Bay region of Florida and Baton Rouge area of Louisiana, 2000.

Water quality in the Mississippi Embayment: Mississippi, Louisiana, Arkansas, Missouri, Tennessee and Kentucky. US Geological Survey Circular 2000(1208):1-29.

This report summarises major findings about water quality in the Mississippi Embayment that emerged from an assessment conducted between 1995 and 1998 by the USGS National Water Quality Assesment Program. Water quality is discussed in terms of local and regional issues and compared to conditions in all 36 NAWQA study areas assessed to date. Findings are also explained in terms of selected national benchmarks, such as those for drinking water and the protection of aquatic organisms.

Valsaraj KT, Kommalapati RR, Robertson ED, Constant WD. Partition constants and adsorption/desorption hysteresis for volatile organic compounds on soil from a Louisiana Superfund site. Environmental Monitoring and Assessment 1999;58(2):225-41.

The adsorption of four volatile organic compounds (1,4-dichlorobenzene, 1,2-dichloroethane, 1,2,2-trichloroethane and 1,1,2,2,-tetrachloroethane) on three soil types from a Superfund site (Petroprocessors Inc) in Baton Rouge, LA was studied with the purpose of obtaining an overall correlation for inclusion in a groundwater transport model being developed for site remediation. The soil-water partition constant, K(d) was determined using a standard ASTM procedure (E-1195-87). Using the data for different soil types (fraction organic carbon between 0.11% and 1.13%) and different mineral surface areas (7 to 45 m2/g), the organic carbon contribution (K(oc)) and the mineral matter contribution (K(min)) to the partition constant were determined. The soils obtained were either from the Pleistocene period or recent shallow deposits at the site. Both log K(oc) and log K(min) were linearly correlated to log K(ow), the octanol-water partition constant. This data provided the basis for obtaining a general correlation for K(d) on different soil types at the site. The predicted values were in agreement with that for a composite soil from the same site. The desorption of compounds from the high clay soil after the 24 hour adsorption period was observed to show a biphasic behavior, namely, an easily desorbed fraction and a desorption resistant fraction. The easily desorbed fraction was found to be satisfactorily predicted using the conventional K(d) as obtained from the adsorption experiment. The slowly desorbing fraction had a time constant of several weeks. The concentration in the desorption resistant compartment was found to be dependant on the initial amount of contaminant available for adsorption. The aqueous phase concentration in equilibrium with the desorption resistant fraction was found to be ~ 8 Î¼g/L for dichlorobenzene and ~ 12 Î¼g/L for dichloroethane. The adsorption of volatile organic compounds on three soil types from a Superfund site

was determined to obtain an overall correlation for inclusion in a groundwater transport model developed for site remediation. The desorption of compounds from the high clay soil after the 24-hour adsorption period showed biphasic behaviors, namely, an easily desorbed-fraction and a desorption-resistant fraction. The concentration in the desorption-resistant compartment was dependent on the initial amount of contaminant available for adsorption.

Martin Jr A, Whiteman Jr CD. Hydrology of the coastal lowlands aquifer system in parts of Alabama, Florida, Louisiana, and Mississippi. US Geological Survey Professional Paper 1999(1416 H).

The coastal lowlands aquifer system of Louisiana, Mississippi, Alabama, and Florida consists of alternating beds of sand, gravel, silt, and clay of late Oligocene age and younger in off-lapping, coastward-thickening wedges of sediment deposited under fluvial, deltaic, and marine conditions. The sediments are highly heterogeneous. Individual sand beds generally are not traceable for more than a few miles. This study is limited to that part of the aquifer system containing water with 10,000 milligrams per liter or less dissolved solids. Thickness of the studied part of the aquifer system ranges from a featheredge along the updip edges of the system to more than 4,000 feet in southeastern Louisiana. Sand content of the aquifer system ranges from less than 10 to greater than 80 percent, and total sand thickness exceeds 2,000 feet in southeastern Louisiana and southern Mississippi. The coastal lowlands aquifer system was divided into five overlapping regional permeable zones, A through E, to quantify flow in the aquifer system. The permeable zones were defined on the basis of water-level data from heavily pumped areas. From youngest to oldest the zones are the Holocene-upper Pleistocene deposits (zone A), lower Pleistocene-upper Pliocene deposits (zone B), lower Pliocene-upper Miocene deposits (zone C), middle Miocene deposits (zone D), and the lower Miocene-upper Oligocene deposits (zone E). Prior to development, flow in the aquifer system was primarily from upland outcrop areas in southwestern Mississippi and central and southeastern Louisiana toward lowlands along the coast and in the major river valleys. Results of simulations of flow in the aquifer system using a six-layer finite-difference flow model indicate that pumpage has significantly altered the natural ground-water flow system. Pumpage from the aquifer system for all uses peaked in 1980 at about 251 million cubic feet per day (1,874 million gallons per day), then declined to about 211 million cubic feet per day (1,579 million gallons per day) by 1985. The total flow circulating within the aquifer system in 1987, about 354 million cubic feet per day, is about 62 percent greater than the predevelopment flow of 222 million cubic feet per day. A large part of the low-lying coastal area has been transformed from areas of natural discharge to areas of recharge. Throughout much of the Coastal Plain, flow directions have been altered and flow converges toward pumping centers. Simulations of ground-water flow indicate that the aquifer system was near steady state in 1987, so pumpage could be continued indefinitely at the 1983-87 rate of about 1,600 million gallons per day. Results of modeling experiments conducted to evaluate the effects of future ground-water pumpage from the coastal lowlands aquifer system show that pumping at a rate 50 percent greater than the 1983-87 rate would be feasible. The upper permeable zones and the outcrop areas of the lower zones, in general, would be most favorable for intensive development based on projected drawdowns of water levels. Development of a major pumping center near the downdip limit of a permeable zone would entail risk of saltwater encroachment.

Aquifer systems and recharge potential in Louisiana from LDEQ source data, Geographic NAD83, LOSCO (1999) [aqrgeog3dpdeq]. Louisiana Oil Spill Coordinator's Office, 1999.

This is polygon dataset depicting the boundaries of aquifer systems in the state of Louisiana. These aquifers have been classified for recharge potential from 'none' to 'high.' The dataset was developed by digitizing maps of the 'State Aquifer Recharge Map and Atlas Plates.' A description and explanation of the maps of that atlas and the aquifer systems named in this data set are contained in the following report: 'Donovan Boniol, Whitney J. Auten, and Bradford C. Hanson, "Recharge Potential of Louisiana Aquifers: A Supplement to the State Aquifer Recharge Map and Atlas Plates," Louisiana Geological Survey Open File Series No. 88-07.'
Recharge potential of Louisiana aquifers, geographic NAD27, LDEQ (1999). Louisiana Dept. of Environmental Quality, 1999.

This is a polygon dataset depicting the boundaries of aquifer systems in the state of Louisiana and adjacent areas of Texas, Arkansas and a portion of Mississippi. These aquifers have been classified for recharge potential frm 'none' to 'high.' The data set was developed by digitizing maps of the 'State Aquifer Recharge Map and Atlas Plates.' A description and explanation of the maps of that atlas and the aquifer systems named in this data set are contained in 'Donovan Boniol, Whitney J. Autin, and Bradford C. Hanson, "Recharge Potential of Louisiana A Supplement to the State Aquifer Recharge Map and Atlas Plates," Louisiana Geological Survey Open File Series No. 88-07.'

Griffin Jr DM, Bhattarai RR, Xiang H. The effect of temperature on biochemical oxygen demand removal in a subsurface flow wetland. Water Environment Research 1999;71(4):475-82.

Investigators have reported that seasonal variation in wastewater temperature has little or no effect on biochemical oxygen demand (BOD) removal in subsurface flow wetlands (also referred to as rock-plant filters). This study examined temperature and BOD data collected biweekly (every 2 weeks) over an 18-month period from a rock-plant filter treating high- strength wastewater (median pump station discharge BOD = 425 mg/L) at an interstate highway rest area in south central Louisiana. Results show a seasonal variation in effluent BOD with greater mean removal occurring when wastewater temperature in the splitter box is greater than 20 °C, whereas removal at wastewater temperature less than 20 °C exhibits a wider variation and lower mean. An exponential model relating splitter box temperature to effluent BOD concentration, R2 = 0.69, fits the data only slightly better than an Arrhenius type relationship, R2 = 0.67. Both models suggest that two cells in series may be required for this facility to meet its BOD permit limit in colder weather. A linear model relating percent of BOD removed to splitter box temperature did not fit data as well (R2 = 0.50).

Collins Iii WH, Easley DH. Fresh-water lens formation in an unconfined barrier-island aquifer. Journal of the American Water Resources Association 1999;35(1):1-21.

Cone-penetrometer testing and computer modeling were utilized to investigate factors controlling fresh-water lens formation at Grand Isle, Louisiana. Measurements of tip resistance, sleeve friction, and electrical conductivity were recorded with depth to permit classification of sediment type and to determine thickness of the fresh-water lens and transition zone. Cone-penetrometer testing provided virtually continuous determinations of change in sediment type and ground-water salinity at a resolution rarely achieved using conventional drilling and water sampling techniques. Three sand bodies are present, each separated by a clay layer. The fresh-water lens is thinner in the center of the island than on the flanks. Fresh-water lens thickness is limited by a clay layer which prohibits downward movement of significant volumes fresh water. The transition zone from fresh water to salt water varies in thickness, being thinnest near the Gulf of Mexico and thickest where silt and clay interfinger with the upper sand. Both the thickness of the fresh-water lens and the shape of the transition zone differ from that predicted by theoretical models. Calibration of SUTRA, a variable-density solute-transport model, indicates that permeability variations are the dominant control on formation of the fresh-water lens. Cane-penetrometer testing and computer modeling were utilized to investigate factors controlling fresh-water lens formation at Grand Isle, Louisiana. Measurements of tip resistance, sleeve friction, and electrical conductivity were recorded with depth to permit classification of sediment type and to determine thickness of the fresh-water lens and transition zone. Cone-penetrometer testing provided virtually continuous determinations of change in sediment type and ground-water salinity at a resolution rarely achieved using conventional drilling and water sampling techniques. Three sand bodies are present, each separated by a clay layer. The fresh-water lens is thinner in the center of the island than on the flanks. Fresh-water lens thickness is limited by a clay layer which prohibits downward movement of significant volumes fresh water. The transition zone from fresh water to salt water varies in thickness, being thinnest near the Gulf of Mexico and thickest where silt and clay interfinger with the upper sand. Both the thickness of the fresh-water lens and the shape of the transition zone differ from that predicted by theoretical models. Calibration of SUTRA, a variable-density solute-transport model, indicates that permeability variations are the dominant control on formation of the fresh-water lens.

Carbonell AA, Pulido R, DeLaune RD, Patrick Jr WH. Soluble barium in barite and phosphogypsum amended Mississippi River alluvial sediment. Journal of Environmental Quality 1999;28(1):316-21.

Barite (BaSO4), a density control material used in petroleum drilling fluids, can enter coastal and wetland environments. Because of its low solubility, it has been generally concluded that barium (Ba) will not leach into groundwater supplies, nor will it be taken up in significant quantities by plants and aquatic organisms. Such conclusions were mainly based on experiments conducted at neutral pH values and under oxidized conditions. The influence of pH and redox potential (Eh) on solubility of Ba from barite and phosphogypsum (PG) in Louisiana Mississippi River alluvial sediment was examined. Sediment suspensions containing barite or PG were incubated under oxidized and reduced conditions at pH 8, 7, 6, 5, and 4. The amount of Ba in solution at each combination (Eh-pH) was measured. Results demonstrated that a combination of low pH and highly anaerobic conditions resulted in a release of Ba to the sediment solution. If low pH and anaerobic environment happen simultaneously, barite can account for significant levels of dissolved Ba entering the environment. In this study, approximately 4.4% of the total native Ba present in Louisiana Mississippi River alluvial sediment was converted to a soluble form under acidic and anaerobic conditions, compared to approximately 0.3% under alkaline and either anaerobic or aerobic conditions. Phosphogypsum application to the sediment significantly reduced the level of soluble Ba compared to control sediments, this was attributed to Ba precipitation as insoluble sulfates or sulfides under oxidized and reduced conditions.

Walters DJ, Lovelace WM, Geological S, Louisiana. Dept. of Transportation and D. Ground-water-quality data for east and west Baton Rouge, east and west Feliciana, and Pointe Coupee Parishes, Louisiana, water years 1944-97. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 1998.

Tomaszewski DJ, Louisiana. Dept. of Transportation and D, Geological S. Hydrogeology and the effects of pumpage on the "1,500-foot" sand south of the Baton Rouge Fault, near Brusly, Louisiana, 1996. Baton Rouge, La.: Louisiana Dept. of Transportation, 1998.

Kleka GM, Carpenter CL, Gonsior SJ. Biological transformations of 1,2-dichloroethane in subsurface soils and groundwater. Journal of Contaminant Hydrology 1998;34(1-2):139-54.

The ability of naturally occurring microorganisms to biodegrade 1,2-dichloroethane was examined in soil/water microcosms prepared using aquifer material obtained from manufacturing sites in Louisiana and Texas with known histories of exposure to the compound, as well as in aquifer samples taken from a site in Oklahoma with no known history of 1,2-dichloroethane contamination. Biotransformation of 1,2-dichloroethane was noted under methanogenic or sulfate reducing conditions in all samples. Under anaerobic conditions, 1,2-dichloroethane was transformed to ethylene in a single step via reductive dihaloelimination. No other metabolites were detected in the reaction mixtures. Microbial adaptation appeared to be required for biotransformation of 1,2-dichloroethane. Lag periods ranging from 7 to 8 weeks preceded degradation in microcosms prepared with aquifer material from the Texas and Oklahoma sites. In contrast, no lag period was evident prior to biotransformation in microcosms prepared from the Louisiana manufacturing site, which is consistent with field evidence for natural biological attenuation in situ based on analysis of the groundwater chemistry. Aerobic biodegradation of 1,2-dichloroethane to carbon dioxide was also observed after 13 weeks in aquifer material from the Louisiana site, but was not evident in samples from the Texas or Oklahoma sites following 18 weeks of incubation. The ability of naturally occurring microorganisms to degrade 1,2-dichloroethane has bearing on assessments of the fate and lifetime of the compound in the environment, as well as having potential application in the remediation of contaminated groundwater. Copyright (C) 1998 Elsevier Science B.V.

Kim JH, Feagley SE. Adsorption and leaching of trifluralin, metolachlor, and metribuzin in a commerce soil. Journal of Environmental Science and Health - Part B Pesticides, Food Contaminants, and Agricultural Wastes 1998;33(5):529-46.

Trifluralin [2,6-dinitro-N,N-dipropyl-4-(trifluoromethyl)benzenamine], metolachlor [2-chloro-N-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) aceta mide], and metribuzin [4-amino-6-(1,1-dimethylethyl)-3-

(methylthio)- l,2,4, -triazin -5(4H)-one] were selected to study adsorption and leaching potentials related to pollution on Commerce silty clay loam soil near Baton Rouge, Louisiana. At a 1:10 soil/water ratio, the Koc values for trifluralin, metolachlor and metribuzin were 875, 135, and 96, respectively. Leaching of these herbicides was evaluated in soil columns (5.4 cm i.d. x 26 cm long). Total recoveries of the herbicides applied to the soil column were 73.1% ± 4.1%. When the soil columns were leached with three pore volumes of water, the distributions of trifluralin in soil and leachate were 99.993% and 0.007% of the total recoveries, respectively. The distributions of metolachlor was 65.27% in soil and 34.7 % in leachate. The distributions of metribuzin was 11.42% in soil and 88.58% in leachate. The results showed that metolachlor and metribuzin were readily leached, while trifluralin was strongly adsorbed to soil. Leaching of three herbicides in the soil column followed the leaching trends of their calculated leaching indices 1.41 x 104, 4.18 x 106, and 3.38 x l08 for trifluralin, metolachlor, and metribuzin, respectively. The results of the study demonstrated the potential of pollution for metolachlor and metribuzin to be leached into the ground water in soils with shallow aquifer.

Grubb HF. Summary of hydrology of the regional aquifer systems, Gulf Coastal Plain, south-central United States. US Geological Survey Professional Paper 1998(1416 A).

The gulf coast of regional aquifer system consists of regional aquifers in sediments of mostly Cenozoic age in an area of about 230,000 square miles in the Gulf Costal Plain of Alabama, Arkansas, Florida, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Tennessee, and Texas and an additional 60,000 square miles offshore. Three aquifer systems (the Mississippi embayment, Texas coastal uplands, and coastal lowlands) have been divided into six regional aquifers and five permeable zones. The aquifers and permeable zones range in areal extent from about 32,000 to 170,000 square miles and typically thicken from their outcrop area toward the Gulf of Mexico or toward the axes of major embayments. The average thickness of aquifers and permeable zones ranges from 140 to 2,010 feet. Horizontal hydraulic conductivity of aquifers and permeable zones ranges from about 20 to 315 feet per day. Water in the gulf coast aquifer systems is generally fresh [less than 1,000 milligrams per liter (mg/L) dissolved solids] in and near outcrop areas of the permeable zones and aquifers. Dissolved-solids concentrations in water from all aquifers and permeable zones generally increase toward the Gulf of Mexico and toward principal discharge areas; concentrations typically increase from 10,000 to 35,000 mg/L over distances of 10 to 40 miles. In the deeper parts of the permeable zones and aquifers, the dissolved-solids concentrations typically exceed that of seawater by as much as a factor of 2. The dominant water type in and near aquifer outcrop areas typically is calcium bicarbonate or a mixture of calcium bicarbonate and sodium bicarbonate. The water type is dominantly sodium bicarbonate in middip areas of the acquifers. The dominant water type typically is sodium chloride near the downdip limit of the aquifers and permeable zones. A variety of geochemical processes contribute to the water chemistry in the gulf coast aquifer systems. The major postulated processes are (1) leaching of soluble salts from the unsaturated zone; (2) alteration of albite; (3) cation exchange; (4) mixing of water by the vertical flow of water from underlying units; and (5) the dissolution of halite from salt diapirs. Simulation of regional ground-water flow (excludes local flow and several miles or less) indicates that regional ground-water flow prior to withdrawal of ground water (predevelopment) generally was from areas of high water-level altitude toward major rivers or broad extensive areas at low land-surface altitude. Of a total 2,900 million gallons per day (Mgal/d) of simulated predevelopment recharge, the most to a single aquifer was to the Mississippi River Valley alluvial aquifer (830 Mgal/d) and the least was to the lower Wilcox aquifer (14 Mgal/d). The largest discharge was also to the Mississippi River Valley alluvial aquifer (about 1,200 Mgal/d) and the smallest was also to the lower Wilcox aquifer (12 Mgal/d). Net vertical flows ranged from less than 1 Mgal/d between the lower Wilcox aquifer and the middle Wilcox aquifer to about 300 Mgal/d between permeable zone B. There is potential for further development of ground-water supplies in the Gulf Coastal Plain because of the abundance of water in streams, lakes, and swamps and the generally good hydraulic connection between the water table and underlying water-yielding units. The aquifer systems have the potential to support additional withdrawals of as much as 10,000 Mgal/d if pumping centers are carefully located. The most favorable conditions for further development of groundwater supplies are generally in the upper permeable zones and aquifers, and the potential for development typically increases from west to east.

Doser LS, Ferrell Jr RE, Longstaffe FJ, Walthall PM. Fluid flow through clayey soils: Stable isotope and mineralogical evidence. Clay Minerals 1998;33(1):43-9.

The evaluation of clays as barriers to fluid movement can be improved by geochemical methods that provide ways to examine the reactivity and weathering of minerals in soils and sediments. X-ray radiography, X-ray powder diffraction, and stable isotope geochemistry provide new data from field locations in the Mississippi River Delta of Louisiana indicating that the clays are not effective barriers to the vertical migration of fluids in the shallow subsurface. Systematic changes in the mineral assemblages, the soil structure and the Î´D and Î´18O values of fine clay fractions can best be explained by an alteration sequence produced as the originally smectiterich clay mineral assemblage was kaolinized by percolating groundwater.

Willis GH, Southwick LM, Fouss JL, Carter CE, Rogers JS. Nitrate losses in runoff and subsurface drain effluent from controlled- water-table plots. Bulletin of Environmental Contamination and Toxicology 1997;58(4):566-73.

Stoessell RK. Delineating the chemical composition of the salinity source for saline ground waters: An example from east-central Concordia Parish, Louisiana. Ground Water 1997;35(3):409-17.

In the absence of significant water-rock interaction, the chemical composition of a saline brine polluting a ground-water aquifer can be delineated from conservative-mixing relations. An example is the Mississippi River Alluvium Aquifer, within Angelina Plantation in east-central Concordia Parish, Louisiana, which has high ground-water salinities, of unknown origin. Chloride concentrations are linearly correlated with concentrations of major cations and with bromide and iodide. These relationships are consistent with mixing of fresh water with a saline source of either a single brine or multiple brines of similar composition and with a lack of significant water-rock interactions in the ground water during and after mixing. The saline source has the following predicted mass ratios for a brine containing 80,000 ppm Cl: Na/Cl, 0.58; Br/Cl, 0.0013; I/Cl, 0.00028; Sr/Cl, 0.0026; K/Cl, 0.0035; CaCl, 0.035; and Mg/Cl, 0.0080. The predicted 87Sr/86Sr ratio is 0.70805. The mass ratios fall within the range of Tertiary oil-field brines in the Louisiana Gulf Coast. The major reservoir for hydrocarbon production in the area is the Wilcox Formation; however, the 'predicted' source brine is unlikely to be a 'pure' Wilcox brine from Concordia Parish. Ratios of 87Sr/86Sr are usually lower and bromide, iodide, and calcium concentrations are always lower in the Wilcox brines than predicted in the saline source.

Megonigal JP, Conner WH, Kroeger S, Sharitz RR. Aboveground production in Southeastern floodplain forests: A test of the subsidy-stress hypothesis. Ecology 1997;78(2):370-84.

It has been hypothesized that periodically flooded forests have higher rates of aboveground net primary production than upland forests and near-continuously flooded forests, but a competing hypothesis holds that the benefits of periodic inputs of nutrients and water may be diminished by stresses associated with anaerobic soils or drought. To test these hypotheses, we measured groundwater table depths and aboveground productivity in floodplain forests of South Carolina and Louisiana. We established paired plots on locally dry, intermediate, and wet topographic positions across three hydrologic transects in each state. These plots encompassed upland hardwood, bottomland hardwood, and cypress swamp forests. Measurements of leaf litterfall, wood production, and groundwater table depth were made in 1987 and 1988. We then used mean growing-season water depth (MWD) to group the plots into three classes: wet (>0 cm), intermediate (0 to -60 cm), and dry (<-60 cm). Aboveground net primary production (NPP) on wet plots (2-yr mean ± 1 SD = 675 ± 271 g·m-2·yr-1) was significantly lower than on intermediate and dry plots (P ‰¤ 0.02). There was no significant difference between intermediate and dry plots (107 ± 189 and 1038 ± 91) g·m-2·yr-1, respectively). In addition, aboveground NPP on intermediate plots was not significantly different from 22 temperate upland forests in the literature. Combining our data with data from the literature, we found that aboveground NPP on wet plots was negatively related to MWD with a slope of -5 g·m-2·yr-1·cm-1. On sites with evidence of hydrologic disturbance (>25% dead stems) the

slope of this line was 5 times greater (-24 g·m-2·yr-1·cm-1). We conclude that the subsidy-stress hypothesis does not adequately describe patterns of NPP across Southeastern U.S. floodplain forests. Conditions of periodic flooding and flowing water do not often lead to high rates of productivity compared with upland forests. However, extensive flooding is nearly always a significant stress on forest productivity, particularly when the flooding regime has been recently perturbed through levee construction or impoundment. Our data support a more complex interaction between subsidy and stress factors.

Boman GK, Molz FJ, Boone KD. Borehole flowmeter application in fluvial sediments: Methodology, results, and assessment. Ground Water 1997;35(3):443-50.

In many situations, inadequate design or performance of ground-water remediation systems is the result of underestimation of aquifer hydraulic heterogeneity, and in particular, the vertical variation of hydraulic conductivity which plays an important role in contaminant migration. Described herein are applications of the electromagnetic (EM) borehole flowmeter to fluvial sediments in Louisiana and South Carolina. The direction of natural vertical flow in the test aquifers was defined easily, and short pumping tests enabled the calculation of hydraulic conductivity profiles for each test well. The results correlated well with other information obtained independently, including natural gamma logs, driller's logs and a hydraulic conductivity profile based on grain size analysis. Large variations in hydraulic conductivity over short vertical and horizontal distances were documented. Tests in gravel-packed wells suggested that flowmeters produce misleading data for a variety of reasons in such situations. Among other things, an annulus of high permeability around a well screen allows flow to bypass the meter, and the phenomenon is amplified by high pumping rates. The resulting error is displayed as an erroneous high permeability zone at the top of the well screen. This observation deserves further study. In its present form the EM flowmeter is awkward to handle on a routine basis. However, none of the present design flaws preclude its effective use.

Bauer SJ, Ehgartner BL, Neal JT. Geotechnical studies associated with decommissioning the strategic petroleum reserve facility at Weeks Island, Louisiana: a case study. International journal of rock mechanics and mining sciences & geomechanics abstracts 1997;34(3-4):643.

The first sinkhole at the Weeks Island Strategic Petroleum Reserve (SPR) site was initially observed in May 1992. Concurrent with the increasing dissolution of salt over the mined oil storage area below, it has gradually enlarged and deepened. Beginning in 1994 and continuing to the present, the injection of saturated brine directly into the sinkhole throat some 76 m beneath the ground surface essentially arrested further dissolution, providing time to make adequate preparation for the safe and orderly transfer of crude oil to other storage facilities. This mitigation measure marked the first time that such a control procedure has been used in salt mining; previously all control has been achieved by either in-mine or from-surface grouting. A second and much smaller sinkhole was noticed in early 1995 on an opposite edge of the SPR mine, but with a very similar geological and mine mechanics setting. Both sinkholes occur where the edges of upper 152 m and lower 213 m mined storage levels are nearly vertically aligned. Such coincidence maximizes the tensional stress development, leading to fracturing in the salt. This cracking takes 20 or more years to develop. The cracks then become flow paths for brine incursion, which after time progress into the mined openings. Undersaturated ground water gradually enlarges the cracks in salt through dissolution, leading to eventual collapse of the overlying sand to form sinkholes. Other geologic conditions may also be secondary factors in controlling both mining extent and sinkhole location.

Walters DJ, Louisiana. Dept. of Transportation and Development. Water Resources S, Geological S, United States. Dept. of the I. Louisiana ground-water map no. 10: potentiometric surface, 1991, and water-level changes, 1985-91, of the Chicot aquifer system in southwestern Louisiana. Baton Rouge, La.: U.S. Geological Survey 1996.

Louisiana Underground Storage Tank Division. Ground water monitoring and reporting: guidance document. Baton Rouge, La.: Office of Solid Waste, 1996.

Lin G. Groundwater flow with heat and solute transport in sedimentary basins; 1996.

Jin P, Barber ME. Numerical modeling of deep well injection near a fault. In: Geotechnical Special Publication; 1996; 1996. p. 912-26.

Variable density industrial wastewater has been injected into a permeable part of the Upper Miocene injection aquifers near Geismar, Louisiana since 1971. The so called `R-1' sand aquifer is the shallowest injection sand aquifer in the Geismar area and therefore represents the primary exposure risk to Underground Source of Drinking Water (USDW) supplies. Using E-log recorded at some 400 well locations, a regional East-West trending fault has been located in the southern part of the study area. The migration of injected wastewater in the `R-1' sand aquifer and the possibility of wastewater migration upward along the fault are particular concern in this paper. Mass transport simulations were performed by modeling two simulation scenarios: the `R-1' sand modeling without the fault and the `R-1' sand modeling with the fault. Four cases were run in the first scenario to investigate the effects of variable density wastewater and groundwater flow velocity on the simulated plume position and to estimate the extent of lateral wastewater migration during the 10,000 years of post-operational period. The fault was modeled in the second scenario by running other four cases. These modeling results indicated that the fault represented a serious exposure pathway for wastewater if the fault acted as a vertical conduit.

Aslan A, Autin WJ. Depositional and pedogenic influences on the environmental geology of Holocene Mississippi River floodplain deposits near Ferriday, Louisiana. Engineering Geology 1996;45(1-4):417-32.

Core descriptions and the mineralogy of Holocene Mississippi River floodplain deposits in Louisiana provide insights on fluid migration pathways and the origin of iron-rich ground waters in the Mississippi River Alluvial Aquifer (MRAA). Vertical changes in the sedimentologic and pedologic characteristics of floodplain deposits near Ferriday, Louisiana, provide evidence for two stages of floodplain development and suggest that depositional processes and drainage conditions changed substantially during the Holocene. Depositional and pedogenic processes produced complex fluid migration pathways in the MRAA confining unit and also contributed to the formation of iron-rich ground waters. Lower Holocene deposits in the study area are older than ˆ¼ 5000 yrs BP and show evidence of crevassing, lacustrine delta building, and multi-channel stream deposition. These processes deposited thin and narrow sheet sands, which represent fluid migration pathways in the MRAA confining unit. Poor drainage conditions during this initial stage of floodplain development also favored the precipitation of authigenic siderite and pyrite in poorly-drained swamps and shallow lakes. The pyrite and siderite probably represent the source of iron-rich ground waters in the MRAA. Upper Holocene floodplain deposits are younger than ˆ¼ 5000 yrs BP and represent the transition to the present-day meandering regime of the Mississippi River near Ferriday. This second stage of floodplain development was accompanied by pedogenesis, which produced slickensides in clayey backswamp soils. The abundance of slickensides and the presence of the thin and narrow sheet sands indicates that fluid migration in the MRAA confining unit near Ferriday is greater than generally recognized. Seasonal water table fluctuations and the mixing of oxygenated meteoric and reduced ground waters cause iron oxide reduction and pyrite oxidation in backswamp settings, which releases iron into solution. The presence of high (up to 16 mg/1) dissolved iron concentrations in water wells that are screened beneath pyrite-and siderite-rich, muddy backswamp deposits near Ferriday, suggests that the distribution of fine-grained alluvium is a primary control on the presence of iron-rich waters in the MRAA. In contrast, water wells that are screened in sandy meander belt deposits, which lack abundant iron-bearing minerals, have low (less than 1 mg/1) concentrations of total dissolved iron. Studies of large floodplains such as the Mississippi River, highlight the importance of floodplain histories for evaluating geologic influences on water quality, developing proper floodplain land use strategies, and for improving our understanding of the environmental geology of floodplain systems.

Ackerman DJ. Hydrology of the Mississippi River Valley alluvial aquifer, South-central United States. US Geological Survey Professional Paper 1996(1416 D).

A quantitative analysis of the regional ground-water flow in the Mississippi River Valley alluvial aquifer was made using observations of changes in water levels and simulation (computer modeling) of aquifer response between 1906 and 1987. The analysis includes an evaluation of the effects of additional ground-water development on the flow system. The boundary of the computer model and of the study area correspond to the physical limits of the Mississippi River Valley alluvial aquifer except that the southern limit is designated where the alluvial aquifer crosses the sub-crop of the top of the Vicksburg-Jackson confining unit. The Mississippi River Valley alluvial aquifer underlies a vast low, flat plain that extends from the apex of the Mississippi embayment southward to the Gulf of Mexico and is the upper aquifer of the Mississippi embayment aquifer system. The aquifer consists of 60 to 140 feet of Quaternary sand and gravel that grades from gravel at the bottom to fine sand near the top, and underlies 32,000 square miles in parts of Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee. The alluvial aquifer is in hydraulic connection with many rivers and drains. Hydraulic conductivity of the aquifer is about 200 feet per day, and storage coefficients vary from 0.0001 to 0.30 for confined and unconfined conditions, respectively. Throughout most of the area the alluvial aquifer is overlain by the Mississippi River Valley confining unit - 10 to 50 feet of silt, clay, and fine-grained sand. It is underlain by the less permeable aquifers and confining units of the Mississippi embayment aquifer system, the McNairy-Nacatoch aquifer, and undifferentiated Paleozoic rocks. Predevelopment flow (prior to large pumpage) in the Mississippi River Valley alluvial aquifer consisted of inflow through the overlying Mississippi River Valley confining unit, inflow from underlying aquifers, and outflow to rivers. Most inflow, about 74 percent, was through the confining unit at an average net rate of 0.8 inch per year. Individual areas differed in the relative contribution from underlying units. The simulated predevelopment potentiometric surface shows movement down the Mississippi River Valley and following the slope of land surface toward major rivers near the axes of the St. Francis, White, Arkansas, Yazoo, and Boeuf basins. Development of the Mississippi River Valley alluvial aquifer started in the early 1900's in central Arkansas, and water use has been primarily for agriculture, particularly the irrigation of rice. Large withdrawals in other areas generally began about 1950. The largest increases in withdrawals occurred in all areas between 1973 and 1982. Maximum withdrawals before 1988 are estimated at 7,800 cubic feet per second (5,000 million gallons per day). Pumpage from the alluvial aquifer has caused a decrease in outflow to rivers, an increase fo inflow from rivers, and an increase of inflow through the overlying Mississippi River Valley confining unit. In some areas the decrease in outflow to rivers and increase in inflow have not been sufficient to meet the demands of pumpage. The long-term excess of pumpage over net inflow has resulted in regional declines in water levels, reduction of water in storage, and decreases to well yields fer some parts of the aquifer. The response of water levels in the alluvial aquifer to pumpage has followed the temporal and areal trend of development. Water levels in the Mississippi River Valley alluvial aquifer has shown long-term drawdown of as much as 90 feet. Only parts of the aquifer north of the Arkansas River and west of Crowleys Ridge show appreciable decreases in saturated thickness. Decreases in saturated thickness through 1982 generally were 20 to 60 feet. Only the area between the Arkansas and White Rivers, where saturated thickness has decreased to less than 50 feet, may be considered to be in danger of being depleted for rice irrigation. Parts of the aquifer north of the Arkansas River and west of Crowleys Ridge, where saturated thickness has decreas d to less than 75 feet throughout large areas, may be considered as not currently in danger but trending toward depletion. One percent or less of all other areas underlain by the aquifer has a decrease in saturated thickness to less than 75 feet. In some areas the direction of flow has changed compared to the predevelopment flow system. Two areas north of the Arkansas River and west of Crowleys Ridge have large depressions in the potentiometric surface and pronounced changes in the direction of flow. Pumpage has not resulted in large-scale regional changes in direction of flow in other areas underlain by the aquifer. Most of the aquifer has only a general lowering of 5 to 15 feet in the potentiometric surface. The contours of the potentiomethc head have shifted upgradient (usually north), indicating an even lowering of the potentiometric surface, resulting in only minor or local changes in direction of flow. Regional flow in the Mississippi River Valley alluvial aquifer has steadily changed since large-scale pumpage began in the early 1900's. By the mid-1970's rivers became a source of more than 30 percent of total flow rather than the sink of net outflow as they were during predevelopment. Inflow through the Mississippi River Valley confining unit increased from a rate of 0.8 inch per year for predevelopment to 1.3 inches per year by

1982. Net inflow from underlying aquifers has varied slightly in amount but has decreased as a proportion of total flow. The alluvial aquifer has had continuous net losses of storage representing about 10 to 25 percent of pumpage. Current rates of loss of water from storage range from 1 to 8 inches per year in the Grand Prairie area, from 5 to 14 inches per year in parts of the Cache area, and are generally less than 1 inch per year elsewhere. To assess response of the regional flow system to continued development and to evaluate the potential of the aquifer to support additional development, two flow-model simulations were made to the year 2022. The effect of continued or increased development and the ability to support development were evaluated by the change in head in the aquifer and decreases in saturated thickness. Simulation results after 40 years of pumping at 1985 rates indicated a moderate effect (a decrease to less than 75 feet of saturated thickness) in the area north of the Arkansas River and west of Crowleys Ridge. Some parts of this area were unable to sustain current development (a decrease to less than 25 feet of saturated thickness). Simulation of additional pumpage over all the aquifer at the rate of 12 million gallons per day per 25-square-mile area above 1985 rates for 35 years resulted in a severe effect (less than 50 feet of remaining saturated thickness) for most of the area between the Arkansas and White Rivers and a large part of the area immediately west of Crowleys Ridge. Drawdowns from 1982 conditions were greater than 10 feet in small scattered locations throughout the rest of the area. None of these small areas coincided with decreases in saturated thickness to less than 70 feet for an area greater than 25 square miles. The areas with greatest potential for development of additional pumpage are in the central part of the delta (northwestern Mississippi), the northern part of the area east of Crowleys Ridge (south-east Missouri), and small parts of the area south of the Arkansas River. These areas coincide with thick parts of the aquifer except where drawdown in excess of 10 feet is indicated. In general, areas with more than 100 feet of saturated thickness have the greatest potential for further development of ground water. However, other areas where additional inflow can be induiced probably will be able to support additional pumpage with less saturated thickness. Sustained yields from the Mississippi River Valley alluvial aquifer are historically greatest where inflow is induced from larger rivers and, to a limited extent, through the Mississippi River Valley confining unit. Therefore, locations where rivers are near and in good hydraulic connection with the alluvial aquifer or locations where would have the greatest potential for further development. Conversely, locations distant from areas where inflow could be induced have less potential for development even if saturated thickness is great. Predevelopment saturated thickness was more than 100 feet in the area west of Crowleys Ridge and less than 75 feet in the center of the area between the Arkansas and White Rivers. The additional saturated thickness in the area west of Crowleys Ridge is apparently only delaying an inevitable decrease in yield and reduction in use.

Xue SK, Iskandar IK, Selim HM. Adsorption-desorption of 2,4,6-trinitrotoluene and hexahydro-1,3,5-trinitro-1,3,5-triazine in soils. Soil Science 1995;160(5):317-27.

Walters DJ, Geological S, Louisiana. Dept. of Transportation and Development. Water Resources S. Louisiana ground-water map no. 11, potentiometric surface, Spring, 1993, and water-level changes, 1987-93, of the Gonzales-New Orleans Aquifer in southeastern Louisiana. Baton Rouge, La.: Denver, CO: Geological Survey, 1995.

Tomaszewski DJ, Anderson ML, Louisiana. Dept. of Transportation and Development. Water Resources S, Capital Area Ground Water Conservation C, Geological S. Data from wells in a chloride monitoring network, Baton Rouge area, Louisiana, 1965-94. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 1995.

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Poulson SR, Ohmoto H, Ross TP. Stable isotope geochemistry of waters and gases (CO2, CH4) from the overpressured Morganza and Moore-Sams fields, Louisiana Gulf Coast. Applied Geochemistry 1995;10(4):407-17.

Oxygen isotope analyses of water, and carbon isotope analyses of dissolved inorganic carbon (DIC), CO2(g), and CH4(g) have been performed on samples from normal and overpressured horizons in the Louisiana Gulf Coast.Î´18OSMOW values of the waters range from -2.2 to +8.7%. Consideration of theÎ´18O values, the chemical composition of the waters, and the water and gas production values indicate that mixing with a low salinity, isotopically light water has taken place. Mixing lines suggest that the isotopically light component may be water vapor condensed during gas production, with a Rayleigh fractionation process accompanying vapor condensation, rather than shallow groundwater. Mixing lines suggest that all formation waters haveÎ´18O‰ˆ + 8€°, which is normal for deep, basinal waters, although Cl- concentrations indicate there are 2 water populations (with approximately 35,000 mg/l and 15,000 to 20,000 mg/l). There appears to be no systematic difference between the overpressured and normally pressured samples, or between samples from different fields.Î´13CPDB values of DIC range from -10.6 to -3.2€°.Î´13CPDB values of CH4 range from -43.9 to -40.8€°, andÎ´13CPDB values of CO2 range from -8.8 to -6.3€°, indicating that these gases have a thermogenic origin. Significant isotopic differences are observed between the Moore-Sams and Morganza samples which suggest that the Morganza gases were produced at higher temperatures and/or by the decomposition of more mature source material. The CO2 and DIC are not in isotopic equilibrium with calcite and dolomite cements immediately above and below the seal, suggesting that precipitation of calcite and dolomite took place in an earlier event(s). The DIC of most samples is at, or near, isotopic equilibrium with CO2, although it appears that some samples have derived a significant component of DIC from isotopically heavier samples located both higher and lower in the section. The lack of isotopic equilibrium between DIC and CO2 for some samples suggest either that some water samples have little or no contact with coexisting gas samples, or that a dynamic process is taking place that prevents equilibrium being achieved. © 1995 Elsevier Science Ltd.

Neal JT, Myers RE. Salt dissolution sinkhole at the Weeks Island, Louisiana, strategic petroleum reserve storage site. Karst geohazards: engineering and environmental problems in karst terrane Proc 5th conference, Gatlinburg 1995 1995:61-5.

A sinkhole was first observed in May 1992 over the outer edge of the two-tiered former salt mine that was converted for oil storage. Results of diagnostic studies show a direct connection exists between the surface collapse area and the undergorund mine. The dissolution of salt below the sinkhole that initiated the leak into the mine was likely caused by several confluent geologic processes, and exacerbated by mining-induced stresses that created fractures which served as hydrologic flowpaths. Modeling studies of mine stresses show that years of tensional stresses may be required before cracking begins to occur, but once begun can continue to develop, and relieve the stress in that specific regime. The crack regime creates the avenue for incursion of groundwater, gradually enlarging as undersaturated groundwater dissolves salt on the sides of the crack. Mitigation measures include increasing the mine pressurization, slowing the dissolution by injecting brine into the sinkhole throat, and permeation grouting in hydrologic flowpaths.

Neal JT, Myers RE. Origin, diagnostics, and mitigation of a salt dissolution sinkhole at the US Strategic Petroleum Reserve storage site, Weeks Island, Louisiana. Land subsidence Proc international symposium, The Hague, 1995 1995:187-95.

A sinkhole was observed over the edge of the two-level former salt mine that was converted for oil storage. Diagnostic studies suggest a direct connection exists between the surface collapse area and the underground mine as shown by correlative measurements of sediment slump rates and probable brine influx into the mine. The dissolution of salt below the sinkhole that initiated the leak into the mine was likely caused by several confluent geologic processes, and exacerbated by mining-induced stresses that created fractures which served as hydrologic flowpaths. Modelling studies of mine stresses show that years may be required before tensional cracking begins to occur, but once begun can continue to develop, and relieve the stress in that specific regime. The crack regime creates the avenue for incursion

of groundwater. Mitigation measures include increasing the mine pressure, slowing the dissolution by injecting brine into the sinkhole throat, and construction of a freeze curtain to restrict hydrologic flowpaths.

Giuliano G. Ground water in the Po basin: Some problems relating to its use and protection. Science of the Total Environment 1995;171(1-3):17-27.

The Po Plain consists of quaternary deposits of the main river and its tributaries. The regional aquifer is mainly a monostratum system despite being subdivided into several layers in places. Due to its hydrogeological setting the high plain, i.e. the area where the best quality groundwater occurs, is highly vulnerable to pollutants and to the high density of hazardous sources. The main problems with respect to the anthropogenic pollution of groundwater are related to halogenic compounds, nitrates and herbicides. Such a combination requires careful management of the water supply, namely the location of new pumping centres, the protection of existing sources and the final use of water resources of different quality.

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Garrison CR, Louisiana. Dept. of Transportation and D, Geological S. Louisiana water-resources conditions : October 1993 through September 1994. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 1995.

Szogi AA, Hudnall WH. Water chemistry of two hydric soils of southern Louisiana. International Journal of Ecology & Environmental Sciences 1994;20(1-2):1-14.

Chemical composition of the shallow groundwater of two hydric soils in the Coastal Plain of southern Louisiana was monitored for one year. Two sites were instrumented with nested wells. Variations in the composition, electrical conductivity (EC) and pH were attributed to differences in soil and parent materials, soil physical properties and groundwater flow. Brimstone soil is supplied by rainfall and lateral movement from the adjacent higher landscape with addition of NO3 and leaching of Na and Cl. Na and Cl accumulate at short distances in depressional areas. Verdun soil has a morphology that would indicate that leaching of Na is a predominant process. However, presently the soil is undergoing secondary salinization produced by discharge from a permanent groundwater table. The discharging groundwater is brackish and of probable marine origin. -from Authors

Stuart CG, Knochenmus DD, McGee BD, Louisiana. Dept. of Transportation and Development. Guide to Louisiana's ground-water resources. Baton Rouge, La.; Denver, CO: U.S. Geological Survey, Earth Science Information Center, 1994.

Rapp TR, Geological S, Jefferson Parish . Dept. of Public U. Ground-water resources of southern Tangipahoa Parish and adjacent areas, Louisiana. Baton Rouge, La.; Denver, CO: U.S. Geological Survey, 1994.

Halford KJ, Lovelace JK, Louisiana. Dept. of Transportation and D, Capital Area Ground Water Conservation C, Geological S. Analysis of ground-water flow in the "1,200-foot" aquifer, Baton Rouge area, Louisiana. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 1994.

Faye RE, Smith WG. Relations of borehole resistivity to the horizontal hydraulic conductivity and dissolved-solids concentration in water of clastic coastal plain aquifers in the southeastern United States. US Geological Survey Water-Supply Paper 1994:2414.

Aquifer bulk resistivity and grain-surface resistivity (inverse of grain-surface conductance) were tested as geoelectrical analogs to the horizontal hydraulic conductivity of clastic, freshwater aquifers in the

Southeastern US. Aquifer bulk resistivity and grain-surface resistivity were moderately correlated to horizontal hydraulic conductivity (70 and 72% correlation coefficients, respectively). Apparent formation factor, defined as the ratio of aquifer bulk resistivity to aquifer water resistivity, was shown to be poorly correlated with horizontal hydraulic conductivity (38% correlation coefficient). Aquifer bulk resistivity was shown to be highly correlated with dissolved-solids concentration and aquifer water resistivity (88 and 93% correlation coefficients, respectively). Regression models using bulk resistivity and aquifer water resistivity as independent variables were applied at four locations in South Carolina and Louisiana to predict dissolved-solids concentrations in aquifer water.

Anon. Novel process rids groundwater of hydrocarbons. Water Engineering & Management 1994;141(5):26-8.

A common response to hydrocarbon contamination of a groundwater protection well has been to provide treatment at the wellhead, such as carbon adsorption or air stripping processes. However many years of treatment are sometimes necessary before the water supply meets regulatory quality levels. This article describes a novel approach to remediation of contaminated groundwater at Rayville, Louisiana, where BCM Engineers has used a two phased vacuum extraction system. The system is assessed in detail. (S.E.Brown)

Acharya P, Ives P. Incineration at Bayou Bonfouca remediation project. Journal of the Air and Waste Management Association 1994;44(10):1195-203.

The Bayou Bonfouca hazardous waste site is located in Slidell, Louisiana, approximately 96 kilometers (60 miles) northeast of New Orleans. This site is ranked number 1,006 on the National Priorities List of Superfund sites. The U.S. Environmental Protection Agency (EPA) conducted a remedial investigation in 1986 and determined the primary potential exposure sources to be groundwater, surface waste piles, and contaminated sediment in Bayou Bonfouca. Based on the results of investigations, EPA and the Louisiana Department of Environmental Quality chose a remedy that involves dredging contaminated sediment from the bayou, excavating contaminated waste piles and soil, and incinerating the solid wastes in a transportable incinerator. The site remedy, which included incineration, was specified in the Record of Decision signed in March 1987. Of the total 142,000 megagrams (Mg) (157,000 tons) of waste to be incinerated, approximately 119,000 Mg (132,000 tons) consist of hazardous sediment from the bayou; 22,600 Mg (25,000 tons) consist of lightly contaminated soils and waste piles, cellulosic materials, and other miscellaneous wastes on the ground. The solid wastes are primarily low heat content sediment and soils and cellulosic materials with polyaromatic hydrocarbon (PAH) concentrations from milligrams per kilogram (parts per million) levels up to two percent. The dredged bayou sediment will be dewatered in six, 115-cubic-meter (150-cubic-yard) plate and frame filter presses before processing in the incinerator. A rotary-kiln-based single train incinerator is deployed at Bayou Bonfouca to process the solid waste feed. On-site pilot studies indicated that the PAHs in groundwater could be removed by on-site pumping, treatment, and discharge of treated effluent to the bayou. The groundwater treatment plant went on-stream in June 1991. Treatment involves oil/water separation, filtration, carbon bed adsorption, and aeration. IT Corporation-OH Materials, a joint venture, was awarded a contract in May 1991 and a notice to proceed in February 1992 to remediate and restore the Bayou Bonfouca site. The remediation project includes air quality monitoring and controls, site preparation, dredging and excavation, bayou bank stabilization and monitoring, equipment mobilization and erection, the trial burn, incineration, demobilization, and site closure. The project completed a successful trial burn in November 1993, and the commercial operation began in December 1993. The expected duration of the project is 40 months from mobilization to site closure.

Acharya P, Ives P. Incineration at Bayou Bounfouca remediation project. Waste Management 1994;14(1):13-26.

The Bayou Bonfouca hazardous waste site is located in Slidell, Louisiana, approximately 96 km (60 miles) northeast of New Orleans. This site is ranked number 1006 on the National Priorities List of Superfund sites. The Environmental Protection Agency (EPA) conducted a remedial investigation in 1986

and determined the primary potential exposure sources to be groundwater, surface waste piles, and contaminated sediment in Bayou Bonfouca. On the basis of the results of investigations, EPA and the Louisiana Department of Environmental Quality chose a remedy that involves dredging contaminated sediment from the bayou, excavating contaminated waste piles and soil, and incinerating the solid wastes in a transportable incinerator. The site remedy, which included incineration, was specified in the record of decision signed in March 1987. Of the total 142,000 Mg (157,000 tons) of waste to be incinerated, approximately 119,000 Mg (132,000 tons) consist of hazardous sediment from the bayou; 22,600 Mg (25,000 tons) consist of lightly contaminated soils and waste piles, cellulosic materials, and other miscellaneous wastes on the ground. The solid wastes are primarily low-heat content sediment and soils and cellulosic materials with polyaromatic hydrocarbon (PAH) concentrations from mg/kg (ppm) levels up to 2%. The dredged bayou sediment will be dewatered in six, 115-m3 (150-yd3) plate and frame filter presses before processing in the incinerator. A rotarykiln- based single train incinerator is deployed at Bayou Bonfouca to process the solid waste feed. On-site pilot studies indicated that the PAHs in groundwater could be removed by on-site pumping, treatment, and discharge of treated effluent to the bayou. The groundwater treatment plant went on- stream in June 1991. Treatment involves oil/water separation, filtration, carbon bed adsorption, and aeration. IT Corporation-OH Materials, a joint venture, was awarded a contract in May 1991 and a notice to proceed in February 1992 to remediate and restore the Bayou Bonfouca site. The remediation project includes air quality monitoring and controls, site preparation, dredging and excavation, bayou bank stabilization and monitoring, equipment mobilization and erection, the trial burn, incineration, demobilization, and site closure. The project completed a successful trial burn in November 1993, and the commercial operation began in December 1993. The expected duration of the project is 40 months from mobilization to site closure.

Southwick LM, Willis GH, Bengtson RL. Leaching losses of norflurazon through Mississippi River alluvial soil. Bulletin of Environmental Contamination and Toxicology 1993;50(3):441-8.

Portier RJ, Shane BS, Walsh MM, Williams MB. In situ remediation of EDC contaminated vadose soil: a toxicological assessment. Waste Management 1993;13(5-7):532-3.

Chlorinated aliphatic compounds are among the most common soil and groundwater contaminants because of their widespread use as industrial solvents. Our on-going study has two main objectives. The first is to examine the in situ biodegradation of one of these compounds, ethylene dichloride (EDC), in the vadose (unsaturated) soil zone above the groundwater, both in the desired aerobic setting and in a system in which anaerobiosis and subsequent production of vinyl chloride has occurred. We will also test whether an upset system can recover if oxygen, nutrients, and, possibly, inoculum are subsequently added. The second objective is to develop and refine a method for conducting mutagenicity assays on volatile organics compounds and to test the assay under anaerobic conditions. We have completed laboratory and field studies of treatment of EDC in the mobile phase in saturated systems to optimize bacterial consortia for EDC degradation in the vadose-zone experiments. A water stream containing 50 parts per million (ppm) EDC was treated in a laboratory-scale Immobilized Microbe Bioreactor (IMBR). The system was able to sustain a average removal rate of 96.4% with a 24-hour retention time over the least 8 days of the experiment. An LSU pilot-scale IMBR was installed at The Dow Chemical Company's Northwest Landfill site at the Plaquemine, Louisiana, plant.

Louisiana Dept of Transportation and Development, Louisiana Dept of Environmental Quality. Construction of geotechnical boreholes and groundwater monitoring systems handbook. Baton Rouge: The Department; 1993.

Kosters EC, Suter JR. Facies relationships and systems tracts in the late Holocene Mississippi Delta Plain. Journal of Sedimentary Petrology 1993;63(4):727-33.

Rising relative sea level provides increased accommodation space while fresh water may be held within the delta plain, creating conditions of both groundwater and nutrients favorable to accumulation of high-quality organic facies. In a subsequent progradational setting, stable relative sea level results in less

accommodation space landward of the shoreline, while fresh water and nutrients are discharged into the Gulf of Mexico, forcing formation of brackish and salt marsh environments, unfavorable to accumulation of high-quality organic facies. -from Authors

Huff GF. Hydrogeochemistry of saline waters in aquifers of tertiary and younger age in northeastern Louisiana and southeastern Arkansas; 1993.

Hanor JS. Effective hydraulic conductivity of fractured clay beds at a hazardous waste landfill, Louisiana Gulf Coast. Water Resources Research 1993;29(11):3691-8.

Wright JA, Shirmohammadi A, Magette WL, Fouss JL, Bengtson RL, Parsons JE. Water table management practice effects on water quality. Transactions of the American Society of Agricultural Engineers 1992;35(3):823-31.

Impacts of water table management (WTM) practices on water quality were modeled using a linked version of CREAMS and DRAINMOD (Parsons and Skaggs, 1988). The CREAMS denitrification component and the linked DRAINMOD-CREAMS model were modified to simulate daily hydrology (runoff, infiltration, evaporation, and soil moisture content), erosion, and nutrient processes for different WTM conditions. Measured data from Baton Rouge, Louisiana, were used to validate the linked model, and then controlled drainage-subirrigation (CD-SI) was simulated to investigate the effects of different WTM systems on runoff, erosion, and nitrogen losses. Results of the study indicated that the linked models performed better than the original CREAMS model in predicting runoff, infiltration, soil moisture content, and erosion, and that the modified linked model performed better than both CREAMS and the original linked model in predicting nitrogen losses from the study site. Results also showed that the CD-SI system simulated by the modified DRAINMOD-CREAMS model predicted increased denitrification and lowered nitrate leaching, unlike the original version. This study concluded that the CD-SI system may be used as a BMP to reduce nitrogen leaching to shallow groundwater systems for areas with high water table conditions.

Walthall PM, Day WJ, Autin WJ. Ground water as a source of sodium in the soils of the Macon Ridge, Louisiana. Soil Science 1992;154(2):95-104.

The relationship between Na and Cl in solution extracts from cores was compared with ion concentrations reported in regional ground water studies. The loess mantle may act as a restrictive barrier by elevating the soil surface above the underlying aquifer and limiting the upward movement of saline ground water. It is also believed that it may act in a similar manner with respect to limiting the downward movement of precipitation. The similar relationship between Na and Cl in the soils and sediments at depth on the east side of the ridge (thicker loess) appears to be preserved by seasonal saturation from the saline aquifer and limited removal of Cl as a result of poor drainage. It was concluded that the source of high levels of exchangeable Na occurring in the soils of the Macon Ridge is saline ground water. -from Authors

Tomaszewski DJ, Louisiana. Dept. of Transportation and D, Geological S. Louisiana hydrologic atlas. map no. 5 Quality of freshwater in aquifers of Louisiana, 1988. [Baton Rouge, LA]; Denver, CO: The Geological Survey, 1992.

Murray HE, Beck JN. Methane in well water from Lake Charles, Louisiana. Bulletin of Environmental Contamination and Toxicology 1992;48(5):768-71.

Cassidy DP, Ranganathan V. Groundwater upwelling, near Bay St. Elaine salt dome in southeastern Louisiana, as inferred from fluid property variations. American Association of Petroleum Geologists Bulletin 1992;76(10):1560-8.

Fluid pressures, temperatures, and salinities derived from 62 well logs were mapped in three vertical cross sections across the Bay St. Elaine salt dome in south-eastern Louisiana to qualitatively determine groundwater flow patterns around the dome. Near-hydrostatic conditions prevail in the sand-rich shallow

section from depths of 0 to 2.5 km. However, fully enclosed within the hydropressured section are lenses of slightly over-pressured sediments, which slope up toward the dome. Pore-water salinities increase with depth within the hydrostatically pressured section, from 0 wt.% at the surface to maximum values of 10-12 wt.% at the top of the overpressured section. Within the overpressured section, salinities decrease to as little as 6 wt.% with increasing depth. Immediately adjacent to the nrotheastern flank of the dome is a steeply dipping lobe of relatively fresh waters (6 wt.% sodium chloride) that separates the flank of the dome from saltier (8-10 wt.%) waters away from the dome. -from Author

Albertson PE, Williamson AN. Engineering answers to groundwater impact questions using a geographic information system (GIS). In: Irrigation and Drainage: Saving a Threatened Resource - In Search of Solutions, Proceedings of the Irrigation and Drainage Sessions at Water Forum '92; 1992; 1992. p. 505-10.

Environmental concerns have raised complex questions about the impacts of increased groundwater levels adjacent to navigational pools along the Red River, Louisiana. Previous studies had produced predictions of water level and environmental impact maps that could be used to address the problem. However, comparison of information contained on these maps proved to be time consuming due to scale differences among the maps involved. An efficient alternative was needed. The Intergraph Modular GIS Environment (MGE) software was selected as an effective engineering tool for solving this problem. This GIS Environment (MGE) software was selected as an effective engineering tool for solving this problem. This GIS application demonstrates how this technology can be used to efficiently encode, store, retrieve, analyze and output the vast amount of data that was assembled to describe pre- and post-project conditions. The data included were land surface elevations, pre-and post-project groundwater elevations, and land use. Data were input to the GIS from maps of various scales; water level information in tabular form; and LANDSAT digital data. The encoded data were then geo-referenced and interpolated so that Boolean relationship logic could be applied for analyses. Results for the area near Alexandria, Louisiana, show in graphic form, the land areas with groundwater change. Land use categories are being compared with the water level information to determine the impact once groundwater/reservoir equilibrium is reached following impoundment of the navigational pool.

Smoot CW, Seanor RC, Geological S, Louisiana. Dept. of Transportation and D. Louisiana ground-water map no. 3: potentiometric surface, 1989, and water-level changes, 1980-89, of the Sparta aquifer in north-central Louisiana. Baton Rouge, La.; Denver, Colo.: U.S. Geological Survey, 1991.

Sharp JM, Raymond RH, Germiat SJ, Paine JG. Re-evaluation of the causes of subsidence along the Texas Gulf of Mexico coast and some extrapolations of future trends. In: IAHS Publication (International Association of Hydrological Sciences); 1991; 1991. p. 397-405.

Analyses of National Ocean Service tidal gauge data from the Texas Gulf Coast and first-order releveling surveys conducted by the National Geodetic Survey indicate very high rates of regional relative sea-level (RSL) rise (eustatic level-level [ESL] rise plus subsidence) up to 20 mm/year. The highest overall recent rates (> 10 mm/year) are found in the northeastern area gauge data, from Sabine Pass on the Texas-Louisiana border southwest to Freeport. Lower, but still high rates (4-6 mm/year) are common near the alluvial valleys of the Brazos and Colorado rivers and south to the Rio Grande Valley. Such rates for natural subsidence are not realistic over geologic time. RSL rise on the 'stable' Florida platform is about 2 mm/year, which is a conservatively high estimate of regional ESL rise in the Gulf of Mexico. Estimates of natural subsidence for the Texas Coast range between 0.1 and 2.4 mm/year. While extraction of ground water is a well-known cause of subsidence along the Gulf Coast, these areas are localized and some of the highest subsidence (or RSL rise) is in areas with little groundwater production. Extraction of hydrocarbons on a regional basis remains a possible cause for the enhanced rates of observed subsidence. Extrapolation of the trend of the past 20 to 30 years predicts a regional subsidence of nearly one meter by the end of the next century. Furthermore, tidal gauge data from Pier 21 in Galveston demonstrate an increasing rate of RSL rise. Finally, a delphic analysis of the risk of future ESL rise yields a reasonable change that the rise in sea level over the same time frame will be of about the same order

of magnitude as that of the extrapolated subsidence. A 2-meter rise in RSL will result in considerable economic dislocations along the Texas Coast because of shoreline retreat and local inundation. These problems will be exacerbated by diminished sediment input to the Gulf by major coastal streams and intensive coastal development. Final determination of the relative amounts of natural and fluid-extraction-induced subsidence will require, among other data, a better areal delineation of subsidence trends over the whole coast.

Rao GN, Beck JN, Murray HE, Nyman DJ. Estimating transmissivity and hydraulic conductivity of Chicot Aquifer from specific capacity data. Water Resources Bulletin 1991;27(1):47-58.

Specific capacity data obtained from Well Construction reports which are available from USGS offices, can provide useful estimates of transmissivity (T), and hydraulic conductivity (K), of an aquifer. The Chicot Aquifer in Louisiana is one of the largest sources of fresh ground water in North America. Hydrologic data collected for the Chicot Aquifer indicate that specific capacity tests can be used in estimating local and regional values for T and K, if the Cooper-Jacob equation for transient flow is used with proper corrections for well loss and partial penetration. Where full scale pumping test data are scarce, specific capacity test data that are adequately distributed spatially can be used to map changes in T and K values and can be summarized statistically to indicate applicable regional values. A computer program called 'TGUESS' which is available from International Ground Water Modeling Center, Holcomb Research Institute, was used in this study. The contour maps for T and K values are prepared for different well depth intervals to avoid wide variation of values.

Martin A. Hydrology of the coastal lowlands aquifer system in parts of Alabama, Florida, Louisiana, and Mississippi / by Angel Martin, Jr., and C.D. Whiteman, Jr. Denver, Co.: U.S. Dept. of the Interior, U.S. Geological Survey, 1991.

Williamson AK. Ground-water flow in the Gulf Coast aquifer systems, south central United States : a preliminary analysis / by Alex K. Williamson, Hayes F. Grubb, and Jonathan S. Weiss. Austin, Tex. : Denver, Co.: Dept. of the Interior, U.S. Geological Survey, 1990.

Stuart CG, Demas CR, Louisiana. Dept. of Transportation and D, Geological S. Organic chemical analyses of ground water in Louisiana, water years 1984-1988. Baton Rouge: Louisiana Dept. of Transportation and Development, 1990.

Rainey JM, Groves FD, DeLeon IR, Joubert PE. Ground water and oil field waste sites: a study in Vermilion Parish. The Journal of the Louisiana State Medical Society: official organ of the Louisiana State Medical Society 1990;142(6):34-40.

Water samples were obtained from 128 private water wells surrounding eight oil field waste sites in Vermilion Parish. The specimens were analyzed for five heavy metals: barium, arsenic, chromium, lead, and cadmium. Half of the specimens were then analyzed for 16 volatile organic compounds. A blood sample was obtained from healthy adults drinking water from the wells tested for volatile organic compounds and this blood sample was also analyzed for volatile organic compounds. None of the water samples had levels of heavy metals or volatile organic compounds that exceeded the National Primary Drinking Water Standards. Barium levels in excess of 250 parts per billion suggested that styrene, toluene, and chloroform might be present. Blood levels of volatile organic compounds were significantly higher than could be accounted for by water consumption with levels in smokers significantly higher than in nonsmokers. These data suggest that as yet there is no contamination of ground water supplies around these sites. Volatile organic accumulation in humans probably occurs from a respiratory rather than from an oral route.

Peralta RC, Datta B. Reconnaissance-level alternative optimal ground-water use strategies. Journal of Water Resources Planning and Management 1990;116(5):676-92.

This study develops regionally optimal ground-water extraction strategies. Alternative explicit planning objectives are: (1) Maximize total pumping from the underlying aquifer while causing the evolution of a steady potentiometric surface; and (2) maintain a prespecified target potentiometric surface. Implicit objectives involve controlling stream/aquifer interflow and water flow across a state boundary, and attempting to avoid gross disruption of current cropping patterns. Models, bounds, constraints, and data are formulated. Alternative optimal strategies and the rationale for preferring one strategy are presented for a region in Arkansas. The objective of maintaining the relatively unstressed target potentiometric surface yields politically and socially unacceptable water-use strategies. The most acceptable strategy maximizes sustainable ground-water extraction, maintains recent ground-water flow to Louisiana, maintains current potentiometric surface heads at the Louisiana-Arkansas border, maintains more than minimally acceptable surface water flow to Louisiana, and approximately maintains current cropping distributions. Developed planning models utilize the embedding approach, over 300 pumping variables, and 700 total variables, indicating the utility of the embedding method for regional sustained yield (steady-state) planning.

Nyman DJ, Halford KJ, Martin A, Geological S, Louisiana. Dept. of Transportation and D. Geohydrology and simulation of flow in the Chicot aquifer system of southwestern Louisiana. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 1990.

Martin A, Whiteman CD, Geological S. Calibration and sensitivity analysis of a ground-water flow model of the coastal lowlands aquifer system in parts of Louisiana, Mississippi, Alabama, and Florida. Baton Rouge, La.; Denver, CO: U.S. Geological Survey, 1990.

Harrison DP, Valsaraj KT, Thibodeaus LJ, Louisiana State Univ Baton Rouge Dept Of Chemical E. Laboratory Investigations of Cascade Crossflow Packed Towers for Air Stripping of Volatile Organics from Groundwater. Ft. Belvoir: Defense Technical Information Center; 1990.

This report evaluates the effectiveness of a cascade crossflow air stripper for the removal of Volatile Organic Compounds (VOCs) from simulated groundwater. Experimental tests were conducted on four VOCs-methylene chloride, chloroform, 1,2-dichloroethane and carbon tetrachloride - on both a 6-inch internal diameter laboratory scale column and a 12-inch internal diameter pilot- scale column. The additional variable, alpha, which is the ratio of gas to liquid flow areas was investigated. Experimental data on stripping efficiencies were used to obtain mass transfer coefficients in crossflow operation. These mass transfer coefficients were compared with literature correlations obtained for conventional countercurrent operation, but modified appropriately for crossflow. For liquid phase controlled chemicals, the modified Onda's correlation satisfactorily predicted the crossflow mass transfer coefficient.

Graber ER, Aharon P, Geological S, Louisiana Water Resources Research I, Louisiana State University . Dept. of Geology and G. Nature and rates of bacterial metabolism in the aquifers of southeast Louisiana. Baton Rouge: Dept. of Geology & Geophysics, Louisiana State University, 1990.

Funayama M. Distribution and migration patterns of subsurface fluids in the Wilcox Group in central Louisiana; 1990.

Turner JE, Dooge JCI, Bree T. Deriving the unit hydrograph by root selection. Journal of Hydrology 1989;110(1-2):137-52.

De Laine's method of deriving the unit hydrograph from the common roots of polynomials corresponding to different storms is used as a basis for proposing a new procedure in which the unit hydrograph roots can be selected from among the polynomial roots for the runoff of a single storm. The selection is made on the basis that the complex unit hydrograph roots form a characteristic "skew circle" pattern when plotted on an Argand diagram. The application of the procedure to field data is illustrated for both a single-peaked and a double-peaked event. © 1989.

Smoot CW, Geological S, Louisiana. Dept. of Transportation and D. Geohydrologic sections of Louisiana. Baton Rouge, LA.: U.S. Geological Survey, 1989.

Ranganathan V, Hanor JS. Perched brine plumes above salt domes and dewatering of geopressured sediments. Journal of Hydrology 1989;110(1-2):63-86.

Previous studies have shown that there is a brine plume with more than 160 g l-1 total dissolved solids (TDS) in the subsurface, perched above Welsh Salt Dome in South Louisiana. The occurrence of this plume has been postulated to be due to the expulsion of geopressured fluids up a fault on the flank of Welsh Dome. The process that resulted in formation of the anomalous brine plume near Welsh Dome is of importance because hydrocarbon production is approximately coincident with the brine plume in map plan, although in cross-sections, the brine plume actually occurs a few hundred meters above hydrocarbon production zones. Using a variable density groundwater flow model, Sutra, we tested the hypothesis that a pulse of fluid flow up the fault could result in brine formation near the top of the dome. When the permeability of the geopressured zone was very low in our simulations, brine formation in the hydropressured zone occurred entirely by brine-density flow and flow was downward along the fault flanking the dome. Above a certain threshold permeability for the geopressured zone, between 10-7 darcy and 10-5 darcy in the vertical direction, geopressured fluids were forced up the fault and brine formation occurred above the dome rather than on the flank. Brines can theoretically form above salt domes in very short geologic times (10-1 Ma) by expulsion of waters from the geopressured zone below, but the fluid effluxes required are gigantic and appear to be unsustainable over large time intervals such as 10 Ma. © 1989.

Olson JL. Quaternary and environmental geology of Baker and surroundings, East Baton Rouge Parish, Louisiana: with emphasis on soil and shallow groundwater contamination; 1989.

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Kuniansky EL, Geological S, Louisiana. Dept. of Transportation and D, Capital Area Ground Water Conservation C. Geohydrology and simulation of ground-water flow in the "400-foot," "600-foot," and adjacent aquifers, Baton Rouge area, Louisiana. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 1989.

Kuniansky EL, Dial DC, Trudeau DA, Louisiana. Dept. of Transportation and D. Maps of the "400-foot," "600-foot," and adjacent aquifers and confining beds, Baton Rouge area, Louisiana. Baton Rouge: Louisiana Dept. of Transportation and Development; 1989.

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Dial DC, Sumner DM, Louisiana. Dept. of Transportation and D, Geological S. Geohydrology and simulated effects of pumpage on the New Orleans aquifer system at New Orleans, Louisiana. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 1989.

Dial DC, Huff GF, Louisiana. Dept. of Transportation and D, Louisiana. Dept. of Transportation and Development. Water Resources S, Geological S. Occurrence of minor elements in ground water in Louisiana, including a discussion of three selected sites having elevated concentrations of barium. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 1989.

Tomaszewski DJ, Louisiana. Dept. of Transportation and D, Geological S. Ground-water hydrology of Livingston, St. Helena, and parts of Ascension and Tangipahoa parishes, southeastern Louisiana. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 1988.

Stuart CG, Lurry DL, Geological S, Louisiana. Dept. of Transportation and D. Public water supplies in Louisiana: v. 2, southern Louisiana. Baton Rouge: Louisiana Dept. of Transportation and Development, 1988.

Strickland DJ, Geological S. A Reconnaissance study to relate land use and ground-water quality in the Gulf coastal plain of Louisiana and Mississippi. Jackson, Miss.; Denver, Colo.: Dept. of the Interior, U.S. Geological Survey, 1988.

Snider JL. Radiochemical analyses of ground water in Louisiana. Baton Rouge, La.: Louisiana Dept. of Transportation and Development, 1988.

Kaufmann RS, Long A, Campbell DJ. Chlorine isotope distribution in formation waters, Texas and Louisiana. American Association of Petroleum Geologists Bulletin 1988;72(7):839-44.

Theoretically, the chlorine isotope ratio, 37Cl/35Cl, can aid in identifying chloride sources and in distinguishing chloride-transport mechanisms among formation waters if ratio differences exist among samples. We measured the chlorine ratios of 18 formation-water samples from oil fields along the Texas-Louisiana Gulf Coast. We conclude that significant chlorine isotope ratio differences exist among formation waters and between the waters and potential sources in the Gulf Coast region, and that the chlorine ratio will be a valuable tool in interpreting chloride geochemistry in this region. -from Authors

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Geological Survey, Martin A, Whiteman CD, Becnel MJ. Generalized potentiometric surface of the lower Jasper and equivalent aquifers in Louisiana, 1984. Baton Rouge, La.; Denver, Colo.: The US Geological Survey, 1988.

Geological Survey. Altitude of the base of freshwater in Louisiana / Department of the Interior, U.S. Geolgical Survey ; by Charles W. Smoot ; prepared in cooperation with the Louisiana Department of Transportation and Development. Baton Rouge, La.: Denver, Co.: The US Geological Survey, 1988.

Dial DC, Tomaszewski DJ, Jefferson Parish . Dept. of W, Geological S. Geohydrology, water quality, and effects of pumpage on the New Orleans aquifer system, northern Jefferson Parish, Louisiana. Baton Rouge, La.; Denver, CO: Dept. of the Interior, U.S. Geological Survey, 1988.

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Boniol DP, Autin WJ, Hanson BC, Louisiana. Dept. of Environmental Q, United States. Environmental Protection A. Recharge potential of Louisiana aquifers : a supplement to the State aquifer recharge map and atlas plates. Baton Rouge, La.: Louisiana Geological Survey, 1988.

Swenson EM, Turner RE. Spoil banks: Effects on a coastal marsh water-level regime. Estuarine, Coastal and Shelf Science 1987;24(5):599-609.

Above- and below-ground water-level fluctuations were measured in the marshes south of New Orleans, Louisiana, between November 1982 and December 1983. The purpose of the program was to define the basic marsh water-level regime and to investigate how canal spoil banks may influence the water-level regime. Two study areas were used: (1) a control area, defined as a section of marsh with unrestricted hydrologic connection to an adjacent bayou; and, (2) a partially-impounded area, defined as an area with limited hydrologic connection to an adjacent bayou due to the presence of dredged canal spoil banks. Data sources included marsh water levels from gages deployed at three sites within the study areas and water levels from the adjacent bayous obtained from the tide gages of U.S. Army Corps of Engineers. Data from all marsh gage sites showed a similar pattern with a distinct surface and subsurface diurnal tidal signal superimposed upon other, larger scale events. These larger scale events correspond to the passage of weather fronts. The data also indicated that a significant amount of water-level fluctuation in the marshes occurs below ground. A comparison of the control area and the partially-impounded site indicated that the spoil banks changed the response of the marsh water levels to the forcing from the bayou, with the result that the partially-impounded area: (1) was flooded 141 hours more per month than the control area; (2) had fewer, but longer flooding events; (3) had fewer but longer drying events; and (4) reduced water exchange, both above and below ground. © 1987.

Strickland DJ. A Reconnaissance study to relate land use and ground-water quality in the Gulf Coastal Plain of Louisiana and Mississippi. Jackson, Miss.: U.S. Geological Survey, 1987.

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Impact of irrigation trend, water table fluctuations, crop management, and tillage systems on groundwater quantity and quality of the southeast (Alabama, Florida, Georgia, and South Carolina) and Delta states (Arkansas, Louisiana, and Mississippi) are discussed. Areas with specific groundwater quality problems such as salt water intrusion and nitrate and pesticide levels are identified. Degradation of surface water quality is discussed relative to irrigation. The discussions provide the basis for developing irrigation and management systems to minimize groundwater withdrawal and surface and groundwater contamination by agricultural chemicals.

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The Gulf Coast Regional Aquifer-System Analysis is one of the studies being conducted in the U. S. Geological Survey's (USGS) Regional Aquifer-System Analysis (RASA) program. Regional aquifers in sediments of mostly Cenozoic age are being studied in an area of about 225,000 square miles in the Coastal Plain of Alabama, Arkansas, Florida, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Tennessee, and Texas. Three aquifer systems have been identified: the Texas Coastal Uplands Aquifer System, the Mississippi Embayment Aquifer System in sediments of mostly Eocene age, and the Coastal Lowlands Aquifer System in sediments of Miocene and younger age. Regional groundwater flow in the three aquifer systems are evaluated using both regional- and subregional-scale digital models.

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Speciation was determined at 25 and 90 degree C in four groundwaters from diverse sources: the Sparta aquifer in Louisiana, near the Vacherie salt dome; Mansfield No. 2 well in the Palo Duro Basin, Texas; the Stripa mine in Sweden; and the Waste Isolation Pilot Plant in New Mexico. Neptunium generally was soluble in all waters and was present exclusively as Np(V) and Np(VI), regardless of initial oxidation state.

The results indicated that plutonium and neptunium solubilities were determined by the oxidation-reduction properties of the waters, i. e. , their abilities to convert these elements to soluble oxidation states. This was not the case for americium, however; Am(IV) was not detected, and the solubility of this element was determined entirely by the chemical properties of Am(III).

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Benchmark networks were installed around each of the US Department of Energy geopressured-geothermal test sites in SW Louisiana. These networks are periodically surveyed to detect subsidence which may be attributable to depressurization of the geopressured-geothermal reservoirs. The histories of oil and gas production and ground-water withdrawal around the geopressured-geothermal test site at Parcperdue indicate that oil, gas and ground-water production may contribute much more to anomalous subsidence than recent geopressured-geothermal brine production. 23(9), 1985

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Hutchins SR, Ward CH. A predictive laboratory study of trace organic contamination of groundwater: Preliminary results. Journal of Hydrology 1984;67(1-4):223-33.

Field studies on a rapid-infiltration site currently under construction at Fort Polk, Louisiana, U. S. A. , have indicated that characteristic trace organics are mostly absent from groundwater underlying the site. Therefore, a laboratory study was undertaken to investigate the potential for groundwater contamination by trace organics during operation of this system. Four columns were packed with topsoil obtained from one of the basins at the site. Feed solution and column effluents were monitored for 22 trace organics by reverse-ion search using capillary gas chromatography-mass spectrometry. Preliminary results indicate that groundwater contamination at the Fort Polk rapid-infiltration site can occur once the system begins operation, although concentrations of specific trace organics may be significantly reduced.

Chi SC, Reilinger RE. Geodetic evidence for subsidence due to groundwater withdrawal in many parts of the United States of America. Journal of Hydrology 1984;67(1-4):155-82.

Analysis of repeated levelings conducted by the National Geodetic Survey indicates many locations of relative subsidence in the U.S.A. Specific criteria are used to identify those subsidence features which most likely result from sediment compaction due to lowering of water levels in underground aquifer systems. Previously reported areas of such subsidence that seem to be confirmed by this study include: south-central Arizona; Savannah, Georgia; Pecos and Houston-Galveston, Texas; Denver, Colorado; San Joaquin Valley, Santa Clara Valley, Saugus Basin, Los Angeles Basin and Bunker Hill-San Timoteo, California; Milford, Utah; Raft River Valley, Idaho; Baton Rouge and New Orleans, Louisiana; and Las Vegas, Nevada. In addition, our analysis indicates that such subsidence is more widespread than previously reported occurring in a number of locations within the Atlantic and Gulf of Mexico coastal plains and along the Mississippi Valley as well as in many other unconsolidated sedimentary basins from which groundwater has been extracted and for which repeated leveling measurements are available. More than 30 new locations of subsidence possibly due to water withdrawal have been identified. The best documented of these include: Ventura, Ontario and San Pedro-Santa Monica, California; Monroe and Alexandria, Louisiana, and Jackson, Mississippi. Subsidence in newly identified locations ranges from several tens of millimeters to a few hundred millimeters over distances of ˆ¼ 10-60 km and times of

2-48 yr. Subsidence may also have occurred in other groundwater basins where water levels have been drawn down, and remained undetected because of a lack of repeated levelings. It is important to be aware of and to continue to monitor such effects because of increasing rates of utilization of groundwater resources and the potential for significant engineering problems due to surface movements. In addition, identifying cases of subsidence due to water withdrawal is essential in order to use effectively releveling observations for investigating tectonic deformation. Along these lines, our analysis suggests that some of the releveling observations used to define a region of tectonic uplift in southern California more likely reflect subsidence due to water-level declines within sedimentary basins around the periphery of the presumed zone of uplift. © 1984.

Hutchins SR, Tomson MB, Ward CH. Trace organic contamination of ground water from a rapid infiltration site: A laboratory-field coordinated study. Environmental Toxicology and Chemistry 1983;2(2):195-216.

A previous study at Rice University demonstrated that trace organic compounds in primary and secondary effluents treated in rapid infiltration systems are detected in associated ground water. A direct cause and effect relationship was not established, however, since background data on trace organics in the ground water were not available. Field studies on a rapid infiltration site currently under construction at Fort Polk, Louisiana, have indicated that characteristic trace organics are mostly absent from ground water underlying the site. Therefore, a laboratory study was undertaken to investigate the potential for ground water contamination by trace organics during operation of this system. Four columns were packed with topsoil obtained from one of the basins at the site. Unchlorinated secondary effluent was also obtained from the site and used as feed solution for the columns. Soil columns were operated for a period of 4 months on a 2-d flooding/12-d drying cycle to parallel design operation of the rapid infiltration system. Feed solution and column effluents were monitored for 22 trace organics by reverse ion search using capillary gas chromatography/mass spectrometry. Each of nine target trace organics found consistently in the feed solution, with the exception of p-dichlorobenzene, was detected in the column effluents during the first inundation cycle; all target trace organics were detected in the column effluents during subsequent cycles. The concentrations of tetrachloroethylene, pdichlorobenzene, acetophenone, 2-(methylthio)benzothiazole and bis(2-ethylhexyl)phthalate in the feed solution were generally reduced by passage through the soil column, whereas diethyl phthalate, benzophenone, N-butylbenzenesulfonamide and dibutyl phthalate concentrations were unaffected or enhanced. Addition of mercuric chloride during the seventh and eighth inundation cycles had variable effects for the different compounds. These preliminary results indicate that ground water contamination at the Fort Polk rapid infiltration site can occur once the system begins operation, although concentrations of specific trace organics may be significantly reduced. © 1983.

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Interest in artificially recharging selected shallow sands in South Louisiana with fresh water has been stimulated by the desire to retard contamination of municipal groundwater supplies by brackish water, to retard ground subsidence and decrease pumping lifts, and to develop emergency subsurface supplies of potable water for communities dependent on surface waters susceptible to contamination. Results of field experiments, laboratory work, and model calculations demonstrate that ion exchange reactions involving clays dispersed in aquifer sands can be expected to modify significantly the composition of waters injected into Gulf Coast sediments. As little as 0.1 weight percent smectite (montmorillonite) can remove,

by exchange with absorbed Na, a significant fraction of the dissolved Ca and Mg present in the injected water. The hardness of the water is thus reduced, which may be a desirable modification in water quality. Exchange occurs as fast as the fluids can be pumped into or out of the aquifer, and the water-softening capacity of the aquifer can be restored by allowing sodium-rich native pore waters to sweep back over the dispersed clays. Each acre of an aquifer 50 feet thick and containing 0.1 wt % smectite could soften half a million gallons of injected Mississippi River water. Many individual Gulf Coast aquifers underlie tens of thousands of acres, and their potential softening capacity is thus enormous. Additional exchange processes involving adjacent aquitard shales presumably will operate over long-term periods. It is possible that Gulf Coast aquifers will be used at some point in the future as processing plants to treat injected water to improve its quality for a variety of municipal and industrial purposes. © 1982 Springer-Verlag New York Inc.

Gottlieb MS, Carr JK, Clarkson JR. Drinking water and cancer in Louisiana. A retrospective mortality study. American Journal of Epidemiology 1982;116(4):652-67.

Thirteen Louisiana parishes (counties) using the Mississippi River as a source of potable water have the highest mortality rates (1950-1969) in the United States for several cancers. To assess a possible relationship with drinking water source, a comparison of cancer deaths and noncancer deaths from 1960-1975 in selected southern Louisiana parishes was conducted. Parishes were grouped for similarities in industrialization and approximately equal exposure of the population to surface water and ground water. Cancers were studied in groups by hypothesized risk: high for bladder, colon, kidney, liver, lymphoma, rectum, and stomach; low for Hodgkin's lymphoma, leukemia, lung, malignant melanoma, multiple myeloma, and prostate; and questionable for breast, brain, esophagus, and pancreas. Noncancer deaths were randomly selected and matched 1:1 to cancer deaths on age, race, sex, and year and parish group of deaths. Water source at death was based on residence at death, surface or ground water, and chlorinated or nonchlorinated water. The risk associated with using surface water least likely due solely to chance occurred for cancer of the rectum. Other risks which were lower but still greater than 1.0 occurred for cancer of the kidney and breast. No risk was observed for other cancers of the gastrointestinal or urinary tract. Risk for multiple myeloma was associated with use of ground water.

Gottlieb MS, Carr JK. Case-control cancer mortality study and chlorination of drinking water in Louisiana. Environmental Health Perspectives 1982;Vol. 46:169-77.

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Gottlieb MS, Carr JK, Morris DT. Cancer and drinking water in Louisiana: Colon and rectum. International Journal of Epidemiology 1981;10(2):117-25.

A case-control mortality study conducted in 20 parishes (counties) of South Louisiana to determine what relationship drinking Mississippi River water might have on mortality from colon or rectal cancer, found a significant risk for rectal cancer associated with surface water. Rectal and colon cancer deaths (692 and 1167) from 1969 to 1975 were matched to non-cancer deaths by age at death (± 5 years), year of death, sex and race, and within groups of parishes with similar industrial and urban-rural characteristics, each group being defined so as to ensure that it included as nearly as possible equal populations using water from ground and surface sources, based on the 1970 census. Colon cancer did not relate significantly to any water variable, but rectal cancer associated strongly with surface, or Mississippi River, water. The odds ratio for rectal cancer between those who were born and died on ground water was 2.07 with 95% C.I.: (1.49-2.88). A multi-dimensional contingency table analysis found the association between rectal cancer and surface water significant at the .0001 level and not dependent on age, race, sex or year of

death. The risk for men was slightly higher than for women, but both sexes showed an increased risk. Chlorination also associated significantly with rectal cancer. Among those who used river water, the risk increased inversely as the distance from the mouth, with greater risk downstream from the many industries which line the river.

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Water found as active leaks and isolated pools in the Weeks Island, Jefferson Island, and Belle Isle salt mines of S Louisiana has del 18O values ranging from -4 to +ll.5%o and delD/% values from -2.3 to -53%o. Most samples are too enriched in 18O to be meteoric waters. It is concluded that the nonmeteoric waters are formation waters which have become incorporated in the salt. From the observed 18O enrichment it is calculated that the formation waters were incorporated during diapiric rise of the salt at a depth of 3-4 km and have been trapped within the salt for 10-13 m.y. Large volumes of salt within salt domes are not naturally penetrated by meteoric groundwaters but can contain limited amounts of trapped formation water.

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Computer prediction models were used to predict annual energy consumption for both air and water source heat pumps in the climate of New Orleans, Baton Rouge, and Shreveport, Louisiana and three more northerly locations - Little Rock, Arkansas; Kansas City, Kansas; and Sioux City, Iowa - where the balance of annual heating to cooling loads differ and ground water temperature is proper for heat pump operation. Load sizes in the models were varied from small residential (2 ton) to small commercial (6 ton) size. The models gave a direct comparison of annual energy consumption for water and air source heat pumps of different efficiency rating and predicted the effect of source temperature on the energy consumption of the units. Energy cost saving potential with solar heating of the water and a buried earth grid were also investigated. Heating, cooling, and supplemental kilowatt-hours are given with ambient air source, local well water, and solar-heat-plus-well-water for cooling mode.

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The widespread belief that 20th-century geochemical prospecting 'originated' in the old world and spread to the United States after 1945 is, at best, highly debatable. A largescale groundwater hydrogeochemical exploration survey was undertaken in Texas and Louisiana in the early 1920's. Boltman (1904) and Lester (1918) described early studies of spring waters associated with uranium ores in the United States. These can perhaps be regarded as forms of orientation surveys. There are now about 2000-3000 literature items

dealing with groundwater hydrogeochemical exploration, and the total number of articles from all branches of geochemical prospecting is probably approaching 30,000. © 1978.

Kharaka YK, Brown PM, Carothers WW. Chemistry of waters in the geopressured zone from coastal Louisiana - implications for the geothermal development. 1978:371-4.

Detailed chemical analyses of 27 formation-water samples from 7 oil and gas fields in the Lafayette area, Louisiana, show that the salinity of water in the geopressured zone ranges from about 22,000 to 275,000 mg/L dissolved solids. The large differences in the salinity of water in the geopressured zone from different fields result mainly from interaction of water with salt beds. The concentrations of H//2S, silica, and a number of toxic trace metals are low in the geopressured geothermal waters. The relatively high salinity of these waters, however, and the moderately high concentration of environmentally toxic compounds are unfavorable to geothermal development. The chemical data indicate that careful evaluation of the compatibility of the spent geothermal waters and the waters in the formations used for injection will be required to minimize loss of porosity due to precipitation of carbonates and sulfates.

Hankins BE, Chavanne RE, Ham RA, Karkalits OC, Palermo JI. Chemical analysis of water from the world's first geopressured-geothermal well. 1978:253-6.

The purpose was to obtain samples of the geopressured-geothermal water and to analyze them for the chemical composition and the dissolved gas content. The well used was an abandoned gas well in Tigre Lagoon Field, East Vermilion Parish, Louisiana. The test spanned 40 days of flowing water. Suspended solids, pH, turbidity, and bicarbonate values showed a decrease as the well flowed. Bottom-hole values for dissolved solids, density, viscosity, and barium were slightly higher than the corresponding values for flowing samples. Values for bottom-hole and flowing samples agreed for most of the remainder of the determinations. Ra-226 values increased as the well flowed for longer periods of time.

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A small-scale field test of underground storage, using an injection well, was performed in Jefferson Parish, Louisiana. Storage in the tested aquifer was proven to be impractical due to the pre-existing ground-water movement rate of 15 cm per day. A mathematical model of the injection-storage-production process accurately predicted the recovery efficiencies observed in the two tests. The quantity of injected water was not adversely affected by geochemical reactions occurring during the tests. The injected water was softened during storage by ion-exchange reactions between injected water and clay particles in the aquifer.

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Visser WA. Waste disposal and underground waters. GEO 1974;53(6):249-56.

Underground waste management, environmental implications and artificial recharge were the subjects discussed in two symposia, respectively in Houston, Texas, in 1971 and in New Orleans, Louisiana, in 1973. In the present paper the author summarizes aspects of the injection of liquid wastes into reservoir rocks through deep wells in the USA. These aspects concern legislation and policy, statistics and actual conditions in some regionally important disposal zones. Attention is given to the protection of useful subsurface waters. Ground waters (those waters that take part in the present hydrologic cycle) and formation waters (those that are isolated from the present cycle) are distinguished. Disposal in the former constitutes a potential hazard to the environment, in the latter under certain precautions disposal may be considered safe. In The Netherlands, conditions are such, that aquifers that are properly isolated from the present hydrologic cycle occur at depths greater than between approximately 500 and 1000 m. Below these depths disposal prospects are present in sandstone/claystone alternations of upper Palaeozic to Tertiary age and possibly in upper Cretaceous limestones. In the northern and eastern parts of the country solid or liquid (including radioactive) wastes could be disposed of in artificial caverns in rock salt deposits.

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In many areas overpumping has drawn down water levels 100 ft to as much as 600 ft (30-180 m). Where these declines have occurred in unconsolidated aquifer systems containing many fine-grained compressible interbeds, the increase in effective stress has caused extensive land-surface subsidence. Significant subsidence due to water-level decline occurs in five States: Louisiana, Texas, Arizona, Nevada, and California. Principal problems caused by the subsidence are changes of elevation and gradient of natural drainages and water-transport structures, failure of water wells from compressive rupture of casings due to compaction, and tidal encroachment in lowland coastal areas.

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The Mississippi embayment, as defined for this investigation, comprises about 100,000 sq mi in the Gulf Coastal Plain, and includes parts of Alabama, Arkansas, Illinois Kentucky, Louisiana, Mississippi, Missouri, Tennessee, and Texas. The Mississippi embayment is part of a vast geologic and hydrologic province. Most of the region is underlain by aquifiers that will yield large quantities of water to wells, so that groundwater is the most readily available source of fresh water. The potential yield of the aquifers that underlie the region is estimated to be about 30,000 mgd of which about 3000 mgd is presently being withdrawn.

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