Briefing Paper on Houston Area Bayous I:
Houston Ship Channel and Upper Galveston Bay

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Description of the Watershed

This subwatershed is located in Eastern Harris, Northwestern Chambers and Southwestern Liberty Counties. This watershed group includes the San Jacinto River below the Lake Houston Dam on the west, extends east past Cedar Bayou to the city of Mont Belvieu, and northward just west of Dayton. Due to its location on the northern shore of Galveston Bay, the southern portion of this subwatershed grouping is also known as North Shore. The Lynchburg Ferry operates at the junction of the San Jacinto River and Buffalo Bayou. Baytown is this regions' largest municipality with more than 66,000 residents according to the 2000 Census. Tidally influenced water bodies inside this watershed grouping include the Lower San Jacinto River, portions of the Upper Houston Ship Channel, Upper Galveston Bay, Goose Creek, and Cedar Bayou.

Land Use and Habitat in the Watershed

Land uses in this watershed group have historically included petrochemical refining and manufacturing along the Houston Ship Channel and around Baytown, rice farming, cattle grazing, and oil production. The area is home to the old Goose Creek Oil Field, one of Texas' first big oil fields, which began production in 1915. The oil field was operated by the Humble Oil and Refining Company (now Exxon). The oil field and the Baytown Refinery of the Humble Oil and Refining Company were the driving forces for much of the development that occurred in the early to mid 20th century around what is now Baytown. The shores of the tidal reaches of the San Jacinto River and Buffalo Bayou were covered by thousands of acres of brackish water marsh at the time of settlement. Today only several hundred acres remain within the borders of the San Jacinto Battleground State Park. Subsidence has drowned most of the marsh area and industrial facilities have constructed bulkheads along much of the shoreline.

While the petrochemical industry still plays a large role in the economy of the area, portions of the subwatershed farther north are largely rural with rice farming and livestock grazing activities being dominant. These activities have converted the land from native prairie, but provide suitable habitat for some of the native wildlife that remains. Exotic species have invaded this landscape and impacted the abundance of native species. Chinese tallow trees and introduced grasses are very common components of the vegetation and imported fire ants are the most common insects in many fields.

This subwatershed includes the southernmost reaches of the Texas piney woods. The city of Mont Belvieu lies on top of a salt dome. There are salt marshes along the bay's edge and extensive forested wetlands. Land surface subsidence has played a large role in the land use of this area. Extraction of groundwater caused the land surface to subside by as much as ten feet in

an area of Baytown known as the Brownwood Subdivision. The subdivision was abandoned after Hurricane Alicia in 1983 and is now home to the Baytown Nature Center and habitat restoration efforts. For a number of years Reliant Energy owned and operated a marsh cordgrass nursery south of Baytown. Propagules grown at the nursery were used in many wetland restoration projects in the Lower Galveston Bay watershed and along the Texas Coast.

Water Quality Issues

Water quality has been impacted by the long existence of the petrochemical industry in the area. As seen in Table 1, a number of water bodies in this area are listed on the State of Texas 303(d) list of impaired waters and are deemed unsuitable for fish consumption due to elevated levels of industrial chemicals in fish and crab tissue. Finfish and blue crabs from these areas should not be consumed.

	PCBs in Catfish, Spotted Seatrout, and Blue Crab	PCBs in Finfish	Dioxin in Catfish and Blue Crabs	Chlordane, Dieldrin, Heptachlor Epoxide in Finfish	Depressed Dissolved Oxygen
San Jacinto River Tidal		▲	▲		
Houston Ship Channel / San Jacinto River Tidal	▲	▲	▲		
Cedar Bayou			▲		▲
Houston Ship Channel Tidal		▲	▲	▲	
Tabbs Bay Black Duck Bay Scott Bay San Jacinto Bay Burnett Bay	▲		▲		
Upper Galveston Bay	▲		▲		

▲ = Total Maximum Daily Load (TMDL) study underway
▲ = TMDL to be scheduled; high rank
▲ = Additional data to be collected before a TMDL is scheduled

Table 1. Summary of water bodies in the area on the Draft 2004 State of Texas 303(d) list of impaired waters. Table created by the Galveston Bay Status and Trends Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

Once on the 303(d) list, the water body becomes the subject of a Total Maximum Daily Load (TMDL) study. The TMDL process uses stakeholder input, existing data, and additional field studies to determine the amount (or load) of a pollutant that the body of water can receive and still support its beneficial use (e.g. seafood supply, aquatic life, public water supply). The load is then allocated among all the potential sources of pollution within the watershed. Measures to reduce pollutant loads are developed as necessary. Once the goal of restoring the waterbody to historic use conditions is met, the stream segment is removed from the 303(d) list.

According to the nutrient indicator (based on nitrogen, phosphorus, and phytoplankton concentrations) in Tables 1 and 2 below, the number of surface water samples exceeding nutrient screening limits set by the Texas Commission on Environmental Quality (TCEQ) appears to have improved somewhat over the last years. However, nutrient loadings still appear to be elevated in the Houston Ship Channel and Upper and Lower Galveston Bay. Note that Cedar Bayou is not listed; the data record is often incomplete.

Rating	Percent of samples exceeding TCEQ screening levels
Very Good	0-5%
Good	6-15%
Moderate	16-30%
Poor	>30%

Table 2. Indicator rating system developed for the nutrients in surface waters indicator. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center.

Subbay or Tributary	1970s	1980s	1990s	2000s
San Jacinto River				
Houston Ship Channel				
Upper & Lower Galveston Bay				

Table 3. Indicator describing the state of nutrients (ammonia, nitrate-nitrite, total phosphorus) and chlorophyll-a concentrations in surface waters as an average proportion of TCEQ screening levels by decade from the 1970s through 2000s. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality and the National Coastal Assessment, Texas Parks and Wildlife Department.

The Houston Ship Channel is noted as having elevated concentrations of fecal coliform bacteria, an indicator of possible human pathogens in the water. However, no water bodies in this watershed grouping are listed for this contaminant on the 303(d) list.

As evidenced by the number of stream segments on the Texas 303(d) list in Table 1, this area appears heavily impacted by industrial sources. Analyses by the Galveston Bay Indicators Project in 2004 compared concentrations of organic compounds in sediments to probable effect levels (PELs) established by the TCEQ (TCEQ, 2004). A PEL is defined as the concentration of a contaminant above which adverse biological effects are expected to occur. Major subbays and tributaries of the bay were rated based on the percentage of sediment samples exceeding PELs in

a given decade (see Table 5). Areas shown in the tables below as yellow or red have an increased risk of adverse biological effects due to elevated levels of sediment contamination.

Rating	Percent of Samples Exceeding the PEL
Very Good	0%
Good	1-9%
Moderate	10-25%
Poor	>25%

Table 4. Indicator rating system developed for toxic contaminants in sediments. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center.

As seen in tables 4 and 5 below, the majority of sediment quality problems occur in the Houston Ship Channel with the greatest problem being associated with industrial organics. Oddly, there were insufficient data for polychlorinated biphenyls (PCBs) in the Houston Ship Channel. PCBs are legacy pollutants used as a fire retardant; their manufacture, sale, and use were banned in the United States nearly thirty years ago. PCBs have been detected at high levels in some fish and are a partial cause of the seafood consumption advisories in place for the Houston Ship Channel and Upper Galveston Bay (see Figure 1 below).

Industrial Organics

Tributary or Subbay	1970s	1980s	1990s	2000s
Houston Ship Channel				
Upper & Lower Galveston Bay	ns			

Table 5. Indicator describing the state of industrial organics in sediment as a proportion of Marine Probable Effects Levels (PELs) published by the TCEQ ns = Insufficient sample size (< 10 samples). Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

Houston Ship Channel Detail	2000s
Acenaphthene	
Acenaphthylene	
Anthracene	
Benzo(a)anthracene	
Benzo(a)pyrene	
Chrysene	
1,2,4,6 Dibenzanthracene	
Fluoranthene	
Fluorene	
Naphthalene	
PCBs	ns
Phenanthrene	
Pyrene	

Table 6. Detail of industrial organics in sediments of the Houston Ship Channel.
ns = Insufficient sample size (< 10 samples). Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

While a number of industrial organics are found in high concentrations in the Houston Ship Channel, the story for metals in sediment is a bit more variable. Out of nine metals assessed by the Galveston Bay Indicators Project, mercury and zinc had the highest concentrations in sediments sampled from this area in years since 1999.

Metals

Tributary or Subbay	1970s	1980s	1990s	2000s
Houston Ship Channel				
Upper & Lower Galveston Bay				

Table 7. Indicator describing the state of heavy metals in sediment as a proportion of Marine Probable Effects Levels (PELs) published by the TCEQ (TCEQ, 2004). Refer to Table 4 above for a description of the color system. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

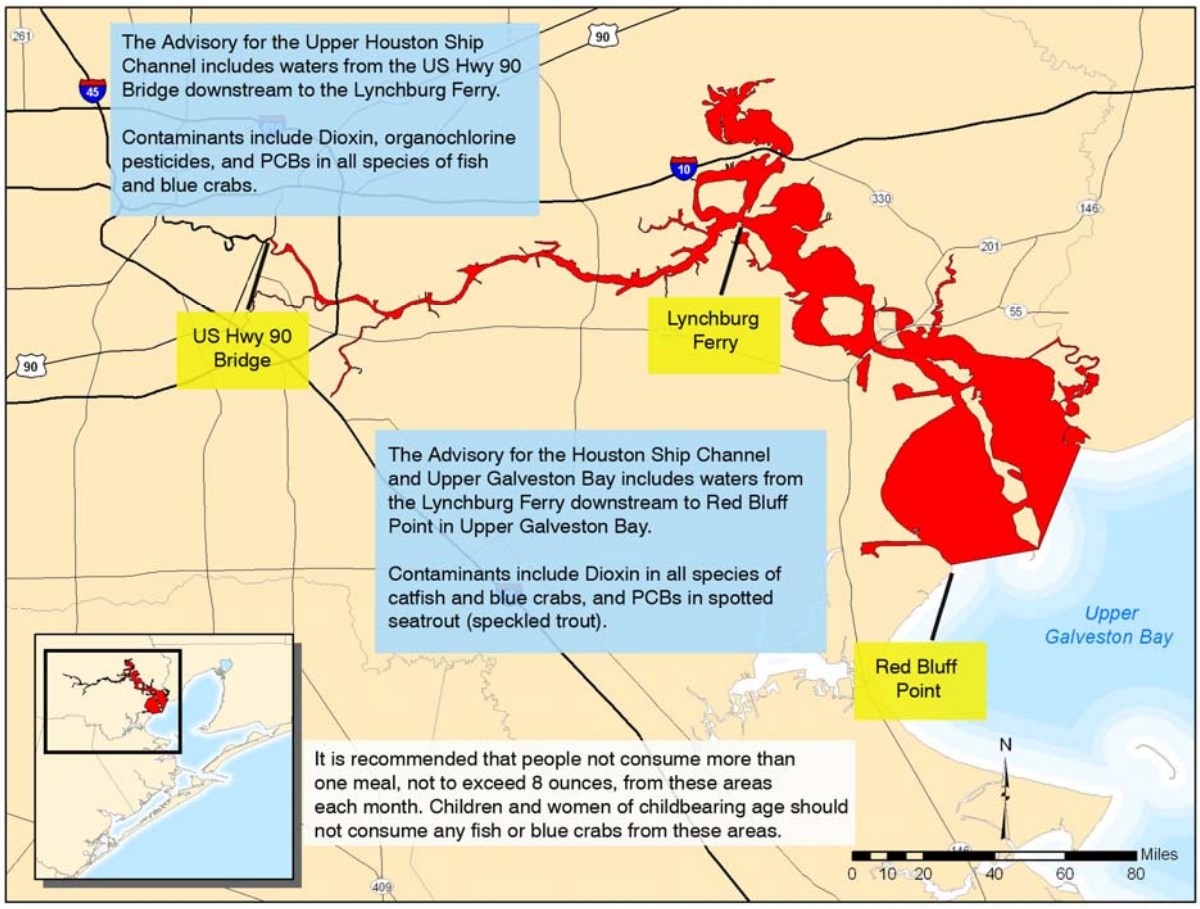
Metal	1970s	1980s	1990s	2000s
Arsenic				
Cadmium				
Chromium				
Copper				
Lead				
Mercury				
Nickel				
Silver				
Zinc				

Table 8. Detail of nine heavy metals in sediments of the Houston Ship Channel. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

Public Health Issues

Three seafood consumption advisories for Galveston Bay and its tributaries have been issued by the Texas Department of State Health Services (DSHS) since 1990. While the majority of bay and tributary surface waters are not included in seafood consumption advisories, the DSHS advises that consumption of seafood taken from the Houston Ship Channel and portions of Upper Galveston Bay poses an increased risk of adverse human health effects. All three seafood consumption advisories in 1990, 2001, and 2005 were issued for these areas (Figure 1). Contaminants of concern include dioxin, organochlorine pesticides, and PCBs. Species of concern include blue crab, catfish, spotted seatrout, and other species of finfish. Additionally, this area is prohibited by the DSHS for the commercial harvest of shellfish.

Figure 1. The Area, Species, and Contaminants Included in Galveston Bay Seafood Advisories Issued by the Texas Department of State Health Services in 1990, 2201, and 2005. Map created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Department of State Health Services.



As mentioned previously, the waterbodies in this subwatershed area are not listed on the Texas 303(d) List for elevated levels of fecal coliform bacteria. However, the Galveston Bay Indicators Project found that concentrations of fecal coliform bacteria in surface waters exceeded TCEQ screening levels to a moderate degree in the San Jacinto River south of the Lake Houston Dam and to a high degree in the Houston Ship Channel. This will not impact contact recreation in the Houston Ship Channel, since it is not used for swimming, canoeing, kayaking, etc. However, the San Jacinto River is used recreationally for these activities.

Rating	Proportion of Samples Above Screening Level
Very Good	0% samples above the screening level
Good	1-9% samples above the screening level
Moderate	10-25% samples above the screening level
Poor	>25% samples above the screening level

Table 9. Indicator rating system developed for the fecal coliform bacteria in surface waters indicator. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center.

Tributary or Subbay	1970s	1980s	1990s	2000s
San Jacinto River				
Houston Ship Channel				
Upper & Lower Galveston Bay				

Table 10. Indicator describing the state of fecal coliform bacteria in surface waters as a proportion of the TCEQ screening level. Refer to Table 12 for a description of the color system. See Appendix E for supporting data. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality and Texas Department of State Health Services.

Other Issues

Land subsidence due to extraction of groundwater has been a major issue in the areas of this subwatershed grouping, particularly near Baytown. As mentioned previously, entire subdivisions subsided to the degree that they were no longer suitable for human use, were bought out by government interests, and converted to greenspace. Given the proximity to the San Jacinto River, flooding can also be a major issue during periods of intense rainfall and high tides typical of major storm systems. As in other areas of the bay, invasive species such as Chinese tallow, water hyacinth, and fire ants out compete or prey on native species with the potential to reduce biodiversity. The channeled applesnail, a voracious herbivore native to South America, has been found on the Eastern side of Galveston Bay in Chambers County and could wreak havoc on the area's rice fields if its range continues to expand.

Conclusion

This area of the Lower Galveston Bay Watershed is one of the most heavily impacted in terms of industrial loadings to local waterways. Numerous stream segments are on the state list of impaired waters due to industrial contaminants in fish and crab tissue. Several seafood consumption advisories have been issued by the Texas DSHS since 1990 due to elevated levels of PCBs and dioxin. Industrial organic compounds in sediment are elevated to levels indicative of high risk of adverse impacts to benthic organisms that dwell in or on the sediments. In addition to water and sediment quality problems and elevated health risks due to consumption of seafood, other issues of concern are land subsidence and relative sea level rise, flooding, and invasive species. Much work needs to be done if the trends in environmental contamination in this area of the Lower Galveston Bay watershed are to be reversed.