REV. 1

PROJECT OPERATIONS MODELING STUDY PLAN

TOLEDO BEND RELICENSING PROJECT FERC NO. 2305

May 2009

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1.0 INTRODUCTION

1.1 General Description of the Toledo Bend Project

The Sabine River Authority of Texas (SRA-TX) and the Sabine River Authority, State of Louisiana (SRA-LA) (collectively, the Authorities) collaborated to develop the Toledo Bend Project (Project) located on the Sabine River. Construction was completed in October 1966. The Project is jointly operated by SRA-TX and SRA-LA through Toledo Bend Project Joint Operations (TBPJO).

The Project was originally planned, licensed, and constructed as a water supply facility, but it also provides multiple uses, such as hydroelectric power generation and recreation. The Project is located approximately 156.5 miles upstream of the confluence of the Sabine River and the Gulf of Mexico. Both the Project and this reach of the river serve as the border between the States of Louisiana and Texas.

The Project Reservoir (which is oriented in a southeast to northwest direction), is approximately 85 miles in length. The Project extends approximately 132 river miles (RM) (channel miles) from Toledo Bend Dam, which is located at RM 147,1 upstream to above Logansport, Louisiana (i.e., Murvaul Bayou), located at RM 279. The Project occupies lands and waters within Panola, Shelby, Sabine, and Newton Counties in Texas and De Soto, Sabine, and Vernon Parishes in Louisiana. Toledo Bend Reservoir is the largest manmade body of water in the southern United States and the fifth largest in surface area in the country.

The Reservoir has approximately 1,200 miles of shoreline with a water surface area of 185,000 acres at the normal maximum reservoir elevation of 172.0 feet mean sea level (msl). The Toledo Bend Reservoir is 7 miles at its widest point and contains a storage volume of 4,477,000 acre-feet between elevations 162 feet and 172 feet. Primary hydroelectric generation occurs between 168 and 172 feet. The watershed above Toledo Bend Dam is approximately 7,178 square miles with an estimated runoff in 2004 of 3.6 million acre-feet (SRA 2008). Historically, water levels have ranged from 161.3 feet msl to 173.9 feet msl.

As currently licensed, the principal Project works consist of:

- A rolled earth-fill dam with a maximum height of 112 feet and a length of 11,250 feet (including saddle dikes);
- A reservoir covering 185,000 acres with approximately 1,200 miles of shoreline and an active storage capacity of 4,477,000 acre-feet;
- A spillway comprised of a concrete, gravity-type, gated ogee section with a concrete chute and stilling basin located on the left abutment (in Louisiana). The spillway has a maximum length of 838 feet with eleven 40-foot by 28-foot Tainter gates. The top of the gates is at elevation 173 feet and top of the spillway ogee is at elevation 145 feet. A continuous flow of 144 cubic feet per second (cfs) is provided at the spillway;
- A powerhouse located in the right abutment (in Texas) containing two 58,500 horsepower (43.875-MW) vertical Kaplan turbines with direct drive generators, a tailrace channel, and appurtenant electrical and mechanical facilities.

1.2 Relicensing Process

The current Toledo Bend license extends to September 30, 2013. The Authorities intend to relicense the Project using the Integrated Licensing Process (ILP) as promulgated by Federal Energy Regulatory Commission (FERC) regulations issued July 23, 2003 (18 CFR Part 5).

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Pursuant to the FERC ILP regulations, the Authorities filed their Pre-Application Document (PAD) and Notice of Intent (NOI) with FERC on September 22, 2008. Following the Authorities' filing of the PAD and NOI, FERC issued Scoping Document 1 (SD1) on November 21, 2008 and convened scoping meetings and a site tour for agencies and members of the public on December 16 – 17, 2008. Based on the information in the PAD and SD1, as well as information exchanged in the scoping meetings, agencies and other stakeholders had until January 21, 2009 to submit comments and study requests. The Authorities received comments and study requests from six resource agencies, one non-governmental organization, and FERC Staff. In total, these commenters recommended forty-four studies, including several studies related to operations modeling. The Authorities have carefully reviewed these recommended studies, and have developed this proposed Operations Study Plan.

2.0 GOALS AND OBJECTIVES

The goals of this study are to:

(1) Provide the necessary information to document the existing flow conditions, the contribution of Project flows to flows at specific locations below the Project, seasonal flow distribution, and the occurrence and frequency of characteristics of low, normal, and high flow periods under Project conditions. The information developed under the Project Operations Modeling Study will provide a critical input to the operations modeling task.

(2) Evaluate the existence and magnitude of Project operational effects due to ramp rates (i.e., rates of flow change) immediately downstream of the Toledo Bend tailrace and in the lower Sabine River downstream to Shoats Creek (RM 54).

(3) Provide a tool (CHEOPS™ model) for evaluating reservoir levels and the Sabine River flow conditions under various potential alternative operational scenarios relative to the Toledo Bend Project operations and proposed hydropower unit at the spillway.

This study will involve the review and analysis of existing hydrology information and the development of additional hydrologic data to supplement the information provided in the PAD. This study will also describe existing flow rates downstream of the Project during periods of normal and low flows to develop a data baseline. An additional component of this study is to document and describe the ramping rates within the spillway caused by the backwater effect anticipated during scheduled releases.

Specific goals include the following:

(1) Review available hydrology data collected by the Sabine River Authority-Texas (SRA-TX), Texas Commission on Environmental Quality (TCEQ), Louisiana Department of Environmental Quality (LDEQ), United States Fish and Wildlife Service (USFWS), United States Geological Survey (USGS), and any other entities, such as the Texas Parks and Wildlife Department (TPWD), Louisiana Department of Wildlife and Fisheries (LDWF), and local universities. Hydrologic data related to Project operations has been provided in the Pre-Application Document (PAD).

(2) Characterize hourly, daily, seasonal, and annual flows in the lower Sabine River downstream to Shoats Creek (RM 54). The study will also develop and analyze patterns of accretion flow and precipitation downstream of the Project.

(3) Supplement existing data on flow attenuation by collecting additional hydrology data from the lower Sabine River. This data will include the installation of leveloggers (i.e., pressure transducers) at specific locations in the lower Sabine River and tributaries. The additional hydrology data will be collected downstream to Shoats Creek at RM 54. These leveloggers will supplement the data already provided in the PAD. The leveloggers will also be used to evaluate the four primary factors associated with flow as part of this study:

  a. Ramp rate
  b. Timing, both seasonal (i.e., peaking) and diurnal
  c. Frequency
  d. Amplitude of the flow change
  e. Magnitude of the flow change

(4) Provide a CHEOPS modeling tool for evaluating reservoir levels and Sabine River flow conditions under various alternative operational scenarios relative to the Toledo Bend Project operations and proposed hydropower unit at the spillway. Results will be used in combination with other studies and/or models to develop an improved understanding of the system relative to possible licensing conditions.

3.0 STUDY AREA

The lower Sabine River hydrology study area includes the immediate tailrace, spillway and spillway channel (RM 147), and lower Sabine River downstream to Shoats Creek at RM 54 (see Attachment A). Inflows from the larger tributaries such as Toro Bayou, Anacoco Bayou, Big Cow Creek, and Shoats Creek will also be determined.

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The ramping rate study area will include the spillway and the tailrace immediately below the dam, as well as the lower Sabine River downstream to RM 54 (Shoats Creek). Past studies indicate this is the upper zone of operational effect and would most likely be subject to ramping influences (Phillips 2007).

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The study area for the Reservoir Operations Model will include:

- The Toledo Bend Project reservoir and reach downstream to Shoats Creek at RM 54
- The installation of a new low-flow hydropower unit within the spillway of the Toledo Bend Dam

4.0 BACKGROUND AND EXISTING INFORMATION

For power generation purposes, the Authorities have historically operated the reservoir between a normal maximum reservoir elevation of 172 feet and 162.2 feet. Recently the Authorities have operated the Project at reservoir levels between 168 feet and 172 feet to comply with requirements of Louisiana state law and contracts with power companies.

The Project is operated in accordance with an operating guide curve that governs the production of both primary and secondary power. Primary power, defined under the Authorities' power sales agreement, refers to power produced each year from May through September and can be generated at any time the water surface elevation is above 168 feet.

During the May through September timeframe when water levels are above 168 feet, the Project powerhouse releases either 7,000 cfs (one unit operation) or 14,000 cfs (two-unit operation) to the lower Sabine River generally for 6 to 8 hours to meet the afternoon and evening peak electrical demand period. The turbines can ramp from speed-no-load to a maximum hydraulic capacity in less than 10 minutes. In addition to the releases for generation, there also is a continuous release of 144 cfs from the spillway to the spillway channel that joins flow from Toro Bayou located approximately 1.0 mile below the spillway. Powerhouse leakage has been estimated currently to be about 30 cfs per unit when the units are not in operation. Bearing cooling water and dam controlled seepage accounts for an additional 5-15 cfs of flow.

Project generation generally occurs five to six days per week during the May to September season, depending on water supply and electrical demand. For the remaining year, generation flows are driven by reservoir levels to meet the Project's reservoir guide curve, and can occur on a constant or pulsed basis, depending on inflows and reservoir elevation. Typically, the reservoir is at its highest during the winter and early springs months and, beginning in May, the Authorities gradually draw the reservoir to reach its lowest level in the fall.

The Lower Sabine River is situated along one of the largest expansions of bottomland and floodplain forest in the region. Existing and relevant information concerning the reach of the Sabine River downstream of the Project has established that summer peaking flows have little effect on these adjacent bottomland communities. Recent studies (Phillips 2003) also stated the long-term pattern of release from the Toledo Bend Reservoir, combined with downstream flow attenuation, creates a flow regime in the lower basin that mimics the pre-dam regime on at least a monthly and annual basis.

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The Authorities have conducted a Pre-PAD study to provide information on the location and distribution of vegetative species and the composition, structure, classification, and condition of the existing bottomland communities within the zone of operational influence of the Project along the Sabine River downstream of the Toledo Bend Project (Appendix C of the PAD – Lower Sabine River Bottomland Study).

Phillips (2007) studied geomorphic controls and transition zones in the lower Sabine River. Phillips evaluated many different types of physical influence on river zonation including geology, valley confinement, channel network characteristics, sinuosity, channel and valley slope, paleomeander scars, point bar characteristics, and hydrology. Based on the coincidence of several of these factors at five key transition zones, Phillips subdivided the 147 miles of lower Sabine River into six major geomorphic zones. While there is an assumed but undefined ecological tie to these zones, Phillips also noted more subtle subdivisions, particularly in the reaches immediately downstream of Toledo Bend Dam. While these smaller subdivisions do not rise to the level of major geomorphic zones, they may have substantial influence on aquatic habitat from a fish habitat and community perspective. The discussion below describes the zone relevant to this study plan, from RM 147 to RM 132 and the powerhouse tailrace.

The first 15-mile reach below Toledo Bend Dam has many visible alterations of habitat due to the construction and operation of the Project. River flows have been rerouted around the first one-mile stretch of Sabine River channel by the two flow-control structures of the Project, the powerhouse and spillway. The powerhouse is located at the southern end of the dam. An excavated tailrace channel runs from the powerhouse in a southeasterly direction for 1.6 miles and joins the Sabine River channel at RM 141. The channel is linear and deep with steep banks. Flows through the tailrace channel from the powerhouse turbines typically are around 7,000 or 14,000 cfs, representing one or two unit generation flow. During non-generating periods, the channel remains wetted due to backwater from the Sabine River and minor seepage from turbines and groundwater sources. While physical habitat in the tailrace channel is unremarkable, it supports a substantial number of fish, primarily suckers and predator species.

The spillway is located at the northern end of the dam, just below RM 147. The spillway channel runs in a southeasterly direction for 1.3 miles where Toro Bayou joins the channel, followed by the confluence with the old Sabine River channel near RM 145. The channel splits and forms a small island at this point. A one-mile reach of the old channel above the confluence is backwatered, but has no measurable flow. From this point, the Sabine River flows approximately four miles to the confluence with the tailrace channel at RM 141. This six-mile reach of river, from the spillway to the tailrace, receives a constant flow of 144 cfs released at the spillway.

Toro Bayou provides additional flow (22 cfs mean annual flow at the upstream gage) to augment the spillway discharge. During occasional flood conditions, this reach also receives all additional river flow in excess of the powerhouse hydraulic capacity (14,800 to 16,000 cfs). From an aquatic habitat perspective, this first six miles of the Sabine River below the Toledo Bend spillway functions as a large tributary, with Toro Bayou providing some natural flow variability. The upper two miles are relatively straight and scoured from flood flows with pool, run, and some riffle habitat. The lower four miles follow the meandering path of the original Sabine channel, and there is sufficient sediment to maintain small point bars at each bend. Pool and run habitat predominates in this reach. However, backwater from the tailrace channel during generation affects stage in this reach well beyond the levelogger station located 1.2 miles upstream of the tailrace.

Below the tailrace and spillway channel confluence, there is a four-mile reach of river (RM 141 to 137) down to the Jones Creek confluence that is relatively straight with an incising channel and pronounced scour. Phillips (2007 and 2003) references the Toledo Bend scour zone to this reach. Sediment load is low in this reach due to the sediment trapping effect of the Reservoir, and sediment mobilization is high. Point bars are not present in this reach and bedrock is evident, limiting incision in some channel locations. In terms of aquatic habitat, there appears to be a low diversity, consisting of mostly shallow to deep runs or pools depending on discharge and little to no cover other than sparse woody debris or bank cover of relatively low value.

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The remainder of this reach, from Jones Creek to Burkeville/Burr Ferry (RM 137 to 132), is transitional in nature. In this reach, the river channel resumes its meandering pattern with sediment recruitment increasing and point bar formations at most river bends. At Burkeville/Burr Ferry, Phillips (2007 and 2003) notes that all evidence of scour resulting from the operation of Toledo Bend has ended. This point marks the first major downstream geomorphic transition below Toledo Bend (Phillips 2007). Phillips notes the distinguishing characteristics at this point include a change in slope (9.8 to 4.6), the return of point bars and active channel migration, and the downstream limit of scour attributable to Toledo Bend operations.

Aquatic habitat in this reach is likewise transitional, with pool and run point bar habitat becoming the dominant feature and increasing amounts of cover including woody debris. Hydraulic influence of daily peaking has diminished substantially at this point from 10 ft within an hour at the tailrace to 3 to 8 ft in 6 hours near Burkeville/Burr Ferry.

Information regarding the Project operations and facilities was included as part of the PAD development and includes but is not limited to the following:

- Physical Features
  - Reservoir Storage Curve
  - Tailwater Curve
  - Spillway Curve
  - Reservoir Area Curve
  - Turbine Curves
  - Generator Curves

    - Limits on Unit Operations
    - Headloss Estimates
    - Leakage
- Operations
    - Withdrawals and Returns
    - Bypass Flows and Return Points
    - Operation Type – Peaking versus Run-of-River
    - Operating Band – Minimum, Maximum, and Target
    - Pump Back Sequence and Procedures
    - Power Demand – Loadshape
    - Maintenance Schedule
    - Historic Operations
        - Lake Elevations
        - Generation – Preferably Monthly
        - Withdrawals and Returns

As discussed in the PAD, the Authorities are studying the feasibility of a new low-flow hydropower unit within the spillway of the Toledo Bend Dam. If constructed, the unit would extract energy from water that is now released to maintain the 144 cfs minimum flow in the river. State-established minimum flow standards for the Sabine River and existing flow data from USGS gages within the area also will be used during the development of the operations model.

Relevant existing information for this study includes the physical configuration of the Project facilities and overall information regarding the operation of the Project. Information regarding the Project operations and facilities was included as part of the PAD (Section 4.0).

5.0 PROJECT NEXUS

The operation of the Toledo Bend Project affects the hydrology of the lower Sabine River at least during low and normal flow conditions from the Toledo Bend Dam downstream to Shoats Creek (RM 54). In the area of Shoats Creek, there are definitive changes in river geomorphology and changes in river and bottomland ecology. Phillips (2008), states that in this area the Sabine River takes on a different character with a wider floodplain, and a transition from dominantly convergent tributaries to dominantly divergent stream network. Phillips (2008) also states that rather than tributaries that flow into the Sabine River, the connecting waterways are dominantly distributaries to which the Sabine River contributes water (particularly higher flows) or streams that may function as tributaries or distributaries, directing flow to or away from the Sabine River channel. Slope also decreases in this area and the number and size of point bars decrease (Phillips 2008). The upstream flow input of Big Cow Creek (RM 70) is also a significant control to the river system. Finally, Phillips (2008) states that below Shoats Creek, Toledo Bend dam impulses are of a minor influence at low flows.

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Operation of the Project has the potential to affect the magnitude, frequency, timing, rate of change, and duration of flows in the lower Sabine River, as well as reservoir levels.

6.0 METHODOLOGY

To accomplish the goals and objectives provided in Section 2.0, this Study will consist of four primary components: Literature and Data Review; Field Data Collection; Data Analysis and Reporting and development of a Project operations model. The fieldwork for the hydrology study will focus on the downstream areas from the spillway and tailrace at RM 146 through RM 54 (i.e., Shoats Creek). The ramping rate study will be included from the tailrace and spillway channel downstream to Burkeville/Burr Ferry at RM 132.

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Literature and Hydrology Data Review

Compile and review available hydrologic data (i.e., flow conditions) and other relevant information related to water quantity collected by the SRA-TX, USGS, TCEQ, LDEQ, USFWS, and any other entities, such as the TPWD and LDWF. Research will also be conducted to obtain all relevant, existing information related to water quantity at the Project. Emphasis will be assembled data will also include information gathered during pre-PAD studies, specifically the Sabine Bottomland Study. Hydrograph data will be collected from the downstream USGS stream gages including the following:

Gage Station Number	Gage Station Name
8022500	Sabine River near Logansport, LA (level only)
8022400	Sabine River near Beckville, TX

8025350	Toledo Bend Reservoir near Burkeville, TX
8025360*	Sabine River at Toledo Bend Reservoir near Burkeville, TX
8025500	Bayou Toro near Toro, LA
8026000*	Sabine River near Burkeville, TX
8028000	Bayou Anacoco near Rosepine, LA
8028500	Sabine River near Bon Weir, TX
8029500	Big Cow Creek near Newton, TX
8030500	Sabine River near Ruliff, TX
8031000	Cow Bayou near Mauriceville, TX

*Data collected from these gages will be used for ramping rates

Based on the existing information, hourly, daily, seasonal, flood flows, and annual flows (i.e., magnitude, duration, frequency and timing) in the lower Sabine River downstream to Shoats Creek will be determined. The patterns of precipitation and accretion flow from tributaries will also be analyzed. Monthly precipitation records at two climatic stations in the lower Sabine River watershed will also be collected for comparison with annual streamflow records.

Based on this search, Project water quantity temporal and spatial trends, issues, and data gaps will be assessed. A brief report documenting the data review findings will be written and shared with the relevant agencies, participants, and stakeholders for input and consideration regarding the final study scope and methods.

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Field Data Collection

To determine the extent of ramping rates, longitudinal operational influence, as well as lateral or overbank flooding during the spring, summer/early fall peaking flow period, and winter, approximately 27 leveloggers will be installed along the Sabine River downstream of the reservoir. These leveloggers will be installed along strategic and representative locations (i.e., spillway channel, tailrace and tailwater, riverbanks and bars, shoals, interior oxbows, natural levees, side sloughs and creeks) throughout the entire downstream reach (see Table 6.1 below).

As in the prior PAD study, leveloggers will also be installed in the interior bottomland oxbows to document any groundwater connectivity with the main stem lower Sabine River. The terminus of the study will be Shoats Creek at RM 54, which is the ecological transition point between the upstream bottomland hardwood and the tidally affected scrub-shrub and emergent wetlands. These levelogger locations are similar to those analyzed during the PAD bottomland connectivity study.

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TABLE 6.1
LOWER SABINE RIVER HYDROLOGY STUDY LEVELOGGER INSTALLATION LOCATIONS

Levelogger Station No.	River Mile	Location (State)	Map No.	Nearest Boat Ramp	Notes
HS-1B (SR-1B)*	146.25	Reservoir Tailwater (TX)	Map 1	N/A	Barometric Logger (upper river location)
HS-1	N/A	Tailrace (TX)	Map 1	N/A	Tailrace (immediately downstream of the powerhouse). Within ramping rate study
HS-2	N/A	Tailrace Canal (TX)	Map 1	N/A	Tailrace Canal (0.5 miles downstream of the powerhouse). Within ramping rate study
HS-3	146.70	Spillway Channel (LA)	Map 1	N/A	Spillway channel downstream of the dam. Within ramping rate study
HS-4	145.45	Toro Bayou (LA)	Map 1	N/A	Toro Bayou upstream of the confluence with spillway channel. Within ramping rate study
HS-5	145.1	Spillway Channel (LA)	Map 1	N/A	Spillway channel downstream of confluence with Toro Bayou. Within ramping rate study
HS-6 (SR-1)*	142.80	Powerline (LA)	Map 1	N/A	Along tailrace channel. Within ramping rate study
HS-7	140.00	Deep Slough (LA)	Map 1	N/A	At Deep Slough just downstream of the confluence of the canal and spillway channel.

Levelogger Station No.	River Mile	Location (State)	Map No.	Nearest Boat Ramp	Notes
					Within ramping rate study
HS-8	139.43	Sandy Creek	Map 2	N/A	At Sandy Creek confluence. Within ramping rate study
HS-9	136.03	Upstream of Runyan Hills	Map 2	N/A	1.7 miles upstream of Runyan Hills. Within ramping rate study
HS-10 (SR-2)*	133.00	Indian Creek (LA)	Map 2	N/A	Upstream of Highway 63 Bridge (RM131.62). Within ramping rate study
HS-11 (SR-3)*	121.20	Detty Creek (TX)	Map 3	"Palmer Lake" Boat Ramp (RM 102.50)	Position on immediate bank
HS-12 (SR-4)*	113.85	Mill Creek (LA)	Map 3	"Palmer Lake" Boat Ramp (RM 102.50)	Position up secondary creek
HS-13 (SR-5)*	104.29	River upstream of Anacoco Bayou (LA)	Map 4	"Palmer Lake" Boat Ramp (RM 102.50)	Position at confluence
HS-14 (SR-14)*	104.29	Anacoco Bayou (LA)	Map 4	"Palmer Lake" Boat Ramp (RM 102.50)	Position upstream of Anacoco Bayou
HS-15 (SR-20)*	99.00	8 miles downstream of the US Highway 190 Bridge (LA)	Map 5	Highway 190 Boat Ramp (RM 91.31)	Position at bank (LA) and along Bottomland Transect 1
HS-16 (SR-21)*	99.00	Interior Oxbow Lake (LA)	Map 5	Highway 190 Boat Ramp (RM 91.31)	Along Bottomland Transect 1 and at Oxbow Lake terminus
HS-17 (SR-25)*	99.00	Interior Oxbow Lake (LA)	Map 5	Highway 190 Boat Ramp (RM 91.31)	Barometric logger along Bottomland Transect 1 and at terminus (mid river location)
HS-18 (SR-22)*	99.00	Interior Oxbow Lake (TX)	Map 5	Highway 190 Boat Ramp (RM 91.31)	Along Bottomland Transect 1
HS-19 (SR-6)*	91.90	Lost Creek (TX)	Map 5	Highway 190 Boat Ramp (RM 91.31)	Position away from Oxbow Lake
HS-20 (SR-7)*	81.58	Church House Creek (TX)	Map 6	Highway 190 Boat Ramp (RM 91.31)	Position at bank
HS-21	74.00	4 miles	Map 7	Highway 190	Along Bottomland

Levelogger Station No.	River Mile	Location (State)	Map No.	Nearest Boat Ramp	Notes
(SR-24)*		upstream of Big Cow Creek (LA)		Boat Ramp (RM 91.31)	Transect 3 and within Oxbow Lake
HS-22 (SR-23)*	74.00	3 miles upstream of Big Cow Creek (TX)	Map 7	Highway 190 Boat Ramp (RM 91.31)	Position at bank and along Transect 3
HS-23 (SR-8)*	71.25	Downstream of Big Cow Creek (LA)	Map 7	Highway 190 Boat Ramp (RM 91.31)	Downstream of Big Cow Creek and off Spikes Cemetery Rd. (LA)
HS-24 (SR-9)*	58.13	Pipeline Crossing (TX)	Map 8	Highway 12 Boat Ramp (RM 35.29)	"Access" Road on TX side
HS-25 (SR-10)*	55.00	Shoats Creek (TX)	Map 8	Highway 12 Boat Ramp (RM 35.29)	Large tract of Bottomland
HS-26B (SR-13B)*	55.00	Shoats Creek (TX)	Map 8	Highway 12 Boat Ramp (RM 35.29)	Barometric Logger (lower river location)

* Original Pre-PAD study levelogger station numbers.

Additional leveloggers may be required in the interior bottomland areas to document overbank flows and oxbow lake conditions

A barometric logger will be installed at RM 146.37 (i.e., Toledo Bend Dam) and RM 55.00 to capture any variation in barometric pressure between the upper and lower study sites. The leveloggers will be anchored to the adjacent wood structure through use of 1/8th stainless steel cable. A temporary benchmark nail will be installed at the anchor point and the height of the nail above the current water level will be measured as reference. The temporary site will be flagged with fluorescent orange survey tape and tracked with GPS for site location reference. The leveloggers will be deployed from late August 2009 through early July 2010 in an effort to capture a wide range of flow conditions. Upstream and downstream photographs will be taken at each installation location. Levelogger data will be at least downloaded monthly. Channel observations will also be recorded; these will include bank height and grade, bank stability, substrate composition, signs of drift lines, inundation, and high water marks.

Reservoir Operations Model

Step 1- Develop a Toledo Bend Project Operation Model - The Authorities will utilize a CHEOPS™ (Computerized Hydro Electric Operations Planning Software) model to develop a Toledo Bend Project Operations Model. CHEOPS is a deterministic, computer model that combines a number of other models, and is customized for each project in which it is used. CHEOPS is a deterministic model in that it contains no random (stochastic) components. Consequently, each component and input is determined exactly by mathematical equations or exact measured data so that for any specified input scenario, the corresponding model output variables are exactly determined. CHEOPS is a computer model, runs on a computer, and is built using Microsoft Visual Basic code with output data written to Microsoft text files and Microsoft Excel worksheets to facilitate data analysis and presentation. This task includes the development of hydrology at each of the node locations using available USGS gage records and historic plant information. The hydrology data will be gathered during the previously mentioned study tasks.

CHEOPS is a numerical representation of a conceptual model regarding operation of the Toledo Bend Project. To capture this concept, CHEOPS' logic follows two sequential steps. In the first step, for each day in the model run period and from upstream to downstream in the system, CHEOPS calculates the amount of water available for use in each Project reservoir in that day. This calculation is based on the reservoir elevation at the beginning of the day, inflow (from the hydrology input file), and a specific end-of-day Target Evaluation for each reservoir. Each Target Evaluation is an empirical model intended to mimic how the Authorities operate the reservoir. The Target Evaluation is determined by statistically fitting an equation to historical reservoir elevation data, and confirming the resulting curve with the Authorities' Operations staff.

In the second step, for each day, and from upstream to downstream, CHEOPS allocates available water for use from each reservoir in 15-minute increments. Unless otherwise modified, the model prioritizes releases from Project reservoirs in the following order from first to last:

1) Minimum streamflow requirements including pulse flows and ramping rates;

2) Reservoir regulatory constraints, such as a minimum pool requirement;
3) Contractual water delivery obligations, such as for consumptive water;
4) Peak energy generation;
5) Peak energy generation; and
6) Off peak energy generation.

Any available water for use in that day that cannot be used is retained in the reservoir and contributes to the next day's beginning elevation.

The CHEOPS model is always run in 15-minute time steps, but output data can be viewed from annual average to daily average down to 15-minute-increment time steps. Model output would be flow out of and into the Toledo Bend Project.

For the Toledo Bend Project, the CHEOPS model will be customized using the existing physical, contractual, and other Project data described in the Existing Information section. It is anticipated that 30-years of operations and flow data will be reviewed in preparation of the model.

Step 2- Validate the Model – Model validation (determining that the model is well founded and fulfills the purpose for which it was constructed) will occur in two steps. In the first step, the Authorities will evaluate the model by comparing the model output to the historical record (mean daily flows, reservoir elevations, diversions, generation, etc.). Differences greater than 5 percent will be examined, the causes identified and documented. It is expected that some differences will occur since it is not uncommon for a licensee to change its operating strategy over time and to even add or modify facilities (including upgrading turbine/generators), which the model cannot predict; and the model does not predict unplanned outages. Where substantial differences cannot be explained, the model will be calibrated (i.e., logic/input data will be adjusted so that the model output estimates are closer to the historic values).

This task also includes model calibration runs for representative wet, dry, and normal hydrology years for which historical operating data is available. Additional model runs will be made for current operation constraints for the hydrology period of record to establish a long-term data set of existing operation as a baseline.

In the second step, the Authorities will verify that the computer model is a faithful representation of the Toledo Bend conceptual model. This will be done by making a number of model runs and reviewing the results with the Authorities' senior staff that have operated the Project.

Step 3- Modify and Re-Verify the Validated Model for New Proposed Facilities, if needed - Currently, the Authorities are studying the feasibility of adding a new low-flow hydropower unit located within the spillway of the Toledo Bend Dam. During this step, the Authorities will include the new proposed unit into the model and repeat the model verification at outlined above.

Step 4- Perform Model Runs - Once minimum streamflow and reservoir elevation requirement resource measures are identified, the Authorities' expert model user would run the model to determine if the Project could reasonably comply with these measures. If requested, the Authorities would be willing to make a reasonable number of specifically requested model runs for agencies and provide the model run results to the agencies.

Step 5- Test Study Hypotheses – Make Final Run. As a final step in this study, once the Authorities have tentatively settled on minimum streamflow and reservoir elevation resource measures it would propose in its license application, the Authorities would perform a final model run. If the model indicates that the Authorities could reasonably comply with the measures (compliance would not require an unrealistic expenditure of funds or unreasonable modification of existing facilities), it will be assumed that the study hypothesis is true.

Data Analysis and Reporting

Streamflow data from the selected mainstem and tributary USGS gages will be analyzed using spreadsheets. The information derived will include:

- Monthly flow duration curves
- Base flows (i.e., annual 1-day, 3-day, and 10-day minimum flow magnitudes and timing)
- Flood flow-frequency curves

- Flood timing graphs depicting annual peak flow magnitude and time of year for the period of record
- Total annual water year runoff of each year of record with total annual precipitation for the same period. The trends in runoff and precipitation, including wet/dry/normal years and any observed cyclic patterns will be provided
- For hourly and daily flows, the past 10 years of streamflow data will be analyzed to provide the effect of current project operations.

The longitudinal zone of Project influence within lower Sabine River and the adjacent riverine bottomland area will be confirmed through analysis of hydrologic data (hydrographs and flow data), stage discharge curves, river gage data, and data provided through the deployment of leveloggers. The leveloggers will also be used to evaluate operational ramping rates including:

- Timing, both seasonal (i.e., peaking)
- Frequency of change
- Amplitude of the flow change
- Magnitude of the flow change
- Duration of flow change

Based on the results of the aquatic biological data collected in the first year of sampling, a biological response threshold concerning flow velocities may be developed. The results and threshold development will be reviewed upon consultation with the FERC, TCEQ and TPWD. If flow velocities are determined to be a potential operational impact, a ramping rate velocity study will be conducted in the tailrace and spillway channel. The methods of this second year study will be determined upon consultation.

An initial and updated/final technical report on the results of the literature review, field data collection, and recommendations will be prepared for this study and will include the following elements:

- Project Introduction and Background
- Study Area
- Methodology

- Discussion and Analysis
- Results (including discussions of Project effects and recommendations)
- Location maps, GIS analysis and photos
- Any agency correspondence and or consultation
- Literature Citations
- Compiled CHEOPS Model

The Initial and Final reports will be submitted to the following agencies:

- Federal Energy Regulatory Commission
- Texas Commission of Environmental Quality
- Louisiana Department of Environmental Quality
- Texas Parks and Wildlife Department
- Louisiana Department of Wildlife and Fisheries
- United States Forest Service
- United States Fish and Wildlife Service
- United States Parks Service
- Other interested stakeholders

7.0 SCHEDULE

The preliminary schedule or the conduct of this Study is outlined below:

1. FERC issues the Study Plan Determination: August 7, 2009
2. Study Planning and Data Review Commences: August 8, 2009
3. Field Data Collection Commences: August 17, 2009
4. Develop, Validate, and Perform CHEOPS model: September 15, 2009-June 1, 2010
5. File Progress Report (Authorities): October 3, 2009
6. Field Data Collection Ends: June 1, 2010
7. File Initial Study Report (Authorities): October 30, 2010
8. Initial Study Report Meeting (Authorities and Stakeholders): November 15, 2010
9. File Study Report Meeting Summary (Authorities): November 30, 2010
10. File Meeting Summary Comments (Authorities): December 30, 2010

11. File Response to Meeting Summary Comments (Stakeholders): January 28, 2011

12. Study Plan Resolution/Amendments by FERC: February 28, 2011

8.0 BUDGET

This study would likely take one study season to complete. The estimated budget for the study is approximately $380,000.

9.0 DISCUSSION OF ALTERNATIVE APPROACHES

The proposed methods for this study are consistent with professional practices and current scientific methodologies. The overall approach is commonly used in relicensing proceedings and is consistent with FERC study requirements under the ILP. No alternative approaches to this study have been identified at this time.

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10.0 REFERENCES

Brinson, M.M, Hauer, F.R., Lee, L.C., Nutter, W.L., Rheinhardt, R.D., Smith, R.D., and Whigham, D. 1995. A guidebook for application of hydrogeomorphic assessments to riverine wetlands. Technical Report WRP-DE-11, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Cowardin, L.M., V. Carter, F.C. Golet, E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Dept. of Interior, Fish and Wildlife Service. FWS/OBS-79/31. 131pp.

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Dept. of Army Waterways Experiment Station, Corps of Engineers, Vicksburg, MS. Technical Report Y-87-1. 100pp.

Louisiana Department of Wildlife and Fisheries. 2004. Natural Communities of Louisiana. Natural Heritage Program.

Martin, W.H., S.G. Boyce, A.C. Echternacht. 1993. Biodiversity of the Southeastern United States: Lowland Terrestrial Communities. John Wiley & Sons. 502 pp.

National Wetlands Inventory in cooperation with the USFWS. 1988. National List of Plant Species that Occur in Wetlands: 1988 Southeast (Region 2).

Pacificorp. 2003. Evaluation of Ramping Effects on Fish Downstream of Link Dam, Keno Dam, J.C. Boyle Dam, J.C. Boyle Powerhouse, and Copco No. 2 Dam. Klamath Hydroelectric Study Plans (FERC Project No. 2082). Portland, Oregon. August 2003 11pp.

Phillips, J.D. 2008. Geomorphic Unites of the Lower Sabine River. Project Report for the Texas Water Development Board and Texas Instream Flow Program, TWDB contract number 074830782. Final Report. August 2008

Phillips, J. D. 2007. Geomorphic controls and transition zones in the lower Sabine River. Hydrological Processes. Published Online in *Wiley InterScience*. URL: www.interscience.wiley.com (accepted for publication 5/21/2007).

Phillips, J. D. 2003. Toledo Bend Reservoir and Geomorphic Response in the lower Sabine River. River Research and Applications 19:137-159. Wiley Interscience.

Radford, A. E., H. F. Ahles and C. R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill.

Texas Parks and Wildlife Department. 2007. Texas Coastal Wetlands. http://www.texaswetlands.org/riverine.htm

United States Army Corps of Engineers. 1991. Wetland Evaluation Technique (WET): Volume I Literature Review and Evaluation Rationale. Wetlands Research Program Technical Report WRP-DE-2

USDA, NRCS. 2004. The PLANTS Database, Version 3.5. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. http://plants.usda.gov

Wharton, C.H., W.M. Kitchens, E.C. Pendleton, and T.W. Sipe. 1982. The Ecology of Bottomland Hardwood Swamps of the Southeast: A Community Profile. USDOI-USFWS. FWS/OBS-81/37. 133 pp.

Deleted: USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA. (Juncus effusus)¶
http://plants.usda.gov/cgi_bin/plant_attribute.cgi?symbol=JUEF¶

ATTACHMENT A

SCHEMATIC DIAGRAM OF THE FEATURES ASSOCIATED WITH THE LOWER SABINE RIVER

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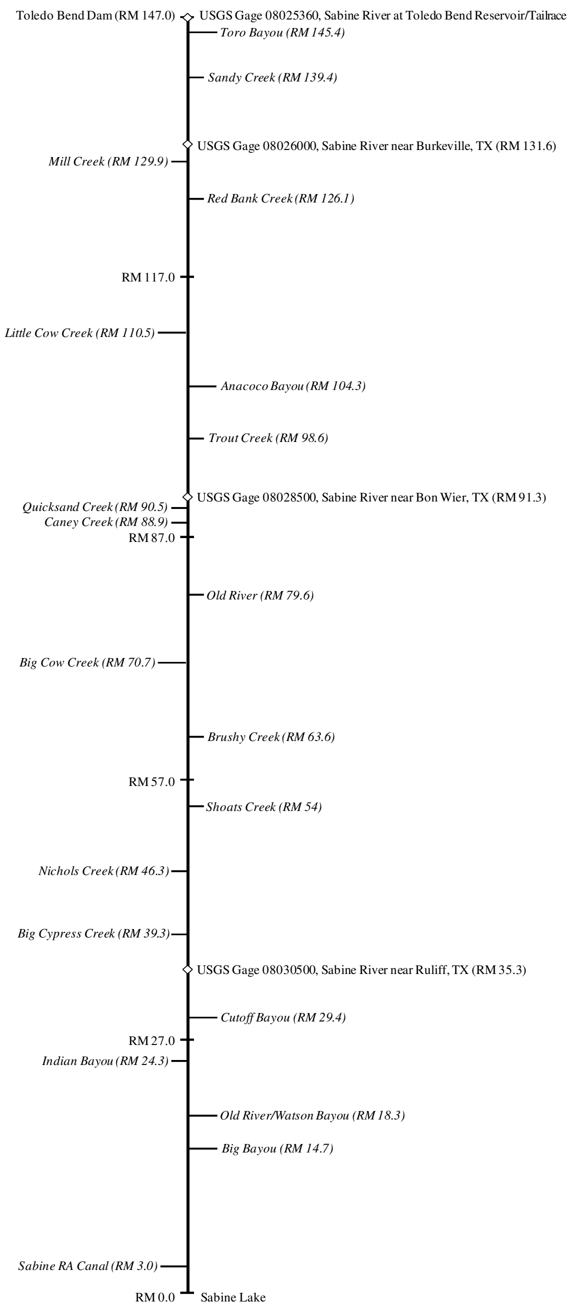

Schematic Diagram of the Features Associated with the Lower Sabine River (figure drawn to scale)