TEXAS INSTREAM FLOW STUDIES: PROGRAMMATIC WORK PLAN

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Texas Parks and Wildlife Department
Texas Commission on Environmental Quality
Texas Water Development Board

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INTRODUCTION

The Programmatic Work Plan for Texas Instream Flow Studies is intended to outline the scope, timeframe, and methodology for planning and conducting priority studies. It also describes the responsibilities of the Texas Water Development Board (TWDB), the Texas Parks and Wildlife Department (TPWD), and the Texas Commission on Environmental Quality (TCEQ), who will jointly conduct the studies, as mandated in Section 16.059 of the Texas Water Code. Study results will be incorporated into future regional and state water plans, and will become essential data for conservation of fish and wildlife resources and consideration in the state water rights permitting process.

A high quality, natural environment is essential for conserving the quality of life Texans, future generations of Texans, and visitors to this state enjoy. Intact and functioning ecosystems are also critical for maintaining a strong state economy. Healthy aquatic systems that maintain biological integrity are essential to conserve the state's natural biodiversity, as well as support tourism, recreational pursuits, commercial and recreational fisheries, and a myriad of other industries.

TCEQ is the state agency charged with implementing the constitution and laws of the state relating to water. Jurisdiction over those areas related to surface water include: 1. water and water rights; 2. continuing supervision over districts created under Article III, Section 52(b)(1), and Article XVI, Section 59, of the Texas Constitution; and, 3. the state's water quality program (§5.013 of the Texas Water Code). Environmental reviews of water right applications are conducted in accordance with §11.147, §11.1491, §11.150, and §11.152 of the Texas Water Code and with TCEQ administrative rules which include 30 TAC §297.53 through §297.56. These statutes and rules require the TCEQ to consider the possible impacts of the granting of a water right on the fish and wildlife habitat, water quality, and the instream uses associated with the affected body of water. In addition, possible impacts to bays and estuaries are addressed. Examples of significant impacts are those that affect natural resources; result in deterioration of water quality or flood protection; result in unallowable reduction of identifiable instream uses; endanger species of plant and animal life and their habitat; significantly reduce productivity of the bay and estuary systems; or contribute to a series of related projects that involve individually minor but collectively significant adverse impacts.

TPWD is the state agency with primary responsibility for protecting the state's fish and wildlife resources (§12.0011 of the Parks and Wildlife Code). TPWD's resource protection activities include: investigating fish kills and any type of pollution that may cause loss of fish or wildlife resources, taking necessary action to identify the cause and party responsible for the fish kill or pollution, estimating the monetary value of lost resources, and seeking restoration through presentation of evidence to the agency responsible for permitting or through suit in county or district court; providing recommendations that will protect fish and wildlife resources to local, state, and federal agencies that approve, permit, license, or construct developmental projects; providing information on fish and wildlife resources to any local, state, and federal agencies or private organizations that make decisions affecting those resources; and providing recommendations to TCEQ on scheduling of instream flows and freshwater inflows to Texas estuaries for the management of fish and wildlife resources. TPWD shall make recommendations to protect fish and wildlife resources, including permit conditions, mitigation, and schedules of

flow or releases and shall be, on its request, a full party in any hearing on an application for a permit to store, take or divert water (§12.024 of the Parks and Wildlife Code).

TWDB is the state agency charged with water planning and financing for the needs of people and the environment. SB1 provided a new direction in water planning, including considerations for environmental assessments. Board rules were developed in compliance with that statute, for environmental considerations in regional and state water plans for the instream flow needs, assessment of wildlife habitat impacts of water resource development, and protection of cultural resources. SB1 directed TWDB to coordinate the regional water planning process and to develop a state water plan that incorporates the regional water plans, including environmental assessments and environmental flow needs through interagency consensus flow criteria. TWDB has a long-term cooperative study with TPWD to establish and maintain on a continuous basis a bay and estuary data collection and evaluation program, and conduct studies and analyses of inflow conditions needed to support a sound ecological environment, as legislatively mandated by Texas Water Code §16.058(a).

Legislative Directive

In 2001, the 77th Session of the Texas Legislature, passed Senate Bill 2, which in part, amended §16.059 of the Texas Water Code to include the collection of instream flow data and the conduct of studies. The legislation directed TPWD, TCEQ, and TWDB, in cooperation with other appropriate governmental agencies, to "…jointly establish and continuously maintain an instream flow data collection and evaluation program…" In addition, the agencies were directed to "…conduct studies and analyses to determine appropriate methodologies for determining flow conditions in the state's rivers and streams necessary to support a sound ecological environment." The priority studies identified by the three agencies are to be completed not later than December 31, 2010.

INSTREAM FLOW FOR RIVERS AND STREAMS

Growing concern has arisen that water development without provisions for maintaining sound ecological environments will lead to loss of important fish and wildlife resources, recreational pursuits, economic opportunities, and the quality of life. To protect these resources, impacts due to water development and the use of water from rivers, streams, and groundwater-fed springs must be avoided or minimized.

The study of instream flows was forged in the last 40 years by scientists from multiple disciplines in response to increased water development throughout the world. For the purposes of this work plan, instream flow is defined as the flow regime adequate to maintain an ecologically sound environment in streams and rivers including riparian and floodplain features (considering hydrology, biology, geomorphology, water quality, and connectivity) and necessary for maintaining the diversity and productivity of ecologically characteristic fish and wildlife and the living resources on which they depend. Instream flow may also be defined as those flows needed to support economically and aesthetically important activities such as water-oriented recreation and navigation. The goal of an instream flow study is to determine an appropriate flow regime (quantity and timing of water in a stream or river) that conserves fish and wildlife resources while providing sustained benefits for other human uses of water resources.

Scientists should consider more than just where aquatic organisms live (habitat) when addressing the instream flow needs of a system. River ecosystems are complex and many biological, chemical, and physical processes are intertwined and dependently linked. The river ecosystem

includes the habitat within the channel, riparian habitat adjacent to the river channel, and the floodplain. The flow regime of the river has ties to water quality and to the physical processes that create and maintain habitat. The timing of flows is also important because fish and wildlife have tied their life cycles to certain flow events and seasons. For example, most fish usually spawn in the spring when flows are higher. Further, some species do better in wet years and others do better in dry years. To ensure diversity and productivity of river ecosystems, both inter-annual and intra-annual (seasonal) variation in flow must be maintained.

Development of sound, defensible scientific information through field studies is often difficult because of the wide variability in weather and the resulting fluctuation of flows and biological responses. Conducting a study during a drought will lead to erroneous conclusions just as working during a period of abnormally high flows. Floods may create unworkable conditions from a safety standpoint, but can also temporarily alter the biological and physical characteristics of the stream. During low flow conditions aquatic organisms are typically forced into refugia habitats, which may bias the biological data.

On-going Cooperative Studies

The Lower Guadalupe River Instream Flow Study began in 1998 with cooperation by the TPWD, TWDB, TCEQ and the Guadalupe-Blanco River Authority (GBRA). Instream habitat and water quality models are being calibrated to assess instream flow needs for fish and wildlife resources in the lower basin (Seguin to Victoria). A critical missing element is biological data (habitat utilization), which has been difficult to develop due to uncooperative river flows (floods, low flows, and hydropower operations). Biological sampling should be completed in 2003. Data needs to be collected for completion of the water quality model and should be finished by summer 2003. Limited information is needed for calibration of instream habitat models and should be finished in 2003 though data collection will be dependent on how quickly the channel reaches equilibrium after the floods of 2002. Once remaining data needs are met, models will be integrated to develop a set of recommendations. A report will be finished in 2004.

An instream flow study is being conducted on the lower Brazos River in cooperation with the TWDB, TPWD, and TCEQ; the permittees (City of Houston and Brazos River Authority) are represented by Freese and Nichols, Inc. This study is associated with the proposed Allens Creek Reservoir project. Agency staff serve on an instream flow steering committee formed as a result of a Memorandum of Agreement. As part of this study, TWDB obtained U.S. Army Corps of Engineers (COE) funding to develop a hydrodynamic river model of the affected segment immediately downstream of the Allens Creek diversion point and to characterize patterns of habitat utilization by the fish community. In addition, the COE funded TWDB to develop a hydrodynamic and salinity model for the estuarine (tidal) segment of the river near its mouth where intrusion of saline water from the Gulf of Mexico is of concern. Final reporting documents will be prepared by the end of February 2003, whereupon the cooperating agencies will determine what remains to be done to complete the study.

On-going Special Studies

Two special studies have been identified; one tied to the lower Colorado River and the other to the Sulphur River. The first was included to recognize the importance of validating instream flow recommendations that have been implemented as part of the Lower Colorado River Authority's Water Management Plan. The second is a study in progress by TWDB and the COE on the upper Sulphur River that is related to the potential future Marvin Nichols Reservoir project. As part of this study, TWDB has developed a hydrodynamic river model of affected stream segments in the

area and will characterize patterns of habitat utilization by the fish community. Preliminary results of the Sulphur River study will be available by the end of February 2003, whereupon the cooperating agencies will develop a study plan for the entire subbasin and determine what remains to be done to complete the study. The need for a subbasin study is primarily due to the Marvin Nichols Reservoir and other potential reservoir projects in the region, including the four unique reservoir sites identified in the State Water Plan. Although the Marvin Nichols Reservoir is planned for construction by 2030, water rights permitting may take place sooner. Recognizing that priority studies will fully utilize agency instream flow program resources, elevating the Sulphur River subbasin study to priority status will dictate that another subbasin study be moved to the second tier.

PRIORITY OF SENATE BILL 2 STUDIES

Priority instream flow studies were identified based on potential water development projects, water rights permitting issues, and other factors (see Appendix). Revisions may be necessary. Comprehensive evaluations will be required in these subbasins to address information needs, as it is probable that defensible data will be needed for major planning, permitting, and feasibility evaluations within the next 10 years.

A second tier of instream flow studies was developed to provide future direction in studies in the event priorities change or supplementary resources are made available to begin additional studies.

Priority Instream Flow Studies

Guadalupe River (lower subbasin): The total drainage area of the basin is 6,700 square miles that provides a major source of freshwater inflow to the San Antonio Bay system. As discussed previously, a subbasin study is on-going on the lower Guadalupe River from Seguin to Victoria. This study along with the completed bay and estuary freshwater inflow study will provide information needed to address a variety of potential water development projects including proposed off-channel reservoirs and river diversions.

Brazos River (lower subbasin): The total drainage area for the Brazos River Basin is 42,800 square miles. Allens Creek Reservoir, which has a water right permit, is being addressed through an interagency study. A MOA among the permittees (TWDB, City of Houston and the Brazos River Authority) and TPWD provides that the permit may be amended to include instream flow conditions as determined by this study. Some elements of the study are on-going.

San Antonio River (lower subbasin): The headwaters for the San Antonio River are in Bandera County, just north and west of San Antonio. The river eventually drains into the San Antonio Bay system and includes 4,180 square miles. The need for a subbasin study is largely tied to the potential for significant reuse of developed water and the uncertainty in water development strategies. There are no large storage facilities in the basin except for Medina Lake. Significant wastewater return flows could be transferred throughout the basin and even out of the basin. Water rights development in the Medina River watershed may require minor evaluations.

Trinity River (middle subbasin): The Trinity River begins north and west of Dallas-Fort Worth and enters Galveston Bay near Chambers. The total drainage area is contained in Texas and includes 17,969 square miles. The need for a subbasin study is based upon existing and probable applications for substantial water reuse in the area downstream of Dallas and Fort Worth. Available water in this reach and instream flows are to a large extent dependent on wastewater

return flows in the Dallas-Fort Worth and north central Texas area. Capturing return flows may prove to be a more economical short-term alternative for Dallas and other entities than tapping water supplies that will incur significant transmission costs. Bedias and Tehuacana are recommended as unique reservoirs sites in the State Water Plan.

Sabine River (lower subbasin): The Sabine River begins in northeast Texas near Greenville and flows south making up the Texas-Louisiana border before flowing into the Gulf of Mexico. Total drainage of the basin is 9,756 square miles. The need for a subbasin study in the lower Sabine River is based upon the potential for substantial water transfers and Federal Energy Regulatory Commission (FERC) hydropower re-licensing at Toledo Bend Reservoir.

Brazos River (middle subbasin): A subbasin study on the middle Brazos River is needed based upon proposed water development of five minor reservoirs on tributary streams and one major reservoir on the Little River. The cumulative effect of these numerous projects could substantially alter the flow regimes and the environment of these tributaries and the middle Brazos.

Second Tier of Studies (alphabetical)

A second tier of instream flow studies was developed to provide future direction in studies in the event priorities change or supplementary resources are made available to begin additional studies.

Guadalupe River (upper subbasin): Recreational activities are an important component of instream uses in the upper Guadalupe River. The Guadalupe River upstream of Canyon Dam (Kerr, Kendall, Western Comal counties) supports a high concentration of water-oriented summer camps, resorts, and bed and breakfasts that depend on sufficient stream flows to maintain recreational activities and aesthetic quality of the region. The Guadalupe River State Park, located near Spring Branch, has approximately four miles of river frontage. Kerrville-Schreiner State Park provides public access to the Guadalupe River near Kerrville. Primary water related activities are canoeing, kayaking, tubing, and swimming.

Although most of the water in the upper Guadalupe River is appropriated by Canyon Reservoir and older water rights, TCEQ receives substantial permitting activity in this area as a result of amendments to existing permits and upstream contracts with GBRA for portions of the Canyon Reservoir water right. Applications in this area are consistently protested because of the recreational and aesthetic impacts of reduced flows. TCEQ staff needs to develop a better understanding of the instream flows needed to support recreational use in these reaches.

Neches River subbasin: The Neches River begins in North Texas near Tyler and flows south into Sabine Lake near Orange. Total drainage in the basin, which includes the Angelina River, is 10,011 square miles. In the Neches River, existing reservoirs such as Lake Palestine, Sam Rayburn Reservoir, and B.A. Steinhagen Reservoir largely dictate instream flow conditions. The permitted Eastex Reservoir, also recommended as a unique reservoir site, will require a COE 404 permit and it appears that a site-specific study will be required before construction begins. Proposals to raise the water level of B.A. Steinhagen will require a water right permit amendment and perhaps a site-specific evaluation.

Red River: The Red River begins in New Mexico, extends across the Texas Panhandle, and follows the Oklahoma-Texas border to Arkansas. The river drains approximately 48,000 square miles. The proposed Lower Bois d'Arc Reservoir would best be addressed through site-specific evaluation; it is also recommended as a unique reservoir site along with Big Pine, Pecan Bayou, and Muenster. Chloride control projects in the Wichita River watershed are currently being

planned for completion. If proven effective and feasible the scope of chloride control could be significantly expanded in the future.

Sabine River (upper subbasin): While the lower Sabine River subbasin is suggested for study because of the impending FERC relicensing of the Toledo Bend Reservoir hydropower facility and the potential for water transfers to supply future users to the west, the upper Sabine River subbasin is no less important for its potential to supply water to users in other nearby regions. Indeed, the water-rich Sabine River Basin should be studied in its entirety because of its abundant water supplies and their potential for use in the future.

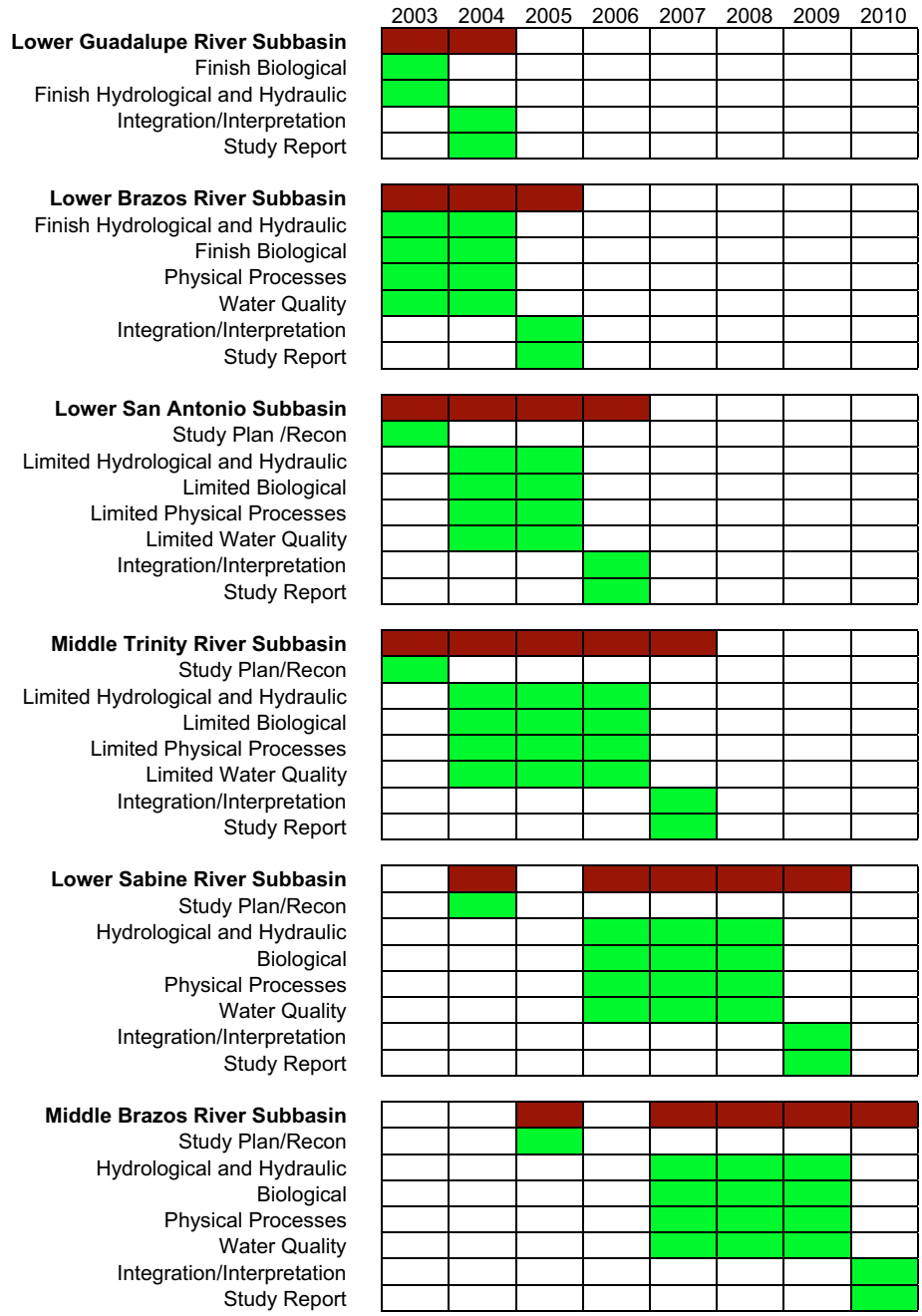
TIMEFRAMES FOR PRIORITY INSTREAM FLOW STUDIES

A comprehensive instream flow study, which addresses all five of the riverine components, is anticipated to take about three years although larger or more complex subbasins may require four or five years. As discussed previously, studies are subject to adverse climatological factors and weather-related delays that can greatly affect the timeframe for completion of data collection and analysis.

The timeframe was developed to allow instream flow study elements to be carried out concurrently in different basins. For example, once reconnaissance and study plans are completed for several subbasins, collection of fish habitat utilization data, a time-consuming task, can proceed on those subbasins. The availability of study plans for multiple basins will facilitate flexible scheduling so that if flow conditions in one system are not appropriate then another system may be sampled.

Semi-annual benchmarks will be established for the first year of the program and annual benchmarks used thereafter. Follow-up review and planning will be conducted for each subsequent year of the timeframe.

Timeframes for Priority Instream Flow Studies



Note: see Methods section for information related to study elements

SCOPE OF STUDIES

The scope of studies should include the five riverine components: hydrology, biology, geomorphology, water quality, and connectivity. This comprehensive scope requires an interdisciplinary approach. An evaluation of hydrology will include determinations of the characteristics of flow such as magnitude, duration, timing, rate of change, frequency and inter- and intra-annual variation; development of hydrologic time series (e.g., naturalized, historic, and modified flow records); and development of a hydrologic network or the geography of flows. The biology component includes development of an understanding of relationships between aquatic communities, life histories, habitat (instream, riparian, etc.), and the hydrology of the system. Geomorphology includes processes that form and maintain stream channels and habitat, flush fine sediments, and transport sediment loads. It is particularly important in studies of alluvial systems. Water quality includes temperature, dissolved oxygen, and other parameters important to survival and reproduction of aquatic organisms. Connectivity refers to the movement and exchange of nutrients, sediments, organic matter, and organisms within the riverine ecosystem.

Recognizing the constraints of time and resources, it will not be possible to address each of these components in a systematic or quantitative manner in each subbasin that is studied.

Recognizing the constraints of time and resources, it will not be possible to address each of these components in a systematic or quantitative manner in each subbasin that is studied. However, each component should be evaluated and documented in the planning phases of each study for its applicability, feasibility, and importance to accuracy of models and study results. The planning phase may also identify important components that have not been specifically recognized in this work plan. These components may require specific attention.

METHODS

An instream flow study in Texas is largely a fish and wildlife resource evaluation of a river segment, sometimes a more comprehensive subbasin evaluation, and rarely a comprehensive evaluation of an entire basin. The goals and purposes can be varied but usually they include the desire to determine the impacts on the fish and wildlife communities from riverine flow alteration.

A subbasin-specific study plan will be developed to outline procedures appropriate for each priority study.

A subbasin-specific study plan will be developed to outline procedures appropriate for each priority study. Given the wide diversity of aquatic ecosystems in Texas, the state's geographical vastness, and the different characteristics among and within river basins, approaches to determine instream flow requirements and predict consequences due to flow alteration must be tailored to address relevant instream flow issues and sampling requirements in each system. Accepted, standard procedures should be used when available (e.g., discharge measurements, surveying, etc.) and QA/QC measures developed to ensure data and model accuracy. Modifications to procedures should be validated prior to implementation. Calibrated models should be validated with empirical data and field observations. Study plans should guide development of scopes of work for contracts.

Study design should be stratified to develop a prioritized series of achievable components covering all instream flow study issues (e.g. reconnaissance, baseline information, hydrology, water quality data collection and modeling, biological relationships, habitat models, riparian or

wetland habitats, etc.). A set of high priority components would form the core study elements needed for a minimal level of study. A comprehensive evaluation would include the core study elements and all supplemental (i.e., subbasin-specific) areas of inquiry and analysis. However, if external constraints (weather, resources, etc.) intervene and preclude a comprehensive evaluation, the information necessary to complete a core analysis will be in place.

Instream Flow Study Elements

Instream flow studies generally have eight major study elements: study design, hydrologic and hydraulic, biological, physical processes, and water quality evaluations, integration and interpretation, study report, and monitoring and validation. There are some instances where an instream flow study may have fewer elements. All of the elements include collection and synthesis of existing information. A brief description of study elements follows:

1. Study Design: This element includes development of objectives; determining the geographic scope of the study; identifying cooperators and their duties and tasks; and conducting reconnaissance to identify study sites, representative reaches, human influences, and fish and wildlife issues. Preliminary physical and biological surveys are also necessary to provide baseline information and to help select appropriate models.

2. Hydrologic and Hydraulic Evaluation: This element includes development and analysis of hydrologic information and includes development of hydrologic time-series (naturalized, historic, and predicted project flow records) and analysis of the characteristics of flow (magnitude, timing, etc.). Hydrologic models may also be developed to provide an understanding of the hydrologic network. Hydrographic surveys are the field studies undertaken to collect data required to calibrate and verify habitat models. Complete hydrographic surveys provide the data needed to calibrate the hydrodynamic model. Hydrodynamic models are computer simulations of flow through the study segments of streams, based on an acceptable modeling approach. These models produce spatially explicit representations of hydraulic habitat (i.e., combinations of current velocity and depth) through a range of modeled flows. Models are calibrated by verifying against independent data sets.

3. Biological Evaluation: This element requires extensive collection of field data. Generally, biological evaluations will focus on fish assemblages but may also address other aquatic vertebrates, invertebrates, or plants. Habitat requirements, life history, and other ecological factors will be addressed in order to provide input to habitat models and provide insight in the integration and interpretation elements. Specific information or models may need to be developed to address riparian habitat such as hardwood bottomlands, wetlands, oxbows, etc.

4. Physical Processes Evaluation: This element includes evaluations of the physical processes that form and maintain habitat, flush and transport sediment, and provide geographic information and characterization of mesohabitats, substrate, and cover (e.g., woody debris, macrophytes, undercut banks, etc.).

5. Water Quality Evaluation: Water quality evaluations may include analysis of existing information but most often will require segment specific modeling in order to relate stream flow with the environmental requirements of fish and wildlife or with water quality standards. Important water quality parameters for fish are temperature, dissolved

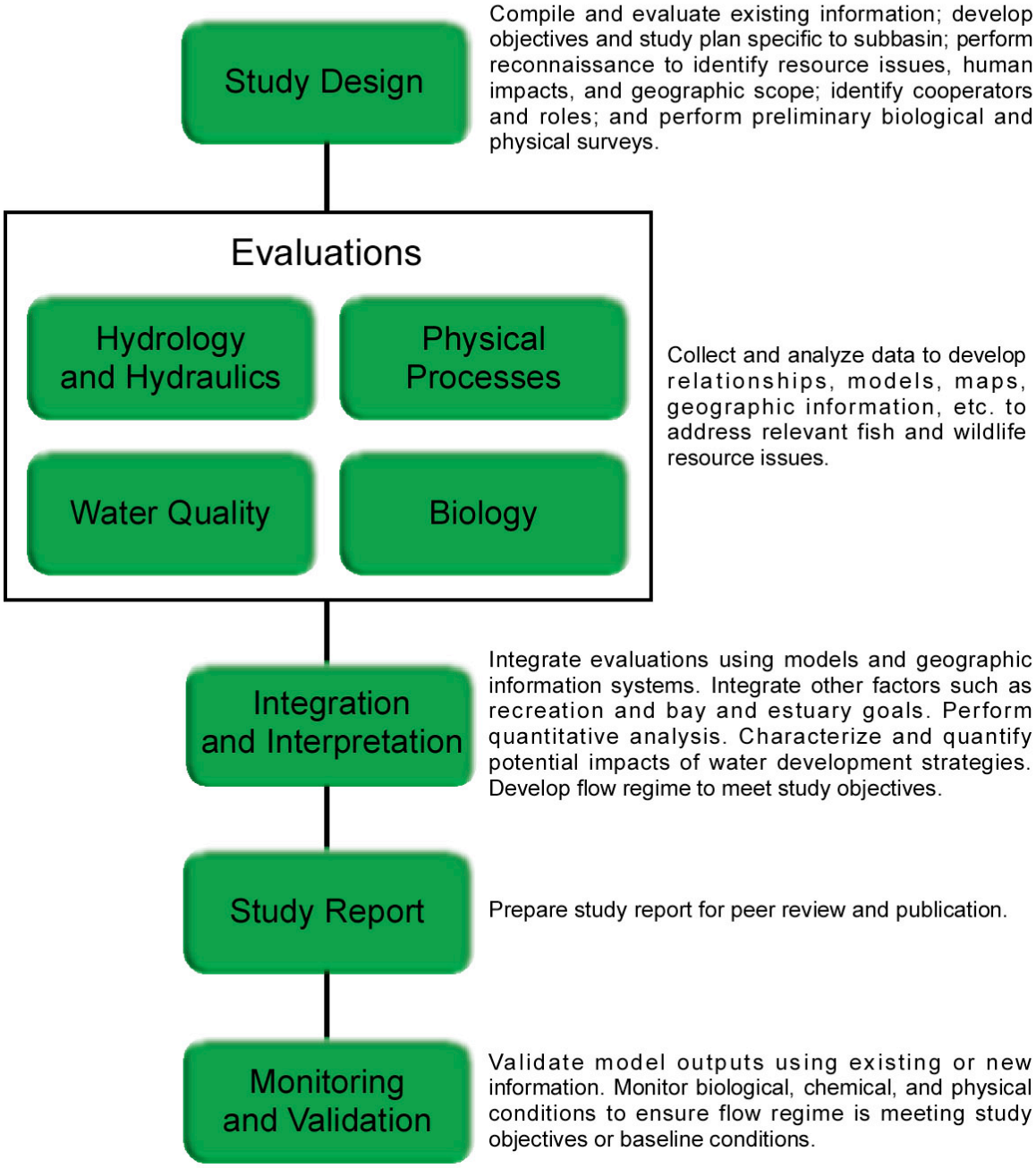
oxygen, total dissolved solids, and turbidity. Special concerns (e.g., salt-water movement in tidal areas) may need to be addressed.

6. Integration and Interpretation: This element includes the integration and interpretation of hydrologic and hydraulic, biological and habitat, physical, and water quality evaluations. Instream habitat models combine the output from hydraulic habitat models with geographic coverages of substrate and cover in a geographic information system. Relationships between flow, instream habitat, and the empirically-derived habitat requirements of target species or guilds will be developed. A complete analysis produces a series of curves illustrating habitat as a function of stream flow. Other factors may also play into the integration such as recreation, bay and estuary objectives, etc. Quantitative analysis will be performed and may include a combination of statistical, optimization, time-series, and alternatives analyses. This element also involves characterization and quantification of potential impacts to fish and wildlife resources, determinations of consequences of flow alterations, and development of instream flow recommendations. An appropriate recommendation provides a flow regime that incorporates inter-annual and intra-annual variation necessary to meet study objectives.

7. Study Report: This element involves preparation of a study report for peer review and publication.

8. Monitoring and Validation: A validation of needs is required to check the results of the quantitative analysis and flow recommendation. Validation is normally accomplished by comparing the study results with information from literature and, where possible, the results from studies of similar and dissimilar streams to gauge whether the results are within the expected range. After implementation of the results in water management, it is important to continue monitoring of the stream to ensure that the implemented flow regime is meeting study objectives or baseline conditions. This will also provide information for adaptive management practices that may become necessary.

FLOWCHART OF INSTREAM FLOW STUDY ELEMENTS



ROLES AND RESPONSIBILITIES

While all three cooperating agencies are expected to participate in all of the study elements and associated tasks, the assignment of a coordinating agency, in some aspects of the study, is necessary for project planning and execution. The assigned roles reflect the respective agencies' specific expertise and their responsibilities in conservation of fish and wildlife resources and water resources management. Cooperators such as river authorities, federal agencies (e.g., U.S. Fish and Wildlife Service; U.S. Geological Survey), and others, will be given the opportunity to contribute and participate in all phases of the study.

Summary of Coordination Roles

Instream Flow Study Element	Coordinating Agency
Study Design	Joint
Hydrological and Hydraulic Evaluation	TWDB
Biological Evaluation	TPWD
Physical Processes Evaluation	Joint
Water Quality Evaluation	TCEQ
Integration and Interpretation	Joint
Study Report	Joint
Monitoring and Validation	Joint

In practice, each study element will require the unified efforts of the cooperating agencies in order to be successfully completed.

Coordination duties are summarized in the accompanying text box. In practice, each study element will require the unified efforts of the cooperating agencies in order to be successfully completed. Further, the roles of the agencies may be modified as required to fit the special circumstances of each stream or river being studied.

To ensure completion of each assigned element according to scientific standards laid out in the study plan, in those instances where there is a coordinating agency, the responsibilities of the coordinating agency (or cooperator) include proactive consultation with each supporting agency (or cooperator) of all phases of element implementation. Coordination efforts shall involve the full range of decision-making and logistics required to implement, interpret, analyze, and integrate assigned study elements and associated tasks. Several of the study elements have been assigned to joint responsibility. These elements are interdisciplinary by nature and will require substantial collaboration among the agencies' technical staff as well as other cooperators. Since each of the priority studies may emphasize different technical approaches, a coordinating agency will be assigned on a study by study basis given the specific study requirements.

Responsibilities of supporting agencies (or cooperators) involve complete and full interaction with the coordinating agency (or cooperator), in a timely and professional manner, to facilitate efficient element implementation and completion of associated tasks; supporting agencies (or cooperators) will provide on-going quality assurance.

Study elements are comprised of specific study tasks. These study tasks are outlined in Table 1. This table will identify the agency and cooperator roles for completing each task in a subbasin study and will be included in each study plan. Tasks (and elements) may be added as specific needs not included in Table 1 are identified. The table will also be used to identify gaps in ability to accomplish study tasks with existing agency and cooperator resources; contractors may be retained to fill these gaps.

Table 1. Instream flow study tasks.

Study Design
compile and evaluate existing information
determine geographic scope of the study
identify cooperators and their duties and tasks
conduct reconnaissance to identify study sites, representative reaches, anthropogenic impacts, and fish and wildlife issues
conduct preliminary physical and biological surveys
develop objectives and study plan specific to subbasin
Hydrologic and Hydraulic Evaluation
analyze hydrologic network
develop time-series data (naturalized, historic, and predicted project flow records)
analyze flow characteristics (magnitude, timing, etc.)
collect data required to calibrate hydrodynamic and hydraulic models
develop, run and analyze hydrodynamic and hydraulic models
Biological Evaluation
collect data on fish assemblages
collect data on other vertebrates, invertebrates, or plants
evaluate habitat requirements, life history, and other ecological factors
collect data/model to address riparian habitat such as hardwood bottomlands, wetlands, oxbows, etc.
Physical Processes Evaluation
evaluate physical processes that form and maintain habitat, flush and transport sediment
develop geographic information and characterization of mesohabitats, substrate, and cover
Water Quality Evaluation
collect data, analyze, and model temperature, dissolved oxygen, total dissolved solids, turbidity and/or other parameters and special concerns
relate stream flow with environmental requirements of fish and wildlife or with water quality standards
Integration and Interpretation
combine output from hydraulic habitat models with coverages of substrate and cover in a geographic information system
develop relationships between flow, instream habitat, and empirically-derived habitat requirements
quantitative analyses
statistical
optimization
time-series
alternatives
integrate hydrologic and hydraulic, biological, physical processes, and water quality evaluations
integrate other factors such as recreation, bay and estuary goals, etc.
characterize and quantify potential impacts of development strategies
recommend flow regime that incorporates inter-annual and intra-annual variation necessary to meet study objectives
Study Report
prepare study report for peer review and publication
Monitoring and Validation
validate study results by comparing with information from literature or other studies
monitor stream to ensure that flow regime is meeting study objectives

PEER REVIEW OF INSTREAM FLOW STUDIES

The peer review process proposed for the Texas Instream Flow Studies will be in three parts.

Part One

The Interagency Science Team (Team) composed of staff scientists and engineers assigned to work on the studies by the agencies, will develop a second volume to describe the methodological approach in more technical detail. This Technical Overview should consist of an expansion of the study elements and tasks and a detailed characterization of the context and scope of studies. The primary purpose of the Technical Overview will be to provide the basis of a review by the National Academy of Sciences (NAS). It shall be the goal of the Team to finalize the Technical Overview by March 2003 and subsequently submit it to NAS for their consideration. The Programmatic Work Plan will remain in effect and guide study efforts until such time as the NAS review is completed. The work plan may be modified at an appropriate point based upon feedback from the NAS peer review. The goal of this peer review is to provide the highest level of confidence for all interested and affected parties that the framework within which these studies will be carried out is scientifically sound.

Part Two

The NAS review will encompass an assessment of the scientific and engineering methods proposed for use in Texas to determine instream flow needs. Strategies that will be applicable across the diversity of individual basin and subbasin studies will vary because of the ecological diversity of the state. The Team will routinely face challenges to assure that models and methods are being applied appropriately or they will encounter unique situations for which innovative solutions will be needed. The Instream Flow Council (IFC) is one means that might be used to provide that level of peer review and assistance. The Team may also access other similar expertise in the various disciplines required in the studies, as well as, academic expertise. The second part of the peer review process will provide critical input and help assure interested parties that the sound science base established through the NAS review is continued throughout the project. The goal of this level of peer review is to establish a readily accessible source of recognized expertise to assure that the individual studies are carried out in a scientifically sound manner.

Part Three

This level of ongoing peer review will focus on assuring that the river authorities and other affected water management entities within each basin and subbasin are involved in the studies to the degree that they are willing to participate and that they may have confidence in the scientific basis of studies directly affecting them. The input and participation of such entities will be sought at the initiation of the specific study(s) most directly affecting them. Their input and expertise will be sought to enhance the study effort. The Team will be responsible for deciding on particular means and methods to pursue in the course of a specific study. Should disagreement with local partners arise, it will be incumbent on the Team to work closely with them to resolve their concerns. The Team will make use of the IFC or similar and appropriate resources as needed to help resolve such conflicts. The goal for this level of peer review is to establish an ongoing relationship with local partners to gain their support and assure those partners that all levels of the instream flow studies are scientifically sound.

APPENDIX: FACTORS USED TO PRIORITIZE STUDIES

State Water Plan

Synopsis of recommended projects in the State Water Plan (TWDB 2002).

Project	Target Decade	Region	River Basin	County	Watercourse	Surface Acres	Volume ac-ft	Yield ac-ft/yr	TPWD Significant Stream	Water Right Permit
Major Reservoirs										
Lower Bois d'Arc	2010	C	Red	Fannin	Bois d'Arc Creek	16,400	Not available	123,000	Yes	
Marvin Nichols I	2030	D	Sulphur	Franklin; Morris; Red River; Titus	Sulphur River	62,100	1,369,717	550,842-619,000	Yes	
Prairie Creek	2000	D	Sabine	Gregg; Smith	Prairie Creek	2,280	45,164	17,215	No	
Little River	2020	G/H	Brazos	Milam	Little River	35,000	930,000	129,000	Yes	
Bedias	2030	H	Trinity	Grimes; Madison; Walker	Bedias Creek	13,000	181,000	90,700	No	
Eastex	2010	I	Neches	Cherokee	Mud Creek	10,089	187,839	85,000	Yes, downstream	Yes
Brownsville Weir	2010	M	Rio Grande	Cameron	Rio Grande	600	6,000	40,000	Yes	Yes
Minor Reservoirs										
Muenster	2010	C	Trinity	Cooke	Brushy Elm Creek	418	4,700	500	No	Yes
New Throckmorton	2010	G	Brazos	Throckmorton	Elm Creek	760	Not available	1,000	No	
Brushy Creek	2010	G	Brazos	Falls	Brushy Creek	Not available	Not available	Not available		Yes
Llano channel dam	2000	K	Colorado	Llano	Llano River	Not available	Not available	1,300		for diversion only
Mills County	2000	K	Colorado	Mills	Blanket Creek	500	11,000	1,120		
Goldthwaite channel dam	2000	K	Colorado	Mills	Colorado River	Not available	Not available	510		for diversion only
Off-channel Reservoirs										
Somervell	2010	G	Brazos	Somervell	Paluxy River to reservoir	164	3978	2,000		
Meridian	2000	G	Brazos	Bosque	North Bosque River to reservoir	92	1400	574		
Groesbeck	2010	G	Brazos	Limestone	Navasota River to reservoir	113	1240	1,500		Yes, partially
Allens Creek	2020	H	Brazos	Austin	Brazos River to reservoir	8250	145,500	99,650	No	In amendment process
Goldthwaite	2000	K	Colorado	Mills	Colorado River to reservoir	Not available	Not available	400		
4-Off Channel Ring Dikes	2000	K	Colorado	Colorado; Matagorda; Wharton	Colorado River to ring dikes	5360	100,000	106,600-130,000	Yes	
3-Off Channel Ring Dikes	2010	L	Guadalupe	Refugio	Guadalupe River to ring dikes	1218	50,000	56,276-94,000	Yes	partial

Table cont.

					Major Conveyances					
Luce Bayou: Trinity River to Lake Houston	2020	H	Trinity to San Jacinto	Liberty to Harris	Luce Bayou: Trinity River	NA	NA	302,500	Yes	
Lower Guadalupe River to Bexar County	2010	L	Guadalupe to San Antonio	Calhoun/Refugio to Bexar	Guadalupe River	NA	NA	56,276-94,000	Yes	
Lower Colorado River to Bexar County	2000	K-P-L	Colorado to San Antonio	Matagorda to Bexar	Colorado River	NA	NA	132,000	Yes	

NA - not applicable

Water Rights Permitting

Water rights permit applications are routinely evaluated for environmental impacts. Many of these applications are for small amounts of water and are normally conditioned with default instream flow criteria, usually the Lyons method. The Lyons method, which was developed by TPWD, has been applied statewide with little regard to stream size or regional differences in hydrology and biology. Given the diversity of aquatic ecosystems in Texas, it would be appropriate to develop and/or refine criteria to more adequately reflect the regional and hydrological diversity of the state for determining instream flow conditions for routine water rights applications.

Several significant permitting issues were identified that have a high level of urgency since applications for permits have already been submitted or are anticipated in the near future. These issues include the reuse of municipal water in the San Antonio and Trinity River basins and potential interbasin transfers (Sulphur, Sabine, Colorado, and Guadalupe river basins). Further, broader concerns include protecting instream flow in over-appropriated stream segments and determining adequate stream flows for water quality protection in water quality impaired segments. Other foreseeable projects that may not be reflected in current water planning efforts should also be evaluated in terms of priority. For example, construction of a reservoir on the Double Mountain Fork of the Brazos River, although not in any regional water plan, could be funded by the Brazos River Authority. Further, the time to construct the permitted Post Reservoir was recently extended yet will require COE 404 and TPWD Sand, Shell, Gravel, and Marl permits. The same is true for Eastex Reservoir and Angelina Neches River Authority. Several chloride control projects (Wichita, Canadian, and Brazos rivers) are in various stages of planning and implementation and will require substantial scrutiny due to their operational requirements and potentially severe impacts.

Hydropower Issues

Synopsis of hydropower issues.

Notice Date	Permit Type	Project No.	Date Filed	Applicant	Project Name	River	County
2/0/01	Collaborative Process	2305-016	7/12/02	Sabine River Authority	Toledo Bend Project (current license expires 2013)	Sabine	Newton
9/6/01	Preliminary	11979-000	4/20/01	Symbiotics, LLC	Wright Patman Dam Hydroelectric Project	Sulphur	Bowie
9/6/01	Preliminary	11982-000	4/20/01	Symbiotics, LLC	Stillhouse Hollow Dam Hydroelectric Project	Lampasas	Bell
9/18/01	Preliminary	11981-000	4/20/01	Symbiotics, LLC	Ferrells Bridge Dam Hydroelectric Project	Cypress Creek	Marion
9/21/01	Preliminary	11980-000	4/20/01	Symbiotics, LLC	Lake Belton Dam Hydroelectric Project	Leon	Bell
7/11/02	Preliminary	12247-000	6/18/02	Conroe Hydro, LLC	Conroe Dam Hydroelectric Project	San Jacinto	Montogomery
7/30/02	Preliminary	12224-000	6/17/02	Eagle Mountain Hydro, LLC	Eagle Mountain Dam Hydroelectric Project	Trinity	Tarrant
7/30/02	Preliminary	12240-000	6/7/02	Pat Mayse Hydro, LCC	Pay Mayse Dam Hydroelectric Project	Sanders Creek	Lamar
7/30/02	Transfer of Licenses	3939-020 & 3940-014	6/28/02	City of Denton (Transferor) Spenser Station Generating Company, L.P. (Transferee)	Ray Roberts Dam & Lewisville Dam	Trinity	Denton
8/1/02	Preliminary	12249-000	6/18/02	Waco Hydro, LLC	Waco Dam Hydroelectric Project	Bosque	McLennan
8/2/02	Preliminary	12203-000	6/11/02	North San Gabriel Hydro, LLC	N. San Gabriel Dam Hydroelectric Project	San Gabriel	Williamson
8/2/02	Preliminary	12233-000	6/17/02	Lavon Hydro, LLC	Lavon Dam Hydroelectric Project	Trinity	Collin
8/6/02	Preliminary	12222-000	6/7/02	De Cordova Hydro, LLC	De Cordova Dam Hydroelectric Project	Brazos	Hood
8/6/02	Preliminiary	12244-000	6/7/02	Town Lake Hydro, LLC	Town Lake Dam Hydroelectric Project	Colorado	Travis
8/8/02	Preliminary	12183-000	6/4/02	Medina Hydro, LLC	Medina Dam Hydroelectric Project	Medina	Medina
8/8/02	Preliminary	12242-000	8/17/02	San Jacinto Hydro, LLC	San Jacinto Dam Hydroelectric Project	San Jacinto	Harris
8/28/02	Preliminary	12227-000	6/17/02	Granger Hydro, LLC	Granger Dam Hydroelectric Project	San Gabriel	Williamson
8/22/02	Preliminary	12231-000	6/17/02	Lake Fork Hydro, LLC	Lake Fork Dam Hydroelectric Project	Lake Fork Creek	Wood
8/25/02	Preliminary	12250-000	6/18/02	Wesley E. Seale Hydro, LLC	Welsey E. Seale Dam Hydroelectric Project	Nueces	Jim Wells