Council Member: US EPA	Point of Contact: John Bowie Phone: (228) 688-388 Email:bowie.john@epa.gov

Project Identification

Project Title: **US EPA & USGS Joint Proposal for Baseline Flow & Gage Analysis and On-Line Tool Development to Support Bay and Estuary Restoration in Gulf States.**	Project
State(s): **TX, LA, MS, AL, FL**	County/City/Region:

General Location: *Projects must be located within the Gulf Coast Region as defined in RESTORE Act.* **This proposal will cover the entire 5 Gulf States with emphasis in the Coastal Area of all Gulf States.**

Project Description

RESTORE Goals: *Identify all RESTORE Act goals this project supports.* ***P*** *Primary,* ***S*** *secondary.*

P	Restore and Conserve Habitat	S	Replenish and Protect Living Coastal and Marine Resources
S	Restore Water Quality	S	Enhance Community Resilience
S	Restore and Revitalize Gulf Economy		

RESTORE Objectives: *Identify all RESTORE Act objectives this project supports. Place a* ***P*** *for Primary Objective, and* ***S*** *for secondary objectives.*

P	Restore, Enhance, and Protect Habitats	S	Promote Community Resilience
S	Restore, Improve, and Protect Water Resources	S	Promote Natural Resource Stewardship and
S	Protect and Restore Living Coastal and Marine Resources		Environmental Education
S	Restore and Enhance Natural Processes and Shoreline	S	Improve Science-Based Decision-Making

RESTORE Priorities: *Identify all RESTORE Act priorities that this project supports.*

- X Priority 1: Projects that are projected to make the greatest contribution
- X Priority 2: Large-scale projects and programs that are projected to substantially contribute to restoring
- X Priority 3: Projects contained in existing Gulf Coast State comprehensive plans for the restoration ….
- X Priority 4: Projects that restore long-term resiliency of the natural resources, ecosystems, fisheries …

RESTORE Commitments: *Identify all RESTORE Comprehensive Plan commitments this project supports.*

- X Commitment to Science-based Decision Making
- X Commitment to Regional Ecosystem-based Approach to Restoration
- X Commitment to Engagement, Inclusion, and Transparency
- X Commitment to Leverage Resources and Partnerships
- X Commitment to Delivering Results and Measuring Impacts

RESTORE Proposal Type and Phases: *Please identify which type and phase best suits this proposal.*

X Project X Planning X Technical Assistance X Implementation Program

Project Cost and Duration

Project Cost Estimate: $5,800,000.	**$5,800,000**	**Project Timing Estimate**: Date Anticipated to Start: Immediately Time to Completion: 7 years Anticipated Project Lifespan: 7 years

Executive Summary

The US Geological Survey (USGS) and the US Environmental Protection Agency (EPA) propose to collaborate on a comprehensive, large-scale, state-of-the-science foundational project to provide vital information on the timing and delivery of flows to freshwater streams, bays, estuaries, and wetlands of the Gulf Coast. This foundational project will provide critical freshwater flow data and easy to access tools and information for all five Gulf Coast States and local governments for priority setting and decision-making related to restoring and conserving habitat, water quality, living coastal and marine resources while enhancing community resilience and the Gulf Coast economy. The USGS is a science organization that provides "impartial information on the health of our ecosystems and environment, the natural hazards that threaten us, the natural resources we rely on, the impacts of climate and land-use change, and the core science systems that help us provide timely, relevant, and useable information." The USGS carries out large-scale, multi-disciplinary investigations and provides impartial scientific information to resource managers, planners, and other customers. The EPA has statutory responsibility under the Clean Water Act to "restore and maintain the chemical, physical and biological integrity of the nation's waters" that "provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water," (CWA Section 101(a)). The EPA's authority includes conducting research and studies that contribute to the protection of waters of the US including lakes, rivers, streams, estuaries, wetlands and coastal waters. Together, the USGS and the EPA have the combined expertise and authorities to carry out this foundational proposal to improve the ability of the state and local governments to make science-based decisions on protection and restoration efforts for the Gulf Coast.

Based on the latest scientific information, the water quality index for the coastal waters of the Gulf Coast region is rated only fair, with 10% of the coastal area rated poor and 53% of the area rated fair for water quality condition (USEPA, 2012). Scientists project that conditions are expected to deteriorate in many of the Gulf Coast estuaries, despite on-going efforts to bring about improvements in these areas. However, the scientific community has coalesced around the concept that alteration of the timing and delivery of freshwater flows is a significant factor affecting the health of both the coastal ecology and economy. Freshwater inflow to estuaries is a major factor affecting salinity, nutrients and sediment and the natural processes within these coastal ecosystems. It is considered one of the most critical components influencing coastal habitat, water quality, successful nurseries, spawning, and species composition and diversity. These critical resources, in turn, provide the livelihoods for coastal communities including recreation and tourism, commercial and recreational fisheries and oyster harvesting – all of which fund the economic engine of the Gulf Coast. In addition and just as critical is the resilience and ecosystem services these resources provide to communities from storm surge, flooding and extreme weather events.

The state-of-the-science for implementing restoration of flows for freshwater and estuarine ecosystems health has improved markedly. Many successful examples now exist for improving the timing and delivery of freshwater flows through collaborative processes such as modification of flow regimes through operational changes made through dam re-regulation, dam removal, conservation and efficiency, improved placement and operation of surface and groundwater withdrawals or green infrastructure. Numerous federal, state and local partnerships have already identified such remedies as a high priority for ecosystem restoration[1]. However, these efforts can often be hampered by the lack of readily available data on stream flows, available gages, and the historical changes in timing and delivery of flow over time, as well as the complex nature of the data and the models needed to interpret the data for decision-making. To

[1] Other federal agencies that have identified restoration of flows or connectivity or who have already taken part in restoration projects include the US FWS, who serves as a national leader in this area as well as the ACOE, NOAA, FERC, the EPA NEPs, and the NPS. The states of Texas and Florida have state mandated programs for the evaluation and protection of flows.

address this foundational science and accessibility gap and to facilitate economically and ecologically critical restoration projects, the USGS and the EPA propose a 7 year, $5.8 million project to conduct a comprehensive assessment of gages and streamflows and development of accessible and easy-to-use on-line tools for state and local decision-makers to facilitate restoration projects in all five Gulf States and begin a process to install new or restore decommissioned gages. Specifically, the project includes:

Regional Streamflow Alteration Assessment

- Develop a regionally consistent set of streamflow metrics at long-term streamflow gages.
- Develop measures of streamflow alteration at long-term stream gages.
- Estimate trends in streamflow metrics and evaluate potential influences related to climatic and land/water management stressors.
- Predict streamflow alteration at ungaged streams.
- Define the optimal streamgage network for assessing flow alteration. This analysis will be used to identify locations of potential new gages and determine which discontinued gages should be restarted to minimize the uncertainty in the estimation of streamflow alteration metrics.
- Work with state partners to determine the priority for restarting existing or installing new gages.
- Develop an online streamflow alteration mapping tool that can be used at the regional, state, and watershed level to identify areas where streamflow alteration are highest and facilitate the prioritization of restoration actions.

A regionally consistent approach will be used to quantify streamflow alteration throughout the five Gulf State area and evaluate how and why selected streamflow metrics have changed over time at long-term stream gages. A statistical model incorporating human disturbance variables will be used to predict the degree of streamflow alteration along ungaged streams. These regionally consistent metrics can be ranked at the region, state, or watershed scale to identify areas where streamflow alteration is highest and prioritize areas to focus restoration efforts.

Focused Watershed Study The EPA and the USGS will then apply these tools in a focused watershed study in one large watershed in the Gulf. The study will develop specific metrics that relate the streamflow regime to freshwater stream and estuarine health. This project will enable water resource managers to evaluate a range of potential management scenarios, such as modifying the release curves for selected reservoirs upstream to evaluate changes in freshwater delivery to an estuary.

Once these tools are in place, they can be used as the foundation to facilitate scientifically based evaluation of restoration projects by state and local decision-makers that will provide long-term and sustainable improvements to water quality, habitat and living coastal resources. These tools will be based on the most up-to-date scientific information and will be readily available and accessible to decision-makers. As a foundational project, it is readily scalable to expand to include ground water evaluation, restoration or installation of additional gages, increases of water quality monitoring at gages for creating loads and water quality tracking and to provide direct support for restoration projects.

EPA and USGS believe this project will make a significant contribution to planning and implementation of restoration efforts on a Gulf-wide basis. The project will promote community resilience in helping Gulf communities in adapting to short and long-term changes in flows, and will improve science-based decision making in targeting and siting restoration work. The publicly-accessible tools generated speak to the Comprehensive Plan commitments to engagement, inclusion and transparency. Increasing understanding of flow regimes in Gulf tidal streams and rivers is an important component in developing regional ecosystem-based restoration efforts.

Proposal narrative

Proposal Introduction and Background

The overall objective of the Clean Water Act is to "restore and maintain the chemical, physical and biological integrity of the nation's waters" (section 101(a)). The interim goal of the CWA is to provide for "water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water," wherever attainable (section 101(a)). The EPA and the State agencies tasked with implementing CWA programs have made substantial progress in protecting the waters of Texas, Louisiana, Mississippi, Alabama and Florida for more than 40 years. However, based on the National Coastal Assessment survey and other water quality reporting data, there is still substantial work to be accomplished and new and complex challenges continue to emerge and need to be addressed. The water quality index for the coastal waters of the Gulf Coast region is rated only fair, with 10% of the coastal area rated poor and 53% of the area rated fair for water quality condition (USEPA, 2012) (See Figure 1). Bricker and others (2007) expect conditions to deteriorate in many of these estuaries.

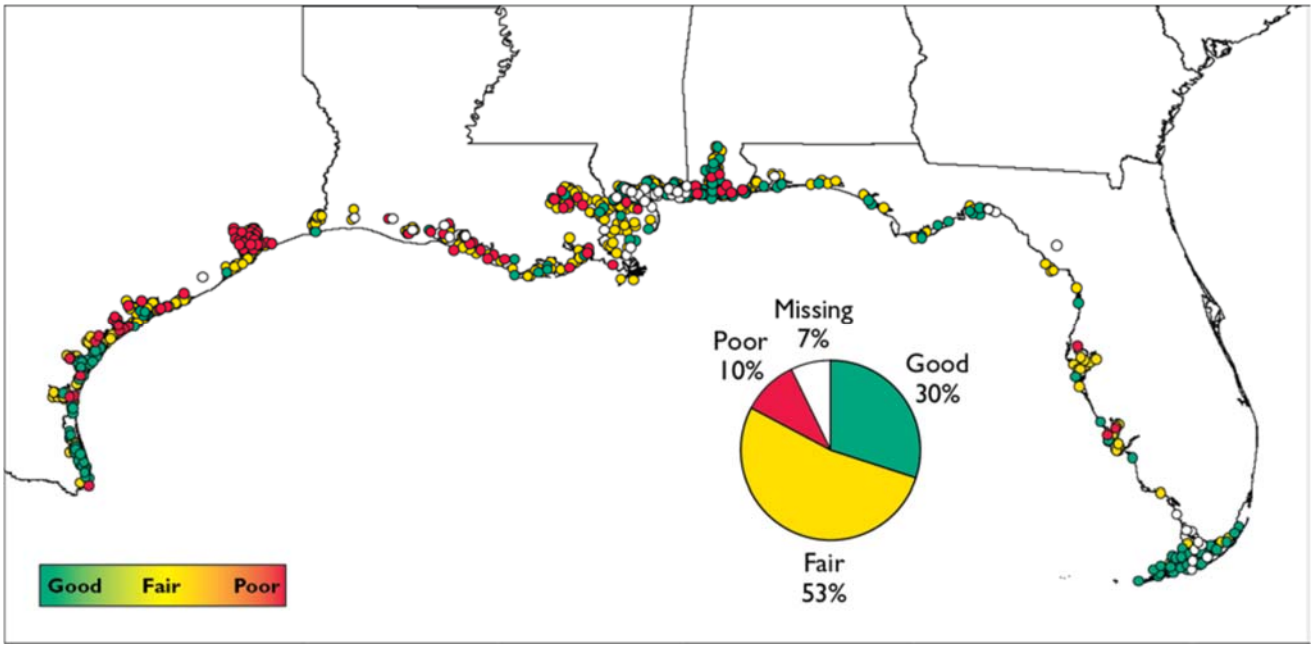

Figure 1. Overall water quality conditions of Gulf Coast estuaries. (USEPA, 2012)

The Gulf of Mexico has undergone close scrutiny of a wide variety of water quality and land use factors that may contribute to the declining coastal conditions. However, there has yet to be a comprehensive or consistent review across all Gulf States to analyze and evaluate one of the most essential factors for the health of the Gulf – the timing and delivery of fresh water to the bays, estuaries and coastal communities. The timing and delivery of freshwater flows are widely considered within the scientific community to be the "master variable" for support of healthy and functional riverine ecosystems. Instream flow has been identified as a major factor for healthy ecological systems in estuaries, affecting all levels of physical, chemical and biological functions. (Poff et al 1997). Every aspect of the lives of aquatic plants and animals is cued by and inextricably linked to the natural variability of our rivers and streams (SIFN 2010). The biological productivity of bays and estuaries including fisheries and oyster harvesting in the Gulf of Mexico is dependent on these freshwater inflows that drive estuary function and health (Powell, et all 2002, Copeland 1966). Powel, et al. found that the natural timing and delivery of freshwater flows from rivers to estuaries are critical for "estuarine circulation patterns, salinity gradients, sediment transport,

nutrient supplies and the production of valuable coastal fisheries" (Powell, et al 2002). Anthropogenic changes to the timing and delivery of freshwater flows to bays and estuaries causes loss of habitat and nursery areas, declines in spawning and productivity, and alters species composition and abundance. (Harte Institute, 2014 and Albers, 2002). A widely accepted conceptual model of estuarine freshwater flow impacts (See Figure 2) indicates that changes to the quantity, quality and timing of freshwater inflows affects salinity, sediments and particulate matter which in turn affects ecological endpoints such as species composition, distribution and abundance (Albers 2002).

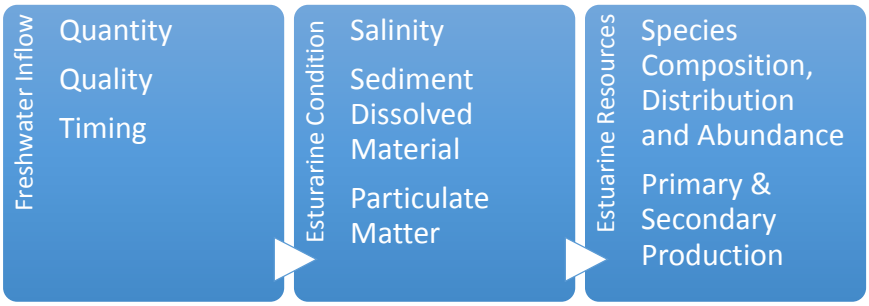

Figure 2: From Albers, 2002.

Many estuarine and coastal habitats, critical for estuarine health, may be significantly degraded by changes to the timing and delivery of freshwater flows. Sea grass beds, for instance, are one of the most critical near shore coastal habitats in the Gulf and are very vulnerable to anthropogenic changes. Sea grasses define the community structure, are extremely productive and are used by a wide variety of species as nurseries, feeding grounds and refuges from predation (Livingston 1990). Sea grasses are a vital part of the food web and provide food for many organisms. Similarly, oyster beds, mangroves, marsh lands and soft-bottom un-vegetated sediment habitats all make up significant habitats and are all vulnerable to degradation based on anthropogenic alteration to the timing and delivery of freshwater flows.

Water quality is affected by alteration of water salinities; variation in oxygen and temperature conditions; changes in the distribution and transport of nutrients, carbon and particulate organic matter to the estuary; increased susceptibility to algal blooms and the disruption of sediment transport. While qualifying and quantifying the connection between freshwater flow and water quality is challenging due to site specificity and the complex nature of estuarine ecosystems, the evaluation of freshwater flow is imperative to understanding the physical, chemical and biological interactions occurring in these systems.

The understanding that freshwater inflow is essential to support the health and function of estuaries is not new. For more than six decades, there has been a plea from within the scientific community to more fully evaluate and respond to concerns about reductions to or changes in the timing and delivery of freshwater flows to estuaries, including specifically bays and estuaries within the Gulf of Mexico. As early as 1953, the vital importance of flows to the fisheries of Texas bays and estuaries was recognized (Hildebrand and Gunter, 1953, Powell et al 2002). In 1966, B.J. Copeland wrote in his paper, *Effects of Decreased River Flow on Estuary Ecology*, "..freshwater flow input to estuaries is an important factor. Without it, estuaries become hypersaline and species composition can be altered drastically" (Copeland, 1966; Albers 2002). H. Dickson Hoese's ended his 1967 paper in a plea to address the "pressure of rising salinities (due to decreased freshwater inflow]" which he indicated will increase in Texas and then the northeast. As Albers points out in her *Conceptional Model of Estuarine Freshwater Inflow Management* "estuarine ecologists have been bemoaning the lack of attention paid to this issue" for a very long time.

Existing Hydrologic Alteration Despite this understanding of the importance of naturalized delivery of freshwater flows to bays and estuaries, the past decades have witnessed a staggering increase in the amount of hydrologic modification of the rivers, streams and coastal waters in the Gulf. In a national assessment, the U.S. Geological Survey found that human alteration of waterways has impacted the magnitude of minimum and maximum streamflows in more than 86% of monitored streams nationally and may be the primary cause for ecological impairment in river and stream ecosystems. As of 2011, more than 84,000 dams were in the U.S. National Inventory of Dams (See Figure 3) (U.S. ACE 2010). However, that does not include the medium and small impoundments that fragment and disrupt stream networks and reduce freshwater flow in downstream waters. New remote sensing tools are being used to identify the full extent of these small and medium impoundments. For example, a recent study in the Apalachicola-Chattahoochee-Flint basin, which discharges to the Gulf, verified *over 25,362 impoundments in that one river basin alone* (Ignatius and Stallins 2011). Many estimates conclude that *well over 60% of water worldwide may be held behind dams* (Vorosmarty and Sahagian 2000). The effect of those alterations on the functionality of the coastal estuaries is significant.

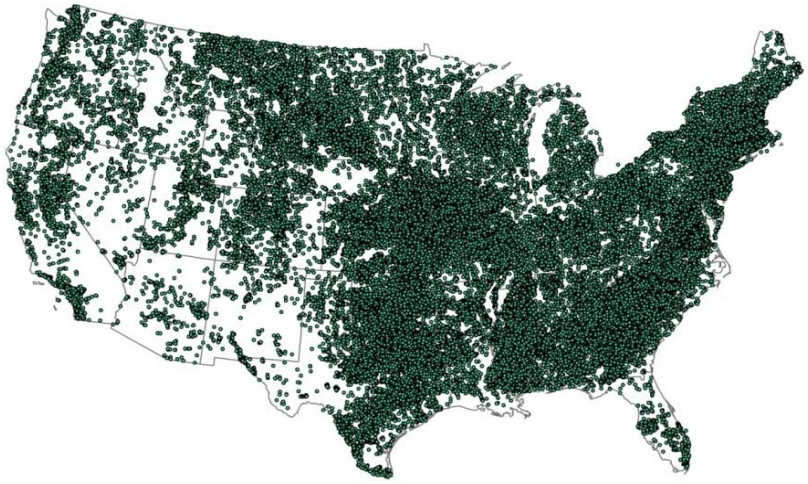

Figure 3. Distribution of the large and hazardous dams in the U.S. Source: U.S. ACE 2010.

Other alterations, such as diversions, include permanent or temporary structures and water pumps designed to divert water to ditches, canals, or storage structures. Diverted waters can be used for hydropower, irrigation, municipal, and/or industrial purposes. Permanent infrastructure to convey diverted waters (pipelines, canals, ditches, etc.) is widespread throughout the U.S. and very prevalent in the near coastal zone of the Gulf Coast states. (See Figure 4).

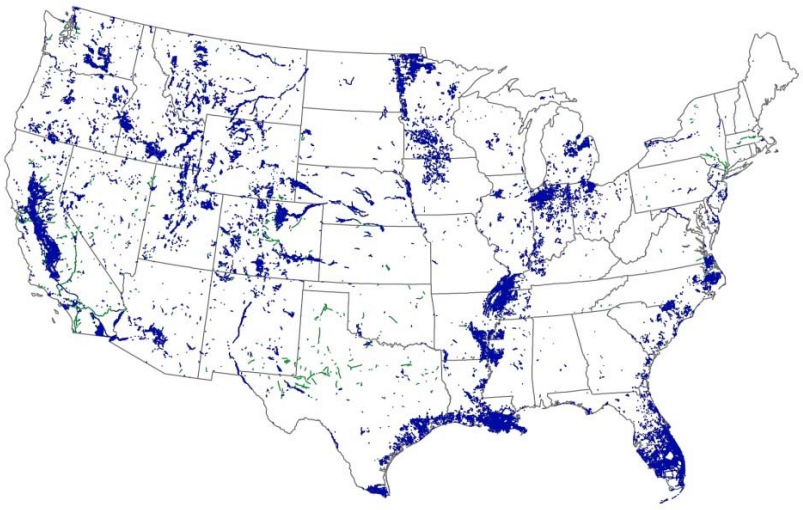

Figure 4. Water conveyance structures (e.g., canals, ditches, and pipelines) in the U.S. from the National Hydrography Dataset.

In 2013, the USGS reported that groundwater depletion, which can have negative impacts on water supply, can lead to land subsistence, reduction in surface water flows and spring discharges and loss of wetlands, has "increased markedly" since about 1950. (Konikow 2013) (See Figure 5).

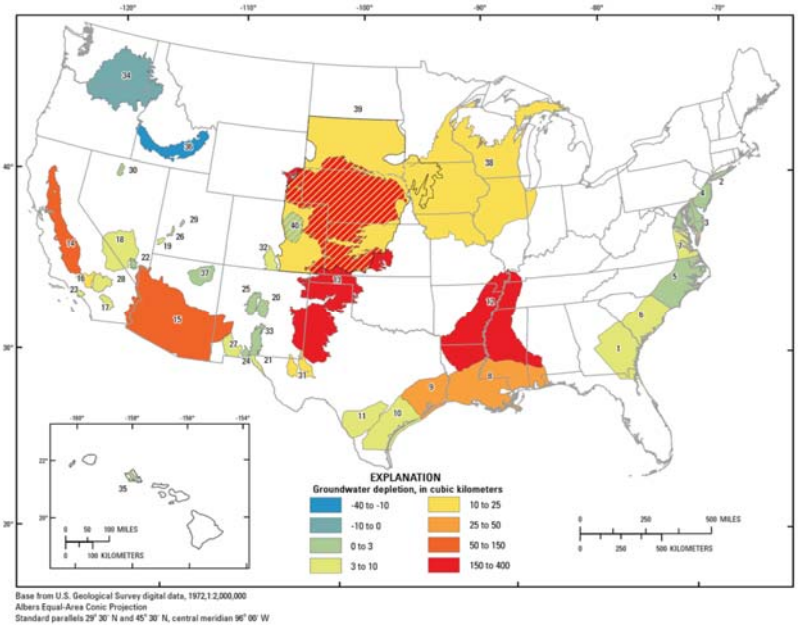

Figure 5: Cumulative groundwater depletion, 1900 through 2008, in 40 assessed aquifer systems or subareas. (Konikov 2013)

The EPA has concluded that as "people alter the environment through activities like development, construction of dams, flood control structures, and diversions of water, we change the volume and rate that water runs off the landscape, into the ground, and into streams. Changes in freshwater inflows to estuaries can adversely affect shellfish survival, and fish reproduction and distribution." (EPA http://water.epa.gov/type/oceb/nep/challenges.cfm#hydro)

Flow Restoration Alternately, restoration of freshwater inflows can positively affect shellfish, fisheries, habitat, and water quality. Increasingly, state and local decision-makers and federal agencies are turning their attention to the restoration of flows as part of a holistic approach to restoring water quality and habitat and to protecting and replenishing living coastal and marine resources and the livelihoods that depend on them. The state-of-the-science for restoring flows that more accurately mimic the natural timing and delivery of flows has increased substantially in the past three decades and has tremendous potential for use in the Gulf. An ever-growing number of successful examples now exist of collaborative restorations that have taken place such as dam removals, conservation and efficiency efforts, improved placement and operation of surface and groundwater withdrawals, installation of green infrastructure, or the modification of flow regimes through operational changes made through dam re-regulation. A number of federal, state and local partnerships have already identified such remedies as a high priority for ecosystem restoration (see also pg. 15). For instance:

- The US FWS has long been at the forefront of the development of environmental flows[2] developing tools and models to develop and implement flow regimes to protect and restore critical habitat and protect and maintain species.
- NOAA's Open Rivers Initiative, designed to contribute to the sustainability of U.S. fisheries and provide economic boosts for communities and provide for public safety, has provided grants to remove more than 90 dams and stream blockages between fresh and salt water.
- The ACOE has partnered with The Nature Conservancy for habitat restoration under its Sustainable Rivers Program, using dam re-regulation to restore more ecologically sustainable flows and create and protect habitat and improve water quality in downstream waters. These projects have successfully restored habitat, improved water quality in downstream waters, and enhanced the economics of upstream and downstream communities.
- The Federal Energy Regulatory Commission (FERC) has successfully partnered with power companies to re-regulate dams and supply much needed ecologically sustainable flows downstream to improve and support habitat and water quality.
- Many of EPA's National Estuary Programs have already identified restoration of ecologically sustainable flows as a top priority.

USGS stream gages are the primary means by which stream flow information is evaluated in the United States. USGS currently operates about 950 stream gages that drain into the Gulf from Texas, Louisiana, Mississippi, Alabama, and Florida (See Figure 6). Over the last 30 years, more than 160 stream gages with more than 20 years of streamflow data have been discontinued (See Figure 7). However, many of the streamflow gages that track freshwater inflows to the Gulf of Mexico remain in operation today. For instance, the USGS National Stream Quality Accounting Network (NASQAN) started water quality monitoring at 37 streamgages near the Gulf coast in the early 1970s. The total drainage area upstream of these 37 streamgages represents about 86 percent of the total drainage area from the U.S. to the Gulf of Mexico. All of these 37 streamgages are in operation today. Most of these streamgages have been in operation for over 70 years, 5 of these streamgages have been in operation for more than 90 years. This long-term information on freshwater inflows to Gulf estuaries can be used to assess if changes have occurred in critical freshwater inflows that may potentially impact the health of Gulf estuaries.

[2] Environmental flows or e-flows is often defined as the quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods that depend on these ecosystems. (Brisbane Declaration, 2007)

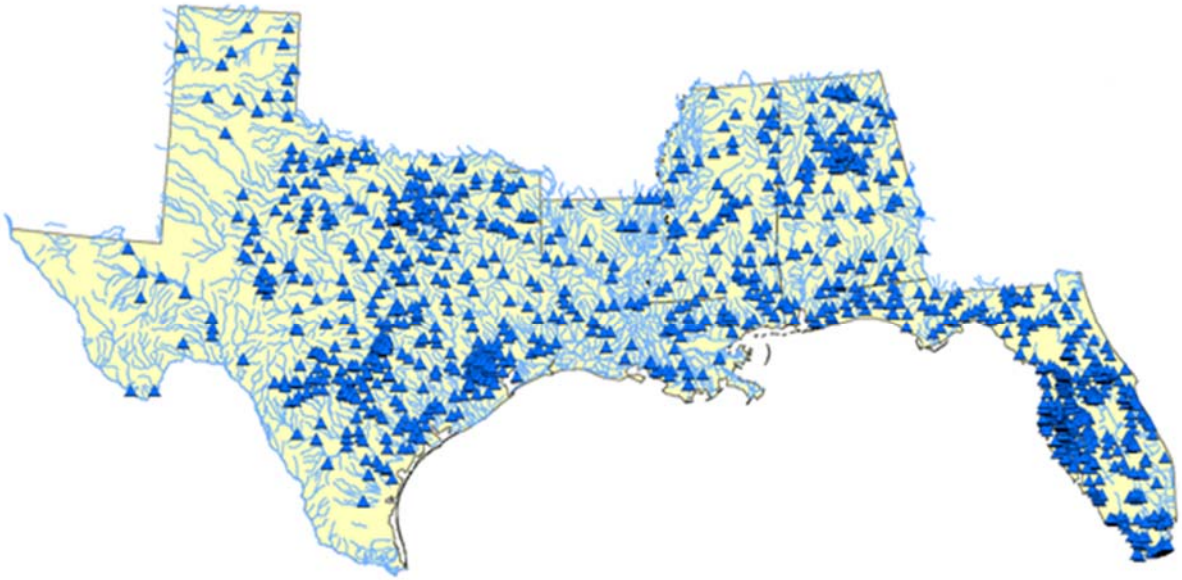

Figure 6. Active USGS streamflow gages in the five states bordering the Gulf of Mexico.

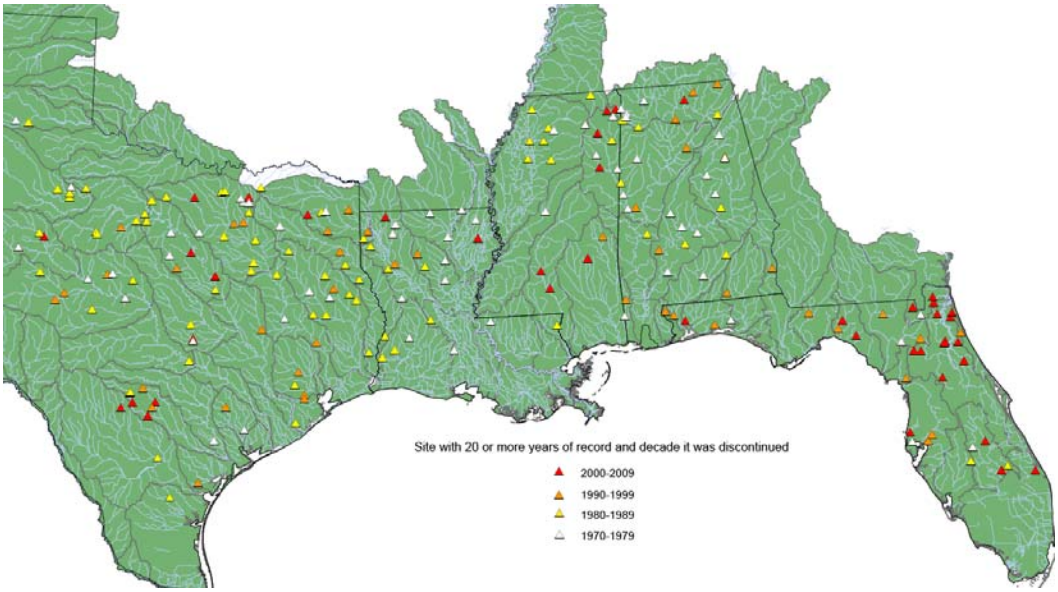

Figure 7. Locations of USGS stream gages in the five Gulf States with 20 or more years of data that were discontinued from 1970 to 2009.

In order to provide state and local decision-makers with the relevant and most up-to-date information on freshwater flows so that they can evaluate and prioritize restoration, the USGS and the US EPA propose to collaborate on a comprehensive, large-scale, state-of-the-science foundational project to provide vital information on the timing and delivery of flows to freshwater streams, bays, estuaries, and wetlands of the Gulf Coast. This foundational proposal will provide vital freshwater flow data and information for all five Gulf Coast States and the many local governments for decision-making related to restoring and conserving habitat, water quality, and living coastal and marine resources while enhancing community resilience and the Gulf Coast economy. Together, the USGS and the EPA have the combined expertise,

missions and statutory authorities to carry out this foundational proposal to improve the ability of the state and local governments to make science-based decisions on protection and restoration for the Gulf Coast.

Proposed Projects and Implementation Methodology

Project 1: Regional Streamflow Alteration Assessment & Gage Gap Analysis
Scope of all of these elements: Five Gulf States

In order to provide state and local decision-makers with easy to use tools and information to make resource decisions and optimize restoration potential while also providing scientifically-credible approaches for decision makers at the watershed scale, a regional streamflow alteration assessment will be developed for all five Gulf States. Streamflow data from the USGS gage network in the five states with streams and rivers draining directly to the Gulf of Mexico will be used to assess how streamflow characteristics representing the five major categories of the flow regime vary spatially and over time. The online streamflow alteration tool will provide easy access to measures of streamflow alteration throughout the region. Water resource managers can use this tool to rank measures of streamflow alteration at the State or watershed scale to prioritize areas for restoration actions.

The proposed approach to freshwater systems throughout the study area will provide regionally consistent information on streamflow alteration. This approach builds upon and will complement the characterization of intra-annual variability of inflows and the connection to estuarine salinity regimes for estuaries and bays along the Texas coast and west-central Florida (Texas Water Board, 2008; Montagna et al., 2002; 2008).

This assessment and the associated tools are designed to provide the means to answer the following types of questions for state and local decision-makers.

- What are the gaps in streamflow data needed for assessing streamflow alteration in my state or local area? Are there existing gages that could be restored to provide the needed data for long term decision-making and to provide for future restoration and maintenance?
- Which streams in my state have the largest amounts of streamflow alteration?
- For my watershed of interest, are there detectable temporal shifts in average annual streamflow regimes at the watershed scale?
- Are shifts in magnitude, timing, duration, and frequency of freshwater delivery to estuaries distinguishable from natural (not direct anthropogenic) signals?
- Do such shifts in streamflow characteristics have a functional and discernible connection to estuarine aquatic health?

The detailed steps and methodologies for this process are as follows:

1a - Develop a regionally consistent set of streamflow metrics at long-term streamflow gages— Streamflow metrics will be computed and made available online. These will represent critical components of the flow regime and quantify low, average, and high flows within five flow-regime categories (magnitude, frequency, duration, timing, and rate of change) (Olden and Poff, 2003) will. This database will provide a regionally consistent resource that can be used by local, state, and federal agencies to inform a wide range of water resource management decisions.

1b - Develop measures of streamflow alteration at long-term streamgages—Hydrological alteration will be quantified at each stream-gaging site by comparing observed flow attributes (*Observed*) to expected natural flow attributes (*Expected*) derived from an empirical model. The *Observed* metric will

consist of a set (e.g., 10 to 20) of streamflow metrics that are computed from daily flow records, and are selected using current scientific information and expert judgment, with the goal of being representative of the five components of the natural flow regime (i.e., magnitude, duration, frequency, rate of change, variability) and of being relevant to ecological health in streams, rivers, and estuaries. We anticipate using streamflow metrics that represent conditions across many years (e.g., average annual peak flow over a 10-yr period) as well as metrics intended to represent conditions each year (e.g., average flows in August of each year). For each of the select streamflow metrics, statistical models will be developed using existing streamflow and climate data, as well as physical watershed information (e.g., topography, geology) for hydrologically undisturbed stream-gaging sites across the Gulf Watershed (approximately 200-300). Each statistical model is developed to predict a specific streamflow metric using the climate and natural (e.g., excluding land cover & other human influences) physical characteristics of the watershed (Carlisle et al. 2010). These same climatic and physical characteristics of each non-reference gaged site are then used as input to the statistical model to generate the E metric for that site. Alteration (for each streamflow metric) at that site is then defined as the deviation of the *Observed* flow metric from *Expected* , where the *Observed* metric is computed from the stream-gage record and the *Expected* metric is derived from the statistical model.

The proposed *Observed/Expected* approach to freshwater systems throughout the study area will provide regionally consistent information on streamflow alteration. This approach builds upon and will complement the characterization of intra-annual variability of inflows and the connection to estuarine salinity regimes for estuaries and bays along the Texas coast and west-central Florida (Texas Water Board, 2008; Montagna et al., 2002; 2008).

1c – Estimate trends in streamflow metrics and evaluate potential influences related to climatic and land/water management stressors—Temporal trends in streamflow metrics will be assessed in two ways. For a given stream-gaging site, temporal trends in *Expected* represent the effect of climatic variation and trends on natural streamflow conditions. This assessment will indicate whether and how climatic shifts have influenced natural flows across the Gulf Watershed. The second approach is to examine site-specific temporal trends in the deviation of *Observed* from E. This assessment will indicate whether and how natural flows are influenced by human activities such as water management and land use. Temporal trends in the deviation of *Observed* from *Expected* will indicate how human influences on flow are changing through time, and when evaluated from a regional perspective, provide an indication of where natural flows in streams, rivers, and estuaries are under the greatest anthropogenic stress. Importantly, trends in *Observed* are less informative than the above approaches because they are composed of the effects of both climate and land/water-management. Analyzing *Expected* and *Observed-Expected* separately will allow us to differentiate between these two major drivers.

1d - Define the optimal streamgage network for assessing flow alteration in the Gulf States region—The proposed assessment method requires a network of streamgages that includes both reference and non-reference sites. The reference sites are used to construct statistical models in order to estimate E at ungaged sites, and the non-reference sites are used to assess flow alteration. The network must include a sufficient number of both types to sites to avoid bias in the results. A valid assessment depends on a network that is representative of the region and large enough to predict conditions with an acceptable level of uncertainty. To achieve this goal, both natural and anthropogenic drainage-basin characteristics will be determined for all streamgage sites in the network. For comparison, the same drainage-basin characteristics will be estimated for all streams in the Gulf States. Comparing the two sets of drainage-basin characteristics will identify biases in the gaging network. Biases in the network can be minimized by adding gaging sites so that the distributions of drainage-basin characteristics of both the gaged and ungaged streams are as similar as possible. This analysis also will be used to identify the location of potential new gaging sites required to achieve an acceptable level of uncertainty. The geospatial and

statistical analysis tools needed to determine the optimal streamgage network already have been developed and are ready to be applied in the Gulf States.

1e - Predict streamflow alteration at ungaged streams—All streams are not monitored for streamflow, thus there is a recognized need to develop a robust method to extend the assessment of streamflow alteration to ungauged streams. Statistical models will be developed to predict the likelihood that 5 to 10 selected streamflow metrics at ungauged stream reaches are altered relative to the expected natural condition (Eng and others, 2013). Human disturbance variables, such as the number of dams, road density, and urban area, will be included in the model to predict the likelihood of streamflow alteration throughout all streams in the study area.

1f - Develop an online streamflow alteration mapping tool—An online streamflow alteration mapper will enable decision makers to access a variety of stream flow information at the regional, State, and local scales. Components of the mapper include:

- Measures of streamflow alteration at long-term stream gages for 10 to 20 streamflow metrics
- Annual variability of streamflow at long-term stream gages for 10 to 20 streamflow metrics
- Estimates of streamflow alteration at ungaged watersheds.
- Access to a regionally consistent database describing over 150 streamflow metrics at all long-term stream gages.
- Ability to rank streamflow alteration metrics at the regional, state, or watershed level to target restoration actions where streamflow alteration is highest.

1g Work with stakeholders to determine which gages should be reactivated. In year 4, the streamgage network optimization assessment will be used to identify about 6 streamflow gages that have been discontinued recently and that have a substantial long-term streamflow record. In Years 5 and 6, an additional 6 streamflow gages will be restarted or new gages installed each year in areas prioritized in the network optimization and through consultation with State agencies. Priority will be given to restarting recently discontinued gages with long-term flow records. The streamgage optimization assessment will serve as a framework to engage State partners in developing a subsequent proposal to fund a broad network of additional stream gages in key areas across the five states for 10 or more years.

1h-Form a Technical Advisory Committee for the Focused Watershed Study -A committee of federal, state, local and non-profit interest groups with representatives from resource management, regulatory agencies, agricultural interests, and energy production would be formed early in project 1 to use as a soundboard for findings as well as for application of findings in a focus area to be assessed in Project 2.

Project 2: Focused Watershed Study

A Technical Advisory Committee will be formed from federal, state, local, and non-profit interest groups with representatives from resource management, regulatory agencies, agricultural interests, and energy production to select one focus area within the Gulf where freshwater inflows to an estuary have changed significantly over time. The focus area will have a well-established, temporally and spatially extensive riverine and estuarine ecological sampling network, and represent a variety of land uses and human modifications to streams and rivers in the area. The USGS and USEPA will assess linkages between changes in streamflow characteristics and ecological response in freshwater streams and the estuary. These findings will be used to engage water resource managers to better understand how these streamflow changes have impacted aquatic resources and develop potential ways these streamflow alterations might be mitigated. A streamflow accounting model will enable water resource managers to evaluate a range of

potential management scenarios, such as modifying the release curves for selected reservoirs upstream to evaluate changes in freshwater delivery to an estuary.

2a - Identify which streamflow metrics in the focus watershed are critical to freshwater fish community health / structure—Streamflow metrics and fish community data for freshwater sites throughout the focus watershed area will be evaluated using multivariate techniques to determine which components of the annual hydrograph are critical to freshwater fish health. The analysis will be conducted using streamflow metrics in terms of their respective deviation from reference hydrologic profiles developed in phase 1 (en sensu Knight et al., 2008; Carlisle et al., 2010a, and 2010b). The result of the analysis will be a subset of streamflow metrics that, when altered, result in an observed ecological response, or ecological limit function (Knight et al., 2013). This function can be used to evaluate potential changes to streamflow (water use, landscape / land use change, and climate) in terms of potential ecological response (degradation) providing managers with a scientific basis for decision making.

2b - Evaluate how annual variability of magnitude, timing, duration, and frequency of streamflow metrics at large river sites in the focus watershed relates to changes in indicators of estuarine health— This task will pair USGS and USEPA National Estuarine researchers, in consultation with a Technical Advisory Team, to improve the understanding of how large river streamflow alterations are impacting indicators of estuarine health.

2c - Utilize a flow accounting model to evaluate and understand how streamflow alteration at locations in the upper basins in the focus watershed impacts freshwater flows to the Gulf--Flow accounting models provide a tool that managers can use to evaluate how streamflow alteration in upstream basins affects downstream conditions. Optimally, models such as these must be empirically based, flexible, compatible with other platforms, while also being easy to use and providing readily interpretable output.

The **OASIS model** (HydroLogics, Inc., 2011) is an excellent example of such a model and is a unique software program that realistically simulates the routing of water through a watershed. OASIS is an extremely powerful tool that estimates streamflow availability in the context of varying supply demands, management options, and changes in operational rules/constraints. This tool enables parties with diverse and often conflicting goals to work together to develop operating policies and solutions that mutually satisfy diverse objectives. In application, OASIS allows managers to understand the frequency and duration that existing or proposed operating rules may be violated and a straightforward means to evaluate alternatives. The model solves for the best means of moving water through the system to meet a prescribed set of goals and constraints. OASIS has been applied at numerous locations such as the lower Rio Grande-Pecos-Conchos, Savannah, Cape Fear, Pamlico, Neuse, and Roanoake rivers systems, as well as two applications in the Mobile Bay watershed (Black Warrior and Alabama - Coosa-Talapoosa Rivers).

Monitoring and Adaptive Management of the Project

This project will be completed with state-of-the-art scientific methods. As new and emerging processes or methods become available, they will be incorporated into the project.

Measures of Success for the Proposed Project

This project will have discreet outputs and deliverables that will allow tracking of all measures and plan elements. To get insight into local and state governments' ease of accessing and using information, a survey tool can be embedded in the website to provide feedback on how easy tools are to use and

understand, with follow-up survey and report on how many entities used information and for what purposes. There will also be an ability to track the number of hits on tools sites.

Project 1 Deliverables:

- Publication – Publication presenting the spatial patterns and temporal shifts of various aspects of the streamflow regime at a regional scale. Much work has been done looking at streamflow characteristics as 'snapshots in time' and how those characteristics correspond to aquatic ecological health, trading space for time to get at gradients of hydrologic alteration. Very little if anything has been analyzed and published looking at large regions, particularly large regions over extended periods of time.
- Publication-Online data report that provides a regionally consistent approach to describing critical components of the flow regime and quantify low, average, and high flows that can inform decisions at the regional, state, and watershed scale.
- On-line Tools-Online streamflow alteration mapping tool to access streamflow alteration at existing stream gages and predictions of streamflow alteration at ungaged streams. Water resource managers can use this information to rank streamflow alteration at the regional, state, or watershed scale to prioritize restoration actions.
- Press Briefs and Public Education-press releases associated with the publications and the online streamflow mapper, in combination with webinars and fact sheets, will facilitate the communication of the importance of streamflow to healthy stream and estuarine ecosystems.
- New Gages Installed or Existing Gages Restarted. Funding for operation of the gages is included for the duration of this project. Additional funding would have to be secured for continuation of those gages.

Project 2 Deliverables:

- Publication - Publication (co-authored by USGS and USEPA) that identifies dominant mechanisms influencing alteration of the flow regime in the focus watershed, with empirically-based examples of freshwater and estuarine ecological response to those changes.
- Publication- Publication describing a flow accounting model in the focus watershed, that provides managers a tool to evaluate how potential changes management options may alter streamflows.

Risks or Uncertainties of the Proposed Activities

The USGS is the national leader for understanding and evaluating stream flow metrics, variability and trends, therefore the risks of this project are limited.

Outreach and Educational Opportunities

This project is particularly well-suited for providing a significant amount of outreach and educational opportunities which will be directly incorporated into the projects. Outreach and education to both the public as well as to state and local decision-makers will expand the general knowledge on the importance of gages as well as on the newly emerging information and successful projects that have already demonstrated the ecological and economic benefits of maintaining or restoring ecological flows.

1. **Communicating the importance of gages.** Stream flow information is vital to management and policy decisions regarding flood and drought protection, industrial and municipal water supply, pollution control, storm water management, and stream ecosystem health. Population growth, irrigation, power generation, recreation, and restoration of aquatic habitat are just a few of the many examples of the competing

priorities for water throughout the Gulf States. The USGS stream gage network provides accurate, long-term and continuous data required to inform management and policy decisions regarding this valuable resource. The spotlight is keenly focused on the value of streamflow information during floods and droughts to address questions such as: When will the river peak and at what level? or How much water is flowing in the stream and will it be enough to meet our needs? However, it is the uninterrupted, long-term stream flow data records that are essential to assessing how the stream flow metrics related to floods, droughts, and aquatic stream health are being modified by human actions. Potential reductions in Federal and State budgets can put many of our stream gages at risk. Providing stream flow metrics across the five Gulf States will highlight the importance of these stream gages and how stream flow information can inform future water decisions as the competition for water resources increases and reduce reliance on estimates of stream flow, which may introduce error into planning and restoration.

2. Creating On-Line Tools The development of the readily accessible and easy to use on-line tool will provide a permanent means of providing outreach and education directly to the state and local decision-makers for which they are designed.

3. Communicating Information on the Ecological and Economic Benefits of Restoring Flows. The state-of-the science on understanding freshwater flows may not be well understood by the public. The project will incorporate information on the ecological and economic importance of freshwater flows to coastal communities in fact sheets, press briefs, on-line tools and in publications which will be made accessible.

4. Publishing Successful Stories of Flow Restorations. EPA and the USGS will profile and publicize successful flow restorations that have taken place in numerous areas around the country resulting in ecological and economic benefits for communities to use for education on the ecological and economic benefits that have resulted for communities.

Leveraging of Resources and Partnerships

The data and information generated from this project will offer many opportunities for leveraging future project as restoration needs are identified. Freshwater flows to coastal areas, improving connectivity and removing dams and barriers to restore habitat for species that migrate between the ocean and freshwater rivers and streams has long been a priority for many agencies, including EPA's NEPs, NOAA, USFWS, FERC and the ACOE. EPA and the USGS would seek partnerships with these well-established programs and experts to ensure that restoration is prioritized in line with existing goals. In addition, Texas has a program in place to evaluate hydrologic conditions and has developed significant expertise in this area. The USGS and USEPA would seek to assist those states and facilitate leveraging federal agencies for any support needed with their program.

Specific existing programs that could be of significant benefit to directly partner with for future restoration, include:

US FWS The US FWS has long been at the forefront of the development of environmental flows developing tools and models to develop and implement flow regimes to protect and restore critical habitat and protect and maintain species and would be an invaluable partner for all aspects of this project.

EPA's National Estuary Program. Many NEPS have identified connectivity and freshwater flow as a significant factor to address and have developed a variety of measures for addressing them in their Comprehensive Conservation and Management Plans (CCMPs). For instance, below are a couple of examples of how NEPs have identified hydrologic issues specifically and correlated hydrology with the

protection of water quality, habitat and specific protections for coastal and estuarine species. To be noted as well, is the protection from alteration or elimination of freshwater streams that are well up in the basin.

Charlotte Harbor National Estuary Program (CHNEP): CHNEP lists hydrologic alteration as one of its four (4) top priority problems. The CHNEP has identified numerous quantifiable objectives and detailed, specific priority actions in its2013 CCMP update, including:

- Utilize historic, current and future scenario estuarine mixing models, focusing on salinity and indicator species for better evaluation of proposed capital and operations projects.
- Utilize integrated ground and surface water models to improve decision-making, addressing ecosystem needs in the context of population growth, development, agriculture and mining water demands.
- Protect headwater tributaries from elimination and restore these tributary courses and their floodplains.
- Set and achieve minimum aquifer levels and meet established minimum flows and levels for tributaries.
- Reestablish hydrologic watershed to contribute flows to their historic receiving water bodies.
- Evaluate the impacts of man-made barriers to historic flows and modify them to establish more natural hydrologic conditions.
- Build and restore water conveyances to have shallow, broad, vegetated and serpentine components that also restore floodplains.
- Identify the hydrologic and environmental impacts of surface water reservoirs on estuaries within the watershed. Mimic natural systems in site selection, design and operation of reservoirs.
- Implement watershed (basin) initiative projects to address hydrologic alterations, loss of water storage and changed hydroperiod, and improve water quality.

Tampa Bay Estuary Program (TBEP): TBEP has an Action Plan in their 2006 CCMP dedicated to freshwater inflow: FI-1-03 "Establish and maintain minimum seasonal freshwater flows in rivers." Specific goals adopted include:

- Maintaining connectivity between open bay waters, large tidal rivers and smaller tidal streams to improve movement of fish, water flow and nutrients among the systems.
- Reducing large fluctuations in water flow from storm events, known as "flashiness," to mimic more natural hydrologic flows and foster production of benthic microalgae and the animals that eat it.
- Tracking conditions in tidal tributaries by monitoring freshwater inflow, watershed development, water quality and fisheries use.

USGS. As part of the USGS National Water Census, the USGS is developing novel tools to help stakeholders better understand the effects of streamflow alteration and water withdrawals on aquatic ecosystems. The goal is to build stakeholder's capacity to use science to develop their own management metrics and guidelines. http://water.usgs.gov/watercensus/ecowater.html

NOAA. NOAA's Open Rivers Initiative, designed to contribute to the sustainability of U.S. fisheries and provide economic boosts for communities and provide for public safety, has provided grants to remove more than 90 dams and stream blockages between fresh and salt water. NOAA's Restoration Center acknowledges the critical importance to remove dams and barriers which will restore habitat for the numerous critical species which migrate between freshwater rivers and streams and the ocean. (www.habitat.noaa.gov/funding/ori.html)

ACOE and TNC. The ACOE has partnered with The Nature Conservancy for habitat restoration under its Sustainable Rivers Program, using dam re-regulation to restore more ecologically sustainable flows and create and protect habitat and improve water quality in downstream waters. These projects have successfully restored habitat, benefited rivers, improved water quality in downstream waters, and enhanced he economics of upstream and downstream communities. The ACOE and TNC have multiple projects on rivers that lead to the Gulf (Green, Black River, White River, Little Red River, Big Cypress Bayou/Caddo Lake) that could be used as a model for additional re-regulation projects in the five Gulf Coast states with proven technologies and practices. The ACOE operates numerous dams upstream of Gulf communities and is tasked with updating Water Control Manuals for the operation of those dams, presenting an opportunity to become a cost share partner with the ACOE for the re-regulation of those dams.

FERC The Federal Energy Regulatory Commission (FERC) has successfully partnered with power companies to re-regulate dams and supply much needed ecologically sustainable flows downstream to improve and support habitat and water quality. For instance, FERC, American Rivers and the South Carolina Gas and Electric Company negotiated an agreement during re-licensing of the Saluda River to improve flows, improve public safety, improve fisheries and increase fishing and outdoor recreation. Numerous dams within the Gulf States and flowing to the Gulf coastal areas will be up for relicensing over the next 20 years. The project objectives could be designed to work with FERC for improving flows to coastal communities.

Proposal Project Benefits

Ecological Benefits This proposal will have far-reaching measureable and sustainable effects by providing the needed tools for state and local decision-makers considering hydrologic restoration. As outlined in the initial proposal, the data and information provided through this proposal will support state and local decisions restoration decisions which could lead to restoration of more naturalized timing and delivery of freshwater flows could directly lead to improvements in:

- Water Quality: Potential to reduce eutrophication in estuaries and produce more naturalized variations in salinity, sediments and nutrients.
- Improve Habitat: Water quality and freshwater flow improvements would have direct positive impacts to sea grasses and other submerged aquatic vegetation, mangroves, salt marshes and other near-coastal habitat.
- Can provide for the recovery of fish, shellfish and other wildlife populations, including those of critical importance for commercial and recreational fishing. Species which could benefit would include scallops, oysters, crab, shrimp, red fish, flounder, striped bass and well as endangered species such as sturgeon.

Economic Benefits There is growing evidence that ensuring for adequate freshwater flow to the rivers and downstream estuaries is not only critical to the health and function of those ecosystems, but it is also important for the support of a thriving state, local and coastal economy. The five U.S. States that border the Gulf of Mexico have a gross domestic product of over $2.5 trillion (Bureau of Economic Analysis 2012). The coastal waters of the Gulf Coast region are among the most productive natural systems, and the region is second only to Alaska for domestic landings of commercial fish and shellfish. The Gulf Coast accounted for about 78% of the total U.S. shrimp landings, averaging about 221 million pounds from 2007 to 2009. The Gulf Coast also accounted for about 62% of the U.S. oyster landings over the same period (National Marine Fisheries Service, 2010)

In July 2012, the EPA published a fact sheet entitled, *The Economic Benefits of Protecting Healthy Watersheds* (EPA 2012) that states that maintaining the integrity of intact watersheds provides significant economic benefits to state and local economies. The referenced studies also show that state and local economies strongly depend upon significant contributions from outdoor recreation, tourism and recreational and commercial fishing. For example:

- A 2012 report found that outdoor recreation contributed $646 billion in direct sales and services to the U.S. economy annually, supporting an estimated 6.1 million jobs, generating $39.9 billion in federal tax revenue and $39.7 billion in state/local tax revenue and providing sustainable growth in rural areas (Outdoor Industry Association, 2012). A 2006 report found that the economic contribution to the South Atlantic (including FL, GA, NC and SC) from outdoor activity was almost $68 billion, second only to the Pacific Northwest. The South Atlantic led the nation in outdoor recreation jobs, numbering 794,841 with another 215,126 in the East South Central States (AL, KY, MS and TN). (Outdoor Industry Foundation, 2006)
- News reports in 2011 indicated that outdoor recreation remained steady even during the recent economic downturn. (Smith, 2011) From 2005 to 2011, during a time when many industries contracted, the outdoor recreation economy grew approximately 5% annually.(Outdoor Industry Association, 2012)
- Hydrologic restoration projects are bringing economic development to smaller communities. According to the Mayor, the town of Rockingham, North Carolina removed an outdated dam in 2009 which was causing water quality problems, and is now creating the Hitchcock Creek Blue Trail to promote water based recreation and bring jobs to the community. A project to remove aging dams and restore naturalized white water flow to the Chattahoochee River on the Georgia/Alabama border has far outstripped projections to bring 144,000 new visitors annually, create 700 jobs and add $42 million additional yearly revenue from recreational tourism. The positive economic impact was so significant to the region that it spurred the creation of a Water Resources Economics Center at Troy University to promote the economic advantages of protecting water resources.
- Healthy estuaries and coastal communities, dependent on the natural timing and delivery of freshwater flows, contribute billions to state economies, for example, a comprehensive study placed the economic value of the Indian River Lagoon in Florida at $3.7 billion. (Hazen and Sawyer, 2008)

Conversely, in those areas where healthy hydrologic conditions are not sufficiently protected, degraded water quality can cause significant economic losses to state and local economies, through increased water and storm water treatment, reduced recreation and tourism income and damage from flooding. In 2012, the State of Florida requested that the U.S. Department of Commerce declare a fishery resource disaster for Florida's oyster harvesting areas in the Gulf of Mexico, particularly in Apalachicola Bay. The disaster, affecting 2,500 jobs was attributed in part to a reduction of freshwater flows to the coastal waters. Protection of healthy, naturalized hydrologic conditions and aquatic ecosystems in the Gulf States are critical to provide numerous jobs and protect the state and local economies.

EPA and USGS believe this project will make a significant contribution to planning and implementation of restoration efforts on a Gulf-wide basis. The project will promote community resilience in helping Gulf communities in adapting to short and long-term changes in flows, and will improve science-based decision making in targeting and siting restoration work. The publicly-accessible tools generated speak to the Comprehensive Plan commitments to engagement, inclusion and transparency. Increasing understanding of flow regimes in Gulf tidal streams and rivers is an important component in developing regional ecosystem-based restoration efforts.

Location Information
This project will be for the five Gulf States.

High-Level budget narrative
Years 1-3 are focused on the Regional Streamflow Alteration Assessments described under Project 1 activities. Years 4-7 cover the Focus Watershed Assessments described under Project 2 as well as restarting or installing the new gages.

Year 1: $850,000 Regional Streamflow Alteration Assessments
Develop a regionally consistent set of streamflow metrics at long-term streamflow gages
Develop measures of streamflow alteration at long-term streamgages
Define the optimal streamgage network for assessing flow alteration
Research and begin development of fact sheets on ecological and economic benefits of restoration.

Year 2: $850,000 Regional Streamflow Alteration Assessments
Publish report on optimal streamgage network for assessing flow alteration
Estimate trends in streamflow metrics
Start development of streamflow alteration mapper
Publish online a regionally consistent set of streamflow metrics at long-term streamflow gages.
Publish fact sheets on ecological and economic benefits of restoration.

Year 3: $800,000 Regional Streamflow Alteration Assessments
Publish article on streamflow alteration trends
Publish article on estimating streamflow alteration at ungaged sites
Release streamflow alteration mapper
Form Technical Advisory Team for Focus Watershed Study (Phase II)
Purchase state license of OASIS

Year 4: $900,000 Focus Watershed Assessments
Evaluate which streamflow metrics are most critical to ecological endpoints in Focus Watershed
Start building input data sets and setting up input data sets for the OASIS model.
Evaluate temporal changes in critical streamflow metrics along large rivers in the Focus Watershed

Year 5: $900,000 Focus Watershed Assessments
Finalize all components of the OASIS model
Continue streamflow metric analysis
Work jointly with EPA to assess how temporal changes in critical streamflow metrics along large rivers in the Focus Watershed are impacting estuary health (SAV, oysters, etc.)

Year 6: $1,000,000 Focus Watershed Assessments
Article on streamflow metrics/fish communities
Article on how streamflows metrics have changed over time at key large river nodes in the Focus
Determine funding source for continuation of new or restarted gages

Year 7: $500,000 Focus Watershed Assessments
Release OASIS model
Article on OASIS model
Communication Blitz on key results and application of the model.

ENVIRONMENTAL COMPLIANCE CHECKLIST

The studies presented here would not trigger the following federal statutes or requirements. If the focused watershed study results in restoration activities, the environmental compliance list would be revised.

Environmental Compliance Type	**Yes**	**No**	**Applied For**	**N/A**
Federal				
National Marine Sanctuaries Act (NMSA)				X
Coastal Zone Management Act (CZMA)				X
Fish and Wildlife Coordination Act				X
Farmland Protection Policy Act (FPPA)				X
NEPA – Categorical Exclusion				X
NEPA – Environmental Assessment				X
NEPA – Environmental Impact Statement				X
Clean Water Act – 404 – Individual Permit (USACOE)				X
Clean Water Act – 404 – General Permit(USACOE)				X
Clean Water Act – 404 – Letters of Permission(USACOE)				X
Clean Water Act – 401 – WQ certification				X
Clean Water Act – 402 – NPDES				X
Rivers and Harbors Act – Section 10 (USACOE)				X
Endangered Species Act – Section 7 – Informal and Formal Consultation (NMFS, USFWS)				X
Endangered Species Act – Section 7 - Biological Assessment (BOEM,USACOE)				X
Endangered Species Act – Section 7 – Biological Opinion (NMFS, USFWS)				X
Endangered Species Act – Section 7 – Permit for Take (NMFS, USFWS)				X
Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) – Consultation (NMFS)				X
Marine Mammal Protection Act – Incidental Take Permit (106) (NMFS, USFWS)				X
Migratory Bird Treaty Act (USFWS)				X
Bald and Golden Eagle Protection Act – Consultation and Planning (USFWS)				X
Marine Protection, Research and Sanctuaries Act – Section 103 permit (NMFS)				X
BOEM Outer Continental Shelf Lands Act – Section 8 OCS Lands Sand permit				X
NHPA Section 106 – Consultation and Planning ACHP, SHPO(s), and/or THPO(s)				X
NHPA Section 106 – Memorandum of Agreement/Programmatic Agreement				X
Tribal Consultation (Government to Government)				X
Coastal Barriers Resource Act – CBRS (Consultation)				X
State				X
As Applicable per State				X

Data/Information Sharing Plan

The core of this project involves the analysis of data and putting it into a format that is the most usable for all state and local decision-makers. This information was provided in detail in the project proposal and includes the development of published reports, public notices and briefings, on-line and data and mapping tools.

All USGS streamflow data are publically available online. Streamflow alteration metrics developed as part of this study will be publically available on the mapper tool and/or published in reports. Appropriate metadata will be made publically available for all spatial information used to help explain human disturbances to predict streamflow alteration.

Reference List of Literature Cited in the Proposal

Alber, M. 2002. A Conceptual Model of Estuarine Freshwater Inflow Management. Estuaries. 25(6B):1246-1261.

Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando, and D.R.G. Farrow. 1999. *National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries*. Prepared for the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects Office and the National Centers for Coastal Ocean Science, Silver Spring, MD.

Carlisle, Wolock and Meador, "Alteration of stream flow magnitudes and potential ecological consequences: a multiregional assessment," *Front Ecol Environ* 2010; doi:10.1890/100053.

Copeland, B. J. 1966. Effects of decreased river flow on estuarine ecology. *Estuarine Ecology* 38:1831–1839.

Eng, Carlisle, Wolock, and Falcone, 2013, Predicting the likelihood of altered streamflows at ungauged rivers across the conterminous U.S., River Res. Applic. 29:781-791

EPA (Environmental Protection Agency) Accessed in October 2014 at http://water.epa.gov/type/oceb/nep/challenges.cfm#hydro.

EPA (Environmental Protection Agency) 2012. "The Economic Benefits of Protecting Healthy Watersheds Fact Sheet." Washington, DC, Office of Water. EPA 841-N-12-004

EPA (Environmental Protection Agency) 2012 "National Coastal Condition Report IV." Washington, DC, Office of Research and Development/Office of Water. EPA-842-R-10-003

Hoese, H. D. 1967. Effect of higher than normal salinities on salt marshes. *Contributions in Marine Science* 12:249–261.

Hydrologics. 2011. Hydrologics: Advancing the management of water resources. Hydrologics, Inc.http://www.hydrologics.net/index.html (October 2014)

Carlisle DM, Falcone J, Wolock DM, Meador MR, Norris RH. 2010a. Predicting the natural flow regime: models for assessing hydrological alteration in streams. River Research and Applications 26: 118–136.doi: 10.1002/rra.1247.

Carlisle DM, Wolock DM, Meador MR. 2010b. Alteration of streamflow magnitudes and potential ecological consequences: a multiregional assessment. Frontiers in Ecology and the Environment. doi: 10.1890/100053.

Ignatius A and Stallins JA. 2011. Assessing spatial hydrological data integration to characterize geographic trends in small reservoirs in the Apalachicola-Chattahoochee-Flint River Basin. *Southeastern Geographer* Vol 51, No 3: pp. 371-393. (See also http://youtu.be/d_zmXR1ZQxA)

Harte Research Institute accessed in October and November 2014 at http://www.harteresearchinstitute.org/freshwater-inflows-website.

Harte Research Institute. Freshwater Inflow Tools webpage accessed in October and November 2014 at http://www.freshwaterinflow.org/

Hildebrand, H.H., and G. Gunter, 1953 Correlation of rainfall with Texas catch of white shrimp, Penaeus setiferus (Linnaeus), Trans.Am.Fish.Soc., 82:151–5

Indian River Lagoon Economic Assessment and Analysis Update. Hazen and Sawyer, August 18, 2008.

Knight, R. R., Brian Gregory, M. and Wales, A. K. (2008), Relating streamflow characteristics to specialized insectivores in the Tennessee River Valley: a regional approach. Ecohydrol., 1: 394–407. doi: 10.1002/eco.32

Knight RR, Murphy JC, Wolfe WJ, Saylor CF, and Wales AK. 2013. Ecological limit functions relating fish community response to hydrologic departures of the ecological flow regime in the Tennessee River basin, USA. Ecohydrology (accepted article) DOI:10.1002/eco.1460

Konikow, L.F., 2013, Groundwater depletion in the United States (1900−2008): U.S. Geological Survey Scientific Investigations Report 2013−5079, 63 p., *http://pubs.usgs.gov/sir/2013/5079*.

Livingston, Robert J. "Inshore Marine Habitats" *Ecosystems of Florida.* Edited by Ronald L. Myers and John J. Ewel. The University of Central Florida Press, 1990.

Montagna, P.A., T.A. Palmer, and J. Beseres Pollack. 2008. Effect of freshwater inflow on macrobenthos productivity in minor bay and river-dominated estuaries – Synthesis. Final report to the Texas Water Development Board, Texas A&M University-Corpus Christi
Montagna, P.A., M. Alber, P. Doering, and M.S. Conner. 2002a. Freshwater inflow: Science, Policy, Management. Estuaries 25: 1243-1245.

McLaurin, Gene, Rockingham, NC Mayor to American Rivers, September 29, 2011 (email)

Olden and Poff, 2003, Redundancy and the choice of hydrologic indices for characterizing streamflow regimes, River Res. Applic. 19:: 101-121

Outdoor Industry Foundation, 2006. "The Active Outdoor Recreation Economy."

Outdoor Industry Association, 2012. "The Outdoor Recreation Economy."

Poff NL, Allan JD, Bain MB, Karr JR, Prestegaard KL, Richter BD, Sparks RE, Stromberg JC. 1997. The Natural Flow Regime. Bioscience 47(11): 769-784.

Powell, G. L., J. Matsumoto, And D. A. Brock. 2002. Methods for determining minimum freshwater inflow needs of Texas bays and estuaries. *Estuaries* 25:1262–1274.

Ready to Raft 2012 Fact Sheet, City of Columbus, Georgia and Phenix City, Alabama. *See also* "Whitewater rafting course to make a big splash on Columbus area economy" at http://www.ledger-enquirer.com/2011/09/25/1751545/chattahoochee-river-whitewater.html.

Smith, Bruce. January 17, 2011. "Solid Recovery For Carolinas Tourism In '11." Associated Press.
Texas Water Board, 2008, Texas Instream flow studies: Technical Overview; Texas Water Development Board, Report 369

Southern Instream Flow Research Agenda; A Proposal to Advance the Science For Instream Flow Protection in Southern Rivers by Southern Instream Flow Network, March 2010.

Vorosmarty, C. J. And D. Sahagian. 2000. Anthropogenic disturbance of the terrestrial water cycle. *BioScience* 50:753–765.

U.S. Army Corps of Engineers. 2010. National inventory of dams. Accessed in August 2010 at http://crunch.tec.army.mil/nidpublic/webpages/nid.cfm, http://geo.usace.army.mil/pgis/f?p=397:1:0::NO

Letters of Support

ELIGIBILITY REVIEW

Bucket 2 – Council Selected Restoration Component

PROPOSAL TITLE

US EPA & USGS Joint Proposal for Baseline Flow & Gage Analysis and On-Line Tool Development to Support Bay and Estuary Restoration in Gulf States

PROPOSAL NUMBER

EPA-5

LOCATION

Coastal Areas of all 5 Gulf States

SPONSOR(S)

Environmental Protection Agency, Department of the Interior

TYPE OF FUNDING REQUESTED (Planning, Technical Assistance, Implementation)

Planning, Technical Assistance, Implementation

REVIEWED BY:

Bethany Carl Kraft

DATE:

November 18, 2014

1. Does the project aim to restore and/or protect natural resources, ecosystems, fisheries, marine and wildlife habitat, beaches, coastal wetlands and economy of the Gulf Coast Region?

◉ YES ○ NO

Notes:

This project seeks funding to conduct a comprehensive assessment of gauges and streamflows and development of online tools to facilitate restoration projects in the 5 Gulf States and begin a process to install new or restore decommissioned gauges.

2. Is the proposal a project?

◉ YES ○ NO

If yes, is the proposed activity a discrete project or group of projects where the full scope of the restoration or protection activity has been defined?

◉ YES ○ NO

Notes:

3. Is the proposal a program?

◯ YES ◉ NO

If yes, does the proposed activity establish a program where the program manager will solicit, evaluate, select, and carry out discrete projects that best meet the program's restoration objectives and evaluation criteria?

◯ YES ◯ NO

Notes:

4. Is the project within the Gulf Coast Region of the respective Gulf States?

◉ YES ◯ NO

If no, do project benefits accrue in the Gulf Coast Region?

◯ YES ◯ NO

Notes:

Eligibility Determination

ELIGIBLE

Additional Information

Proposal Submission Requirements

1. Is the project submission overall layout complete? ***Check if included and formatted correctly.***

A. Summary sheet	☑	F. Environmental compliance checklist	☑
B. Executive summary	☑	G. Data/Information sharing plan	☑
C. Proposal narrative	☑	H. Reference list	☑
D. Location information	☑	I. Other	☐
E. High level budget narrative	☑		

If any items are NOT included - please list and provide details

Location info only references Gulf States with emphasis on coastal areas.

2. Are all proposal components presented within the specified page limits (if applicable)?

◉ YES ○ NO

Notes: