ACTION PLAN 3 OF 3

SUSTAIN FRESHWATER INFLOWS (FWI)

Environmental flows describe the quantity, quality, and timing of water flows needed to maintain ecologically healthy streams and rivers, as well as the bays and estuaries that they feed (Texas Water Development Board, *Texas Instream Flow Program*). Environmental flows are broken down into instream flow (the amount of water running in a river or stream) and freshwater inflow.

Freshwater inflow is the freshwater that flows into an estuary from rivers, streams, and creeks. This includes the contribution of wastewater effluent discharges, return flows (water that returns to surface or ground water after human use), and stormwater runoff into the bay and its tributaries. Galveston Bay's productivity is a result of the mixing of freshwater from the Trinity River, San Jacinto River, and area bayous and creeks with saltwater from the Gulf of Mexico.

Freshwater inflows carry nutrients and sediment to bay systems while reducing salinity ranges and maintaining a salinity gradient (change in salinity with depth). Tidal influences can move coastal saltwater miles up tributaries while the mass of freshwater inflows can extend miles into the Gulf. Bays and estuaries rely on a specific range of salinity and nutrient levels and sediment deposition to maintain optimal productivity and ecosystem services.

Adequate nutrient concentrations, along with a range of natural salinity levels, offer ideal conditions for phytoplankton and other organisms at the bottom of the food chain to thrive, while an adequate rate of sedimentation allows for the stabilization of wetland areas and salt marshes.

Estuarine species can generally survive a wide range of salinities, and can tolerate salinity extremes for brief periods. However, each species has an optimum range of salinity and temperature, and prolonged exposure outside of this range can be detrimental.The optimum salinity range for oysters is between 15-30 parts per thousand (ppt) (Hofstetter 1990). Changes to the natural volume, timing, and quality of freshwater inflow may impact the productivity of economically important and ecologically characteristic species. For example, a 2010 Texas A&M University-Galveston (TAMUG) study found oyster production increases in bay areas with lower salinity levels and suitable substrate (Quigg, A. et al, 2010). Ensuring adequate freshwater inflows to Galveston Bay will result in positive economic benefits to the region.

A Note About the Salinity of Galveston Bay

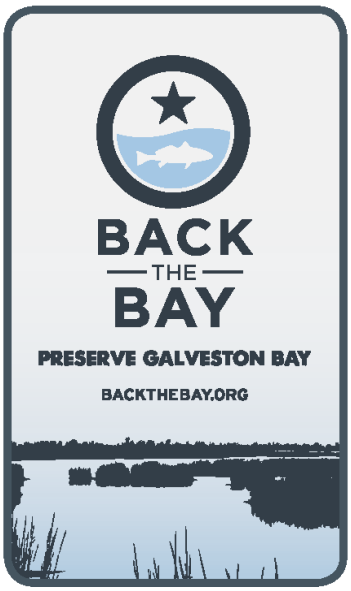
"During times of drought in the lower Galveston Bay watershed, the salinity of the bay system may range from 20 practical salinity units (psu) at the Trinity River delta to 35 psu at Bolivar Roads. When the Trinity River or all tributaries are under flood conditions, the salinity will be 0 psu well into Trinity Bay and less than 15 psu at Bolivar Roads.

In times of normal flow, salinity ranges from less than 10 psu in upper Trinity Bay to around 30 psu at Bolivar Roads, but there is typically a tidal wedge of high salinity water, greater than 30 psu, in the bottom of the Houston Ship Channel. A salinity wedge also reaches up the Trinity River; its existence is the cause of the U.S. Army Corps of Engineers Wallisville Lake Project on the Trinity River just west of Lake Anahuac (Lester, 2011a, p. 9)."

Status of Freshwater Inflows Implementation

Management of water supplies and the consideration of environmental flows have evolved since development of *GBP'95*. The GBEP and its partners created the Galveston Bay Freshwater Inflow Group (GBFIG) in 1996 to develop strategies to maintain adequate freshwater inflows to Galveston Bay. Texas Senate Bill 1, passed in 1997, established 16 Regional Water planning groups for the state to determine how to meet future water needs over a fifty-year planning horizon. Region H is the planning body for much of the lower portion of the Galveston Bay watershed. The GBFIG developed environmental flow recommendations and encouraged Region H to consider those flows when modeling available freshwater and developing regional freshwater management plans (HARC, 2017). Texas Senate Bill 2, passed in 2001, focuses on an instream flow data collection and study process for Texas' rivers.

In 2007, the 80th Texas Legislature passed Senate Bill 3, which tasked TCEQ to develop environmental flow standards for Texas' rivers and bays using a stakeholder approach. The legislation established the Environmental Flows Advisory Group and the Science Advisory Committee. The Environmental Flows Advisory Group formed the Basin and Bay Area Stakeholder Committee (BBASC) for each basin and bay system and the stakeholder committee appointed a Basin and Bay Expert Science Team (BBEST) for their basin. The Trinity and San Jacinto Rivers and Galveston Bay BBEST was appointed on December 1, 2008, and was tasked with recommending an environmental flow regime for the Trinity and San Jacinto Rivers and Galveston Bay based solely on scientific information (TCEQ, 2017).





Back the Bay campaign material (far left). A view from the Coastal Heritage Preserve in Galveston (center). A U.S. Fish and Wildlife Service aerial image (top right). Wetland in the Galveston Bay estuary (bottom right) (photo credits: Sarah Bernhardt).

The BBEST recommendations were submitted to the the BBASC in November 2009 and to the Environmental Flows Advisory Group and TCEQ in May 2010. The TCEQ adopted environmental flow standards for the Trinity and San Jacinto Rivers and Galveston Bay in April 2011. Following adoption, BBASC, assisted by the BBEST, prepared and submitted a work plan in 2012 that:

- establishes a periodic review of the environmental flow recommendations and a schedule for continuing validation or refinement of them, and
- prescribes monitoring and studies.

As stated by the Trinity and San Jacinto Rivers and Galveston Bay BBEST, the status of the systems "…are healthy and sound ecological environments" (Trinity and San Jacinto and Galveston Bay Basin and Bay Expert Science Team, 2009, p. 4). However, climate variability, such as increasing frequency of extreme drought and flood events, and population growth present emerging challenges that may affect the availability of freshwater inflows in the future and the bay's productivity. The 83rd, 84th, and 85th Texas Legislatures appropriated funds to the Texas Water Development Board for the continued study of environmental flows and to support the work plans for adaptive management.

FIGURE 24
FWI ACTION PLAN MATRIX

ACTION PLANS AND CORRESPONDING ACTIONS			PLAN PRIORITIES			
			Ensure Safe Human and Aquatic Life Use	Protect and Sustain Living Resources	Engage Communities	Inform Science-Based Decision Making
Action Plan: Sustain Freshwater Inflows (FWI)						
	FWI-1	Regional Planning for Freshwater Inflows	x	x	x	
	FWI-2	Freshwater Inflows Research and Management	x	x		x
	FWI-3	Water Conservation and Education	x	x	x	

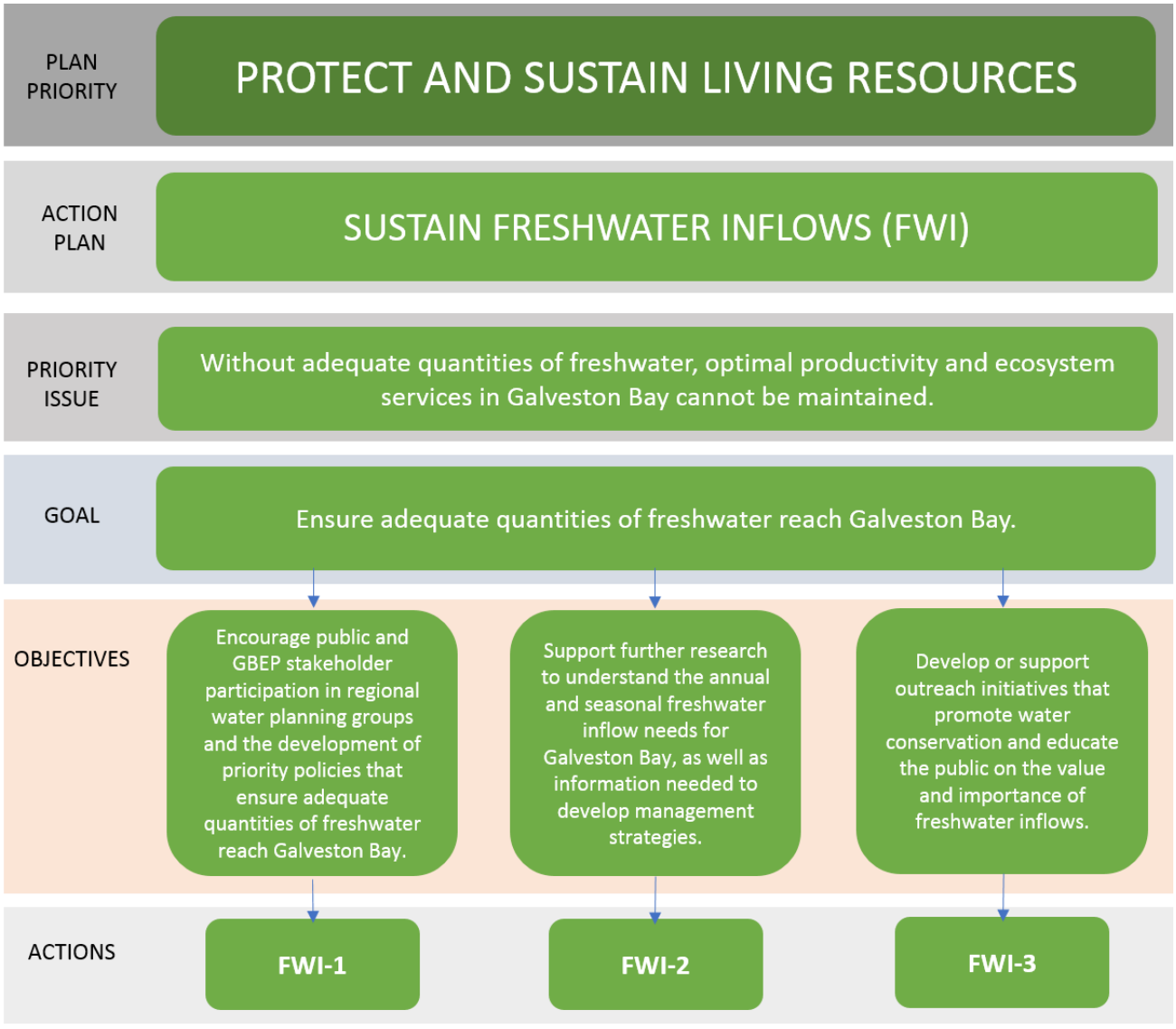
Action Plan Overview

The FWI Action Plan includes three Actions to ensure there are adequate levels of freshwater inflows. The GBEP and its partners will encourage public and stakeholder participation in regional water planning groups and development of priority policies that ensure adequate quantities of freshwater inflows to Galveston Bay (**FWI-1**). It is also essential to support research that aids in understanding the annual and seasonal freshwater inflow needs for Galveston Bay, as well as information needed to develop management strategies (**FWI-2**). Developing and / or supporting outreach initiatives that promote water conservation and educate the public on the value and importance of freshwater inflows is the third crucial component to ensuring there are adequate levels of freshwater inflows in Galveston Bay (**FWI-3**).

Successful implementation of regional planning efforts (**FWI-1**) and water conservation and education programs (**FWI-3**) require coordination with the PPE subcommittee of the Galveston Bay Council on Actions **SPO-1** and **PEA-2**, included under Plan Priority Three: Engage Communities. Similarly, supporting research that aids in understanding of freshwater inflows (**FWI-2**) closely aligns with Action **ACS-2**, and will also be coordinated between the NRU and M&R subcommittees.

More information about **SPO-1** is on page 108. More information about **PEA-1** is on page 116. More information about **ACS-2** is on page 142.

FIGURE 25
FRESHWATER INFLOWS ACTION PLAN



FWI-1

Regional Planning for Freshwater Inflows

Objective: Encourage public and GBEP stakeholder participation in regional water planning groups and the development of priority policies that ensure adequate quantities of freshwater reach Galveston Bay.

Priority Issue: Without adequate quantities of freshwater, optimal productivity and ecosystem services in Galveston Bay cannot be maintained.

Description: The GBEP and its partners are encouraging public participation in regional water planning efforts and the development of priority policies that ensure adequate quantities of freshwater reach Galveston Bay.

Implementation location: Lower Galveston Bay watershed.

ACTIVITIES	TIMEFRAME AND OUTPUT(S)	IMPLEMENTATION COST
Develop partnerships to inform public of opportunities to comment on regional water planning.	Within 2-5 years, identify opportunities to participate in the regional water planning processes to ensure the rules that govern the regional water plans better protect water for wildlife (specific goals to be determined, could include increasing the number of partners each year).	$0 - $200,000
	Within 5-10 years, work with partners to create a plan and materials to address key issues.	$0 - $200,000
	Within 10-plus years, see completion of plan items to address key issues.	$0 - $200,000

POTENTIAL IMPLEMENTERS

City of Fort Worth
City of Houston
City of Dallas
Galveston Bay Foundation
National Wildlife Federation
Sierra Club
Texas Living Waters Project
Texas Parks and Wildlife Department
Texas Water Development Board
U.S. Department of Agriculture - Natural Resource Conservation Service
Other water authorities, including Trinity River Authority, North Fort Bend Water Authority, Gulf Coast Water Authority, Gulf Coast Authority, San Jacinto River Authority, and others

PERFORMANCE MEASURES

1. Plan to address key issues of fresh water inflows completed.
2. Number of resource materials developed to address key issues of fresh water inflows.
3. Number of people reached with fresh water inflow resource materials and outreach.

REFERENCES

GBP'95: None
SAP Reference: Freshwater Inflow and Bay Circulation: Goal 1 / Objective A / Objective B / Objective C

FWI-2

Freshwater Inflows Research and Management

Objective: Support further research to understand the annual and seasonal freshwater inflow needs for Galveston Bay, as well as information needed to develop management strategies.

Priority Issue: Without adequate quantities of freshwater, optimal productivity and ecosystem services in Galveston Bay cannot be maintained.

Description: To ensure adequate quantities of freshwater reach Galveston Bay, the GBEP and its partners are supporting further research to understand the annual and seasonal freshwater inflow needs for Galveston Bay, as well as information needed to develop management strategies.

Implementation location: Lower Galveston Bay watershed.

ACTIVITIES	TIMEFRAME AND OUTPUT(S)	IMPLEMENTATION COST
Support research to understand the annual and seasonal freshwater inflow needs for Galveston Bay, as well as information needed to develop management strategies.	Within 2-5 years, present at the State of the Bay Symposia.	$0 - $200,000
	Within 2-5 years, collect data and share results and partner publications on the GBEP website.	$200,000 - $ 1 million
	Within 2-5 years, provide support on the development and public delivery of white papers, technical presentations, and workshops (number TBD).	$0 - $200,000
	On a cycle of every 5-10 years, use research data to contribute to the *State of the Bay Report.*	$0 - $200,000

POTENTIAL IMPLEMENTERS

Houston Wilderness
Local Municipalities
National Wildlife Federation
NOAA
NOAA Fisheries
Texas A&M University - Galveston
Texas Living Waters Project
Texas Parks and Wildlife Department
Texas Water Development Board
U.S. Fish and Wildlife Service
U.S. Geological Survey
University of Houston - Clear Lake

PERFORMANCE MEASURES

1. Number of research studies addressing the annual and seasonal freshwater inflow and freshwater management needs of Galveston Bay completed.
2. Number of freshwater inflow white papers, presentations, and workshops completed.
3. Number of GBEP website visits.

REFERENCES

GBP'95: None
SAP Reference: Freshwater Inflow and Bay Circulation: Goal 1 / Objective A / Objective B / Objective C

FWI-3

Water Conservation and Education

Objective: Develop or support outreach initiatives that promote water conservation and educate the public on the value and importance of freshwater inflows.

Priority Issue: Without adequate quantities of freshwater, optimal productivity and ecosystem services in Galveston Bay cannot be maintained.

Description: To ensure adequate quantities of freshwater reach Galveston Bay, the GBEP and its partners are developing or supporting outreach initiatives that promote water conservation and educate the public on the value and importance of freshwater inflows. These efforts will leverage and build upon existing outreach and awareness initiatives.

Implementation location: Lower Galveston Bay watershed.

ACTIVITIES	TIMEFRAME AND OUTPUT(S)	IMPLEMENTATION COST
Develop or support outreach initiatives that promote water conservation and educate the public on the value and importance of freshwater inflows.	Within 2-5 years, create regional initiatives plan that supports water conservation and the value of freshwater inflows (specific goals to be determined, could include increasing the number of partners each year).	$0 - $200,000
	Within 5-10 years, see significant progress on regional initiatives plan items (50% of goals met).	$200,000 - $1 million
	Within 10-plus years, see completion of all regional initiatives plan items (100% of goals met).	$200,000 - $ 1 million

POTENTIAL IMPLEMENTERS

Galveston Bay Foundation
Local Municipalities
National Wildlife Federation
Texas Living Waters Project
Texas Water Development Board
Other water authorities, including Trinity River Authority, North Fort Bend Water Authority, Gulf Coast Water Authority, Gulf Coast Authority, San Jacinto River Authority, and others

PERFORMANCE MEASURES

1. Regional plan for water conservation completed.
2. Number of partners supporting the water conservation plan.
3. Number of regional plan initiatives completed.

REFERENCES

GBP'95: None
SAP Reference: Freshwater Inflow and Bay Circulation: Goal 1 / Objective A / Objective B / Objective C