The SSPEED Center Summer Report: A Focus on Nature-Based Solutions

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Executive Summary

The SSPEED Center's work started in 2009 with evaluating and developing a surge protection system for the Galveston Bay area following Hurricane Ike. Later, the Center expanded its efforts to studying riverine flooding issues, including creating flood early warning systems. In the meantime, our work has also been evolving to address a simple proposition: that nature, properly valued and structured, can do much of the work of flood protection that concrete and steel alone cannot. That idea traces back to the beginning in 2009, when a $750,000 grant from Houston Endowment, Inc., championed by senior environmental grants officer Ann Hamilton, funded our first study of the lessons learned from Hurricane Ike. Fifteen years later, that modest start has grown into a portfolio spanning coastal protection, riverine flood analyses, nature-based conservation, mixed structural and ecological engineering, and flood warning systems. This more recent focus on nature-based solutions has been met with real validation arriving this year. Congressman Randy Weber's filing of H.R. 9325 marks a milestone in the fifteen-year effort behind establishing the Lone Star Coastal National Recreation Area, while efforts involving carbon storage (e.g. BCarbon and Grassroots Carbon) continue to show that landowners can be paid directly for the ecological services their land provides, with millions of dollars now flowing to ranchers and farmers across Texas and beyond. Finally, in the wake of the tragic July 2025 flooding along the Upper Guadalupe River, we have also moved quickly to extend our two decades of flood warning expertise to the Texas Hill Country, partnering with UT Arlington on a new early warning

system built to give residents life-saving hours of advanced notice of impending flooding.

Alongside these efforts, we continue to advance mixed structural and nature-based projects, including (1) the Galveston Bay Park Plan (and the Texas City levee expansion), (2) a groundbreaking effort to fund coastal erosion control through carbon credits for the Gulf Coast Protection District, and (3) new hydrologic modeling work with the Coastal Prairie Conservancy and in the Brazos River Basin that is putting hard numbers behind the flood-reduction value of restored and preserved prairie. In addition, a growing suite of artificial intelligence initiatives, guided by what we call Earth Rules, is beginning to reshape how we understand water systems, environmental review, and materials recycling. Taken together, this work reflects a common thread: as our understanding of natural systems deepens, engineering and economics increasingly point in the same direction, toward solutions that work with the land rather than against it. The sections that follow describe each of these efforts in turn.

Pure Nature-Based Flood Protection Solutions

All of the nature-based solutions originally designed by the SSPEED Center were focused on hurricane flood protection for existing development along and near the coast. A concern was raised that this would only lead to further development of coastal lands. The general proposition is that much of the Texas coast sits at low elevation and, given that Texas is not prone to regulate private lands, the best way to avoid developing low-lying coastal lands that are subject to inundation by hurricane surge flooding is to find alternative sources of income to those landowners related to the ecological services provided by those lands. In this regard, three distinct projects have evolved from the Center's efforts: BCarbon, the LSCNRA, and Grassroots Carbon.

BCarbon

One major effort spawned by SSPEED Center's work for Houston Endowment was the decision to pursue some type of process that would directly pay landowners for the ecological services provided by their land, thereby increasing cash flow and decreasing the pressure to sell and subdivide the land for development. Here, after a few years of research, it was decided that carbon dioxide capture and sequestration in forests, prairies and marshes along the Texas coast was the best option for compensating landowners for maintaining or creating such ecological services on their lands.

In November 2019, the SSPEED Center joined with the Baker Institute at Rice to form a stakeholder group to investigate the voluntary carbon market. This initial stakeholder group of about 50 landowners, potential buyers, academics and environmentalists decided in August 2021 to form a non-profit carbon credit registry called BCarbon, with Jim Blackburn, the co-director of the SSPEED Center, serving as the first CEO of BCarbon (unpaid).

It is important to note that a registry is a central cog in the credit-delivery system. As shown in Figure 1, the voluntary carbon market has many pieces. These include landowners, project developers, and buyers, as well as the registry that sets the standards, and the verifiers and validators that ensure that the rules for credit issuance set by the registry are being met. At the time BCarbon was created as a carbon credit registry, there were few registries worldwide, and they are a key element in developing a vibrant market.

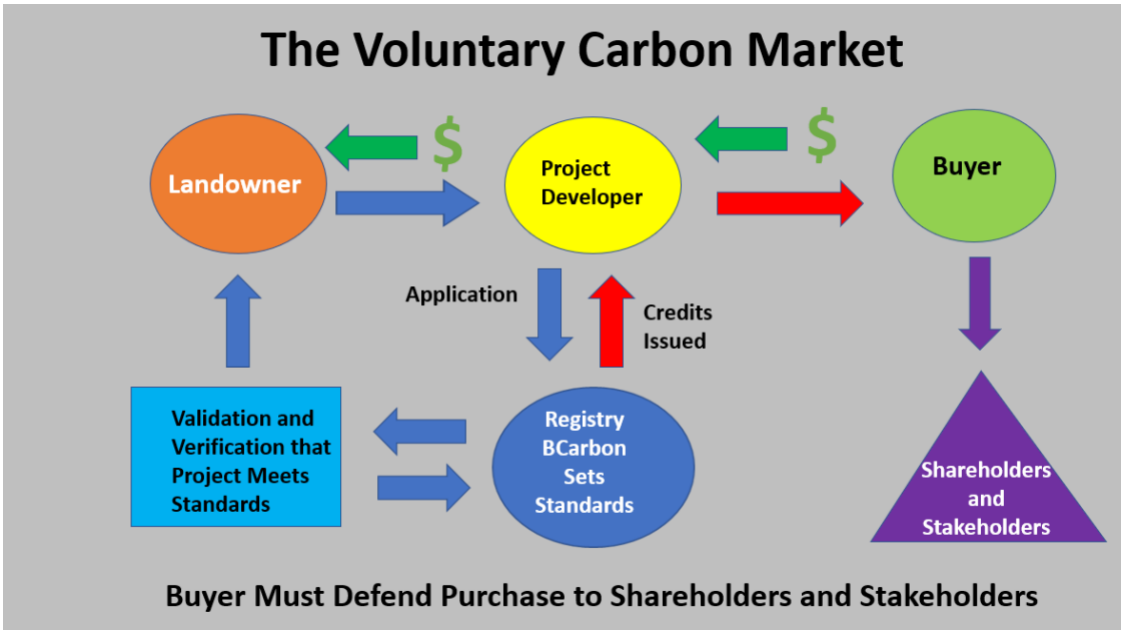

Figure 1. Overview of the carbon market. BCarbon shown as Registry (blue circle) with a direct relationship to Project Developer. Image by Jim Blackburn

From 2021 to 2025, BCarbon survived with the assistance of numerous philanthropic donations, and over that time, it adopted a set of rules called "protocols" for issuing carbon credits for soil accumulation of carbon, for accumulation in the trees of our forests, for protection of the existing carbon threatened to be lost from the erosion of coastal marshes due to sea level rise and subsequent accumulation in the marsh soil, and more recently for plugging orphaned or abandoned oil and gas wells that were leaking methane to the atmosphere. After an initial slowdown in the carbon credit market from 2022 through 2024 due to notable credit failures, the voluntary market began to recover and, in mid-2026, is moving forward again.

Over this period, BCarbon has issued millions of tons of carbon credits, with about 2 million tons of carbon dioxide equivalent (CO_2e) removed by plugging leaking methane wells, about 18,000 tons of CO_2e being removed through soil carbon storage, and about 90,000 tons of CO_2e for forest carbon credit drawdown. These credits are now being bought and sold in 2026, with more to be issued and transacted. Today, BCarbon is led by its CEO Eric Unverzagt, with the prospects for continued growth and expansion looking quite positive.

An important element that distinguishes BCarbon from other carbon credit registries is its relationship with Rice University, with which it has a Memorandum of Understanding that allows Rice to conduct research in support of various concepts BCarbon believes may be worthy of carbon crediting. Together, Rice and BCarbon hope to expand the scope and integrity of the carbon market, which will be especially important for the future of Texas landowners and businesses. Among other projects, BCarbon and the SSPEED Center are working with the Baker Institute and Earth Carbon to develop a carbon credit program in Tamaulipas, Mexico, as well as in several other Mexican states. BCarbon also has projects in Uruguay and Kazakhstan, with ongoing discussions throughout the world.

Due to the interest in carbon crediting, the agricultural landowner is beginning to have another source of income. Landowner James Clement, who works with the soil carbon measurement company Earth Optics, recently released data for his South Texas and West Texas ranches, showing he earned more income from carbon crediting than from cattle. This is important new information that will transform ecological protection across Texas and the United States, as the ecological processes of millions of acres of land will be protected by selling the rights to the carbon stored by the natural system. Additionally, flood-prone land is beginning to generate cash flow previously unavailable to the landowner.

Learn more: https://bcarbon.org/

The Lone Star Coastal National Recreation Area

For existing public and private conserved lands, SSPEED Center's mission was to increase their economic value to the region by bringing people to the Texas coast through nature tourism– creating an economic sector that could survive hurricane inundation. We embraced a National Park Service model called a national recreation area as a perfect fit – not only was it flexible, but the national park system also is one of the best sources of travel destinations for national and international travelers alike. Birdwatching on the Upper Texas Coast is world-class, and the coastal marshes, forests, prairies, and

beaches provide a variety of recreational opportunities from Jefferson County to Matagorda County, the focal area of what is now known as the Lone Star Coastal National Recreation Area (LSCNRA).

The basic idea of a national recreation area is that it does not require the lands to be owned, managed, or regulated by the federal government. There are several examples of these partnerships around the country, and this model was adapted and became the proposed Lone Star Coastal National Recreation Area, creating a uniquely Texas model. Through a stakeholder-driven process led by the Lone Star Coastal Alliance and NPCA, legislation under development was perfected. The model embodied in the legislation creates a locally led, voluntary framework for local, state, and federal government entities, conservation, historical, and cultural NGOs, and other local entities and landowners to coordinate and present existing protected lands and sites as a coherent whole. It doesn't require expanding the federal estate or creating new regulatory authority, and it has no impact on private property.

Recently, significant progress has been made toward creating this landmark Texas coastal recreation program. On June 17, 2026, Congressman Randy Weber (TX-14), a Republican from Brazoria County, gave notice of filing H.R. 9325, the Lone Star Coastal National Recreation Area Act, which would create the LSCNRA. According to Rep. Weber's press release:

> The measure would expand outdoor recreation opportunities, support conservation and coastal resilience, and help preserve the natural, cultural, and economic resources that make the Upper Texas Gulf Coast unique.
>
> The proposed recreation area would span portions of Jefferson, Chambers, Galveston, Brazoria, and Matagorda Counties along the Upper Texas Gulf Coast. Home to more than five million Texans, the region includes some of the nation's most treasured coastal resources and recreation areas.

Although much work remains to be done to obtain passage of legislation in both the House and the Senate, this is a milestone accomplishment more than fifteen years in the making. Throughout this time, one of the SSPEED Center partners – Elizabeth Winston-Jones – has been at the forefront of the effort to realize the vision embodied in the LSCNRA, leading efforts by the Lone Star Coastal Alliance, along with its President, J.P. Bryan. Together, their efforts, along with Suzanne Dixon's ongoing support, have led us to this important filing.

Stay tuned to the SSPEED Center website for updates on how this legislation is faring in the House and, hopefully, the Senate. A vision of the LSCNRA from the Lone Star Coastal Alliance is shown in Figure 2.

Figure 2. Varied geography and opportunities within the proposed Lone Star Coastal National Recreation Area. Image from Lone Star Coastal Alliance.

Learn more: https://www.lonestarcoastal.org/

Grassroots Carbon

As research leading to the LSCNRA and BCarbon was being completed, the SSPEED Center also determined that a private-sector carbon credit developer was needed on the Texas Coast. To pursue this concept, a for-profit entity called Soil Value Exchange (SVX) was created by Dr. Henk Mooiweer, Jim

Blackburn, and Megan Parks based on SSPEED Center research. When Blackburn became CEO of BCarbon, he returned his shares to Parks and Mooiweer, who subsequently formed Grassroots Carbon out of SVX in 2021, joining with Lew Moorman, Ed Byrne, and Soilworks Natural Capital.

Today, Grassroots Carbon is among the most successful developers in the voluntary carbon market. In 2025, Grassroots Carbon generated over $20 million in revenue for private landowners in 21 states, representing 1.7 million acres now dedicated to carbon capture and storage, with millions more yet to be signed to carbon contracts.

Grassroots Carbon focuses on regenerative ranching that replicates the action of buffalo grazing across the native prairie by separating larger landholdings into paddocks that are grazed to a point. Then, the cattle are moved to the next paddock, leaving behind a healthy ecosystem that can regenerate the prairie plants available to support the cattle when the rotation comes around again. Regenerative grazing has been the subject of multiple documentaries by filmmaker Peter Byck of Arizona State University, including Soil Carbon Cowboys and other similar features. In Figure 3, the regenerative grazing system utilized by rancher Loy Sneery of Matagorda County – an original BCarbon stakeholder and Grassroots Carbon landowner – is shown.

Figure 3. Cattle being moved from one paddock to another on the ranch of Loy and Helen Sneery in Matagorda County, Texas.

Modeling Subsurface Flow in Cypress Creek's Coastal Prairies

True Furrh is working with Coastal Prairie Conservancy (CPC), formerly the Katy Prairie Conservancy, to study how the Conservancy's protected lands shape flood behavior in the Upper Cypress Creek watershed in northwest Harris County. The study area combines Upper Cypress Creek with the north end of the Addicks watershed, and includes 21.6 square miles of CPC-protected land upstream of the Katy-Hockley gauge, with an overflow region that drains into Addicks Reservoir. True built a two-dimensional HEC-HMS model of the watershed using 2018 LiDAR terrain, 2019 land cover data, and USGS soils data, then calibrated it against three historical storms (Memorial Day 2015, Tax Day 2016, and Hurricane Harvey 2017) using USGS stream gage records and high-water marks.

Along the way, the research ran into a limitation common to most flood models: they assumed that once rainfall infiltrates the ground, it's gone for good, removed from the system entirely. That assumption holds up fine for pavement or heavy clay, but it breaks down for a natural prairie, which soaks up water during a storm and slowly releases it afterward. A model that can't represent that release ends up treating infiltration purely as a volume control rather than a timing control. This limits how field-measured infiltration rates can be used and provides an incomplete picture of the prairie's hydrological benefits. To fix this, the team used a new version of HMS that allowed for a rebuilt of the model's subsurface process as a set of storage layers that drain into the channel at different speeds: fast, erosive surface runoff over hours; a slower subsurface lateral flow two to five times slower during the storm itself; and an even slower groundwater contribution ten to thirty times slower that keeps feeding the creek between storms.

The improved HMS model performs far better than the surface-only version of HMS. For Tax Day 2016 at the Katy-Hockley gauge, adding the subsurface storage layers lifted the model's goodness of fit from a KGE of 0.63 to 0.91 and its peak bias was reduced from 9 percent down to 4.2 percent, while the recession limb (the slow decline after the flood peak where the prairie's

sponge effect matters most) improved dramatically in comparison to the observed hydrograph. The model also lined up well against 12 high-water marks recorded across Cypress Creek on Tax Day. Breaking down the Tax Day runoff data further, the team found that a considerable portion of the total runoff volume arrived at the gauge as delayed interflow rather than immediate surface runoff, and that interflow accounted for the majority of the flood's recession (see Figure 4). This is a clear signature of CPC's grasslands, which store water and release it gradually rather than all at once. The team has also built a faster empirical version of the HMS model that reproduces the Hurricane Harvey hydrograph in seconds rather than minutes, opening the door to running many more storm and land-use scenarios. As a next step, True and teammate Kyle Ostlind plan to work with CPC to distinguish between restored prairie and long-preserved prairie parcels at finer resolution and then simulate what runoff would look like without CPC's protected lands in place. The ongoing research would directly quantify the flood-reduction value of the Coastal Prairie Conservancy's preservation and restoration work.

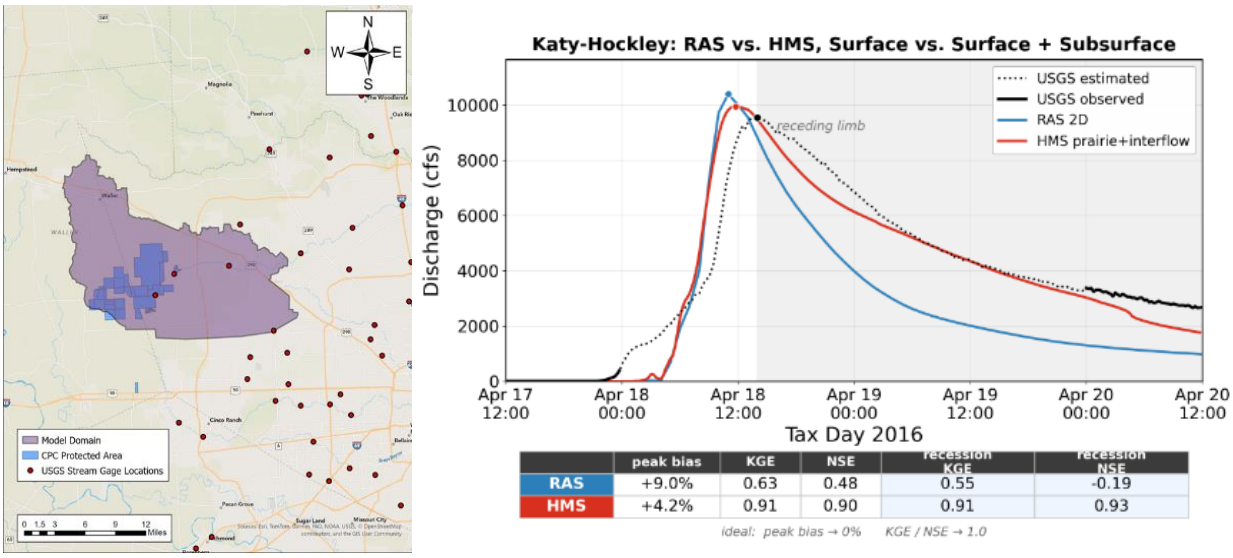

Figure 4: When infiltration is integrated into the system, it becomes a control on timing and volume, both parts of attenuation. This allows the use of field-observed infiltration rates (Ksat). On the right, the model including interflow more closely matches the observed and estimated flow rates. Model domain area shown on the left.

Prairie Restoration and Flooding in the Brazos River Basin

SSPEED Center PhD candidate Madison Guerinot and her advisor, Dr. Avantika (Avi) Gori**,** have been studying whether restoring coastal prairie can meaningfully reduce flooding in the Lower Brazos River Basin, a 2,000-square-mile watershed stretching from northwest of Houston to the Gulf. Madison built a two-dimensional HEC-RAS model of the lower basin and calibrated it against Hurricane Harvey and the 2015 Memorial Day flooding at three USGS gages. She then used satellite vegetation data to estimate how much additional rainfall a healthy coastal prairie could absorb compared to the pasture and hay land it would replace. With that relationship established, Madison generated a range of restoration scenarios, some concentrating 20,000 acres of new prairie in a single contiguous block, others scattering the same acreage across many smaller sites. Testing each scenario across the upstream, midstream, and downstream portions of the basin, Madison determined where and how restoration delivers the greatest flood benefit.

Preliminary results suggest that restoring prairie upstream produces flood-reduction benefits that extend across the entire watershed, not just near the restored acreage, and that contiguous restoration performs consistently across different storm types. The next phase of the work will run additional storms through each scenario to quantify changes in flood depth, extent, and duration. It will evaluate whether the carbon sequestered by the restored prairie could help fund the projects through carbon credits. Madison's work echoes the same nature-based, self-funding model elsewhere in the SSPEED Center's portfolio.

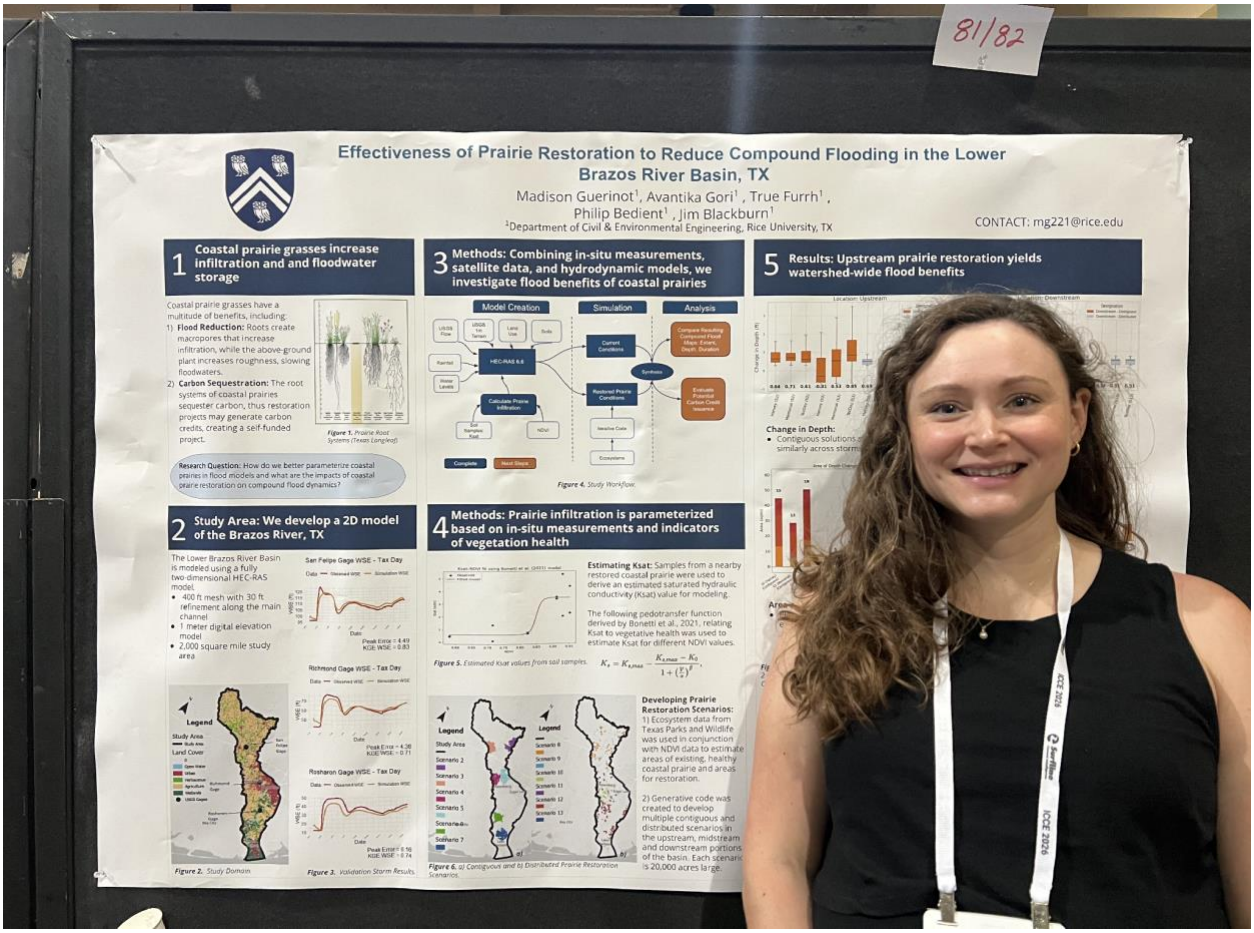

Figure 5. Madison Guerinot presenting "Effectiveness of Prairie Restoration to Reduce Compound Flooding in the Lower Brazos River Basin, TX" at the ICCE conferences in Galveston, May 2026.

Mixed Structural and Nature Based Projects and Flood Warning

Currently, the SSPEED Center is continuing to work on major mixed structural and nature-based projects and flood warning systems. The Galveston Bay Park Plan provides an in-bay solution for hurricane storm surge, and a separate study for the Gulf Coast Protection District on building the unfunded G-28 coastal erosion protection project with income from carbon credits. The Flood Early Warning System for the Upper Guadalupe River will help protect people in the Hill County "flash flood alley."

Flood Early Warning System for the Upper Guadalupe River

On July 4, 2025, a storm system stalled over Central Texas and dropped torrential rain across the Hill Country, a region long known to hydrologists as Flash Flood Alley because its thin soils and steep, rocky terrain send rainfall downhill almost as fast as it falls. Along the Upper Guadalupe River in Kerr County, the water rose more than 20 feet in a matter of hours, cresting near 37 feet at Hunt, where the river's north and south forks converge. More than 130 people died in the flooding, including 25 young girls and two counselors at a nearby summer camp. Kerr County had no dedicated flood warning system in place that night, and a lack of cell phone coverage across parts of the watershed compounded the tragedy.

In the aftermath, SSPEED Center director Philip Bedient and colleagues at the University of Texas at Arlington's Water Engineering Research Center (WERC) began work on the Hill Country Flood Early Warning System (FEWS). The Texas governor's office awarded $4 million to UT Arlington to lead the project, with the SSPEED Center participating as a partner responsible for the computer modeling system and floodplain map library that will underpin the operational warning platform. The goal is to give local officials and residents one to three hours of warning before floodwaters arrive, enough time to close roads, evacuate low-lying areas, and move people out of harm's way.

The approach builds on a flood early warning system known as FIRST, the Flood Information and Response System, that the SSPEED Center originally developed to protect Houston's Texas Medical Center after Tropical Storm Allison in 2001 and has since expanded to four major Houston watersheds. Because there is no time during a fast-moving storm to run a full hydraulic simulation, the SSPEED Center is precomputing a library of roughly 125 flood inundation maps for the Upper Guadalupe watershed, built using HEC-RAS modeling across a grid of small cells spanning more than 1,000 square miles of Hill Country terrain. As weather radar updates the rainfall every 5 to 15 minutes, a hydrologic model (HEC-HMS) will be run simultaneously to generate flows and water levels at selected locations in the watershed. The

FEWS system will then match this current flood data at these locations with the closest pre-modeled flood map scenario and instantly display the corresponding inundation map for areas between these selected locations, to give a complete picture of the anticipated flooding in the watershed in real-time, rather than waiting on a live hydraulic model run that the region's narrow warning window cannot afford to wait on.

The urgency of this work was underscored last August, when Bedient testified before a joint hearing of the Texas Senate and House committees on disaster preparedness and flooding, held in Kerrville just miles from some of the worst losses of the July flood. He called for statewide investment in real-time flood warning systems, telling lawmakers that the necessary technology already exists and simply needs to be put into place. Figure 6 is an aerial view of the Upper Guadalupe River in Kerr County.

FEWS is being developed alongside a companion effort led by Texas Tech University, which received a $24 million state grant to install additional weather stations and two new radar systems in the Hill Country. The system will include installing rain gauges and sensors to confirm and refine the model's predictions over time. Together, these efforts are building a high-resolution monitoring and forecasting network purpose-built for Texas watersheds with SSPEED Center extending its flood warning expertise, which it has spent more than two decades developing in Houston, to the communities of the Texas Hill Country.

Figure 6. An aerial view of the Upper Guadalupe River in Kerr County, Texas, February 2026, with the newly paved Texas State Highway 39. Photo by Jared Jones

Learn more: https://magazine.rice.edu/spring-2026/after-storm

Galveston Bay Park Plan

The Galveston Bay Park Plan (GBPP) today is proposed as a part of the Coastal Texas project – previously known as the Ike Dike – as an alternative to the proposed two gate structures to be constructed within Galveston Bay at Dickinson Bayou and Clear Lake. The GBPP is proposed as a 25-foot levee extending along the Houston Ship Channel, connecting to Chambers County on the north and to the Texas City levee on the south. An image of the GBPP is set out in Figure 7.

Figure 7. Image of Galveston Bay Park Plan showing levee extending from Chambers County in the top middle to the Texas City levee in the bottom left, with fill areas shown in white (existing) and green (proposed) indicating conceptual location of future dredge disposal, wetland development, and park development.

As currently proposed, the GBPP would be constructed in three parts. First, virgin clay from the proposed deepening of the Houston Ship Channel (as part of the Port of Houston's Project 12) would be used to construct a physical earthen levee (with openings for small-vessel navigation and circulation) extending along the channel and connecting to Chambers County and the Texas City levee. Second, the gate structures for being able to close those small-vessel navigation and circulation openings would be constructed, along with the major gate across the channel. And third, over time, maintenance dredging material would be used to create wetland cells and parkland, adding a nature-based design component to this structural flood protection. In this way, the approximate $7 billion construction cost could be spread across two, if not three, potential funding sources.

At this time, work is underway on two aspects of the ongoing GBPP design. First, Dr. Avi Gori and her graduate student, Fuad Hasan, are undertaking

ADCIRC hurricane surge modeling to determine the change in hurricane surge associated with building the first phase of the park plan, which uses the clay dredged material to build the physical earthen levee. Secondly, the engineering firm AECOM is undertaking an analysis to determine whether sufficient clay material can be obtained from the dredging of proposed Project 12, which involves deepening the Houston Ship Channel.

Over time, it is hoped that funding will become available to conduct a thorough design and cost analysis of the small-vessel navigation and circulation gates needed to complete the second phase of this project. This second phase will also involve detailed design of the large gate crossing the channel, which has been conceptually designed by Walter P. Moore and is shown in Figure 8.

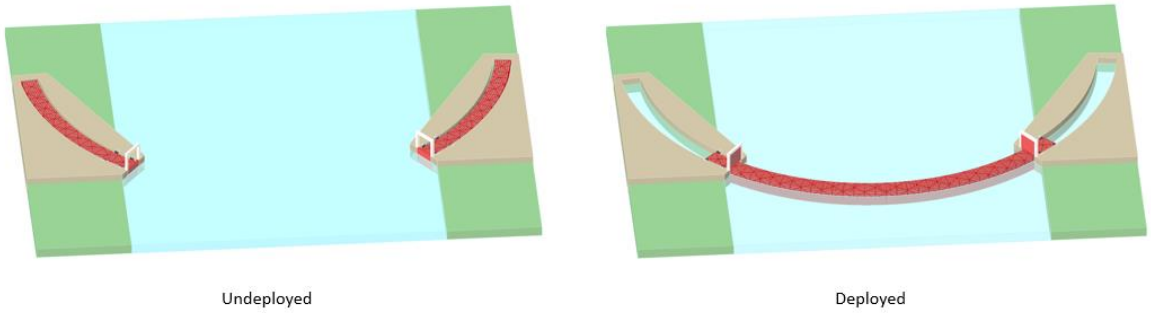

Figure 8. Conceptual design of arc gate structure for the Houston Ship Channel as part of the Galveston Bay Park Plan. Image from SSPEED Center.

Learn more:
https://sspeed.rice.edu/_files/ugd/d29356_fe2bb5565989471b8ff7aefc2a2d9655.pdf

The Texas City Levee Expansion Proposal

As a result of our work on the Galveston Bay Park Plan, the SSPEED Center conducted modeling of the implementation of both the Texas Coastal Project proposed by the U.S. Army Corps of Engineers and the Texas General Land Office (GLO). Under this project, a barrier would be created along the coast

that includes sand dune construction to 14 feet along the Bolivar Peninsula and West Galveston Island, a gate structure across the pass between the Bolivar Peninsula and Galveston Island (known as Bolivar Roads), and a ring dike around the City of Galveston. Additionally, gates were proposed within the bay at the entrances to Clear Lake and to Dickinson Bayou.

After the execution of a Memorandum of Understanding with the Corps and the GLO, the SSPEED Center's Galveston Bay Park Plan has come to be considered as a potential alternative to the two in-bay gates proposed by the Corps. After designing the current version of the Galveston Bay Park Plan, the SSPEED Center conducted computer modeling to assess how the combined Coastal Texas project and the Galveston Bay Park Plan would reduce the impacts of a Category 5 hurricane. The results of this analysis were as expected, however, there was a new revelation that surprised all of us at SSPEED Center.

As shown in Figure 9, the modeling of Storm 36's Cat5 impact on the combined Coastal Texas and GBPP project indicates a significant risk of surge overtopping Galveston Island and West Bay, producing backside flooding in Texas City and the Clear Lake area. The bay-side flooding is largely abated by the combined approach compared with the result from the coastal barrier alone, as shown in Figure 10. Even with the Coastal Barrier alone, this back-side flooding is apparent. However, this backside flooding issue remains a major concern even after the construction of both projects. It is important to note that the SSPEED Center focuses on flood risks beyond those used for design by the Corps of Engineers in its public works analyses. For example, the Corp's coastal barrier project has been designed to about 14 feet on the West End of Galveston Island, which is about equivalent to a Category 2 hurricane surge from a storm coming ashore south of Galveston Island. By contrast, the SSPEED Center is focused on the larger Cat 4 and Cat 5 storms, which our analyses indicate to pose a greater risk than suggested by the historical record. Indeed, issues such as increased Gulf temperatures and the rapid intensification of storms have led the SSPEED Center to focus on these larger storms.

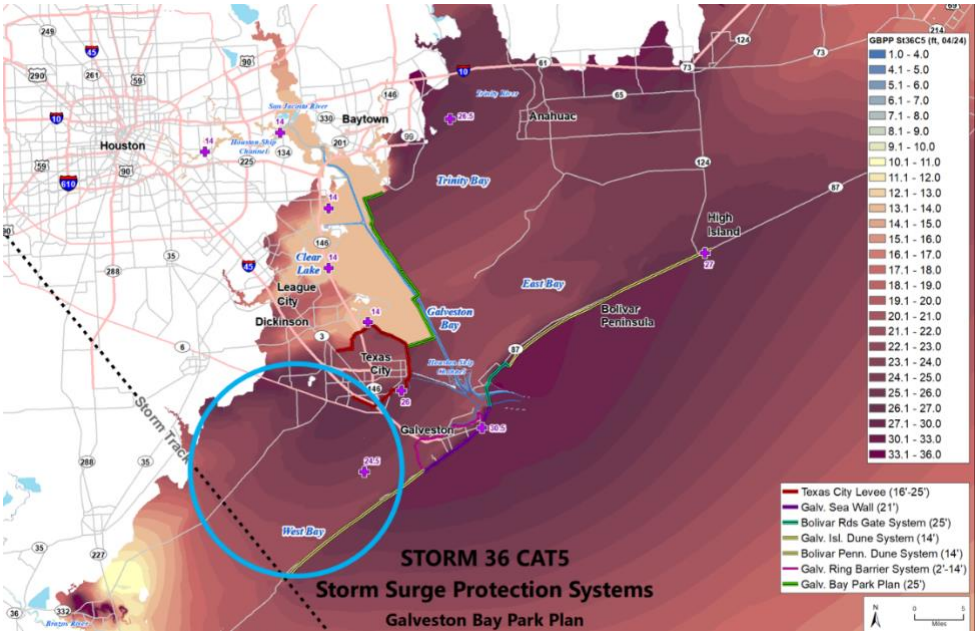

Figure 9. Computer modeling of impact of a category 5 storm on the Galveston Bay area with both the Texas Coastal project and the Galveston Bay Park Plan constructed, with the blue circle emphasizing the area of potential back-side flooding behind Texas City and into the Clear Lake area. Image from SSPEED Center.

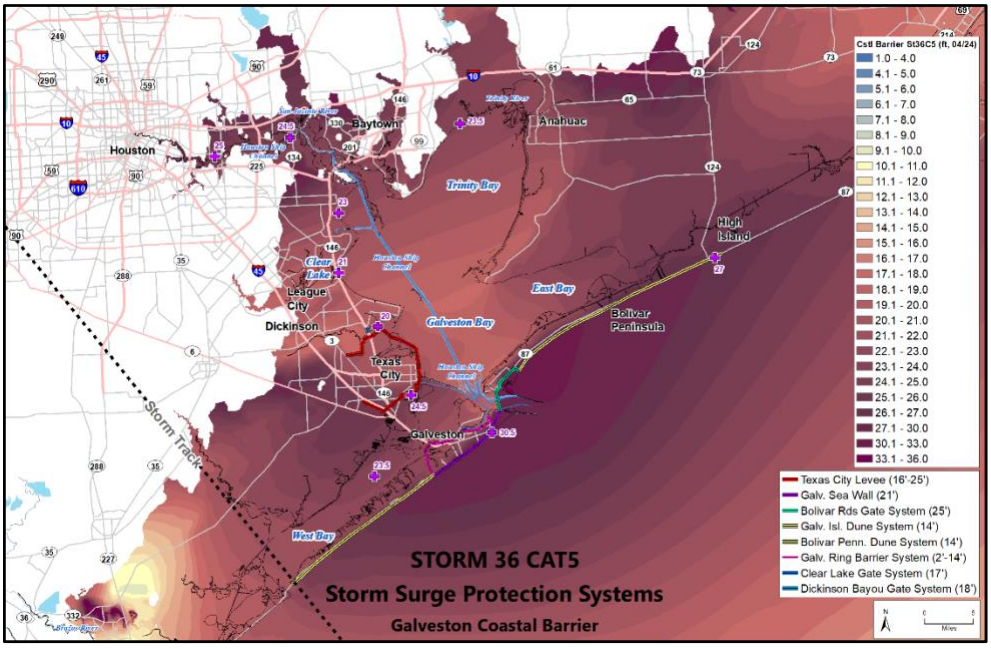

Figure 10. Impact of a category 5 storm with only the Texas Coastal Project in place. Image from SSPEED Center.

As a result of this modeling effort, Valero Corporation has funded SSPEED Center to design an extension to the Texas City levee to determine its feasibility and the potential cost to address this back-side issue. To this end, SSPEED Center has undertaken a geographic information system (GIS) analysis of the best geographic area to construct such a barrier (shown in Figure 11), and we have contracted with AECOM to undertake the conceptual design of such a system. The results of these efforts should be available in the fall of 2026.

Figure 11. GIS-identified corridor for potential expansion of the Texas City levee. Image from SSPEED Center.

Using Carbon Credits to Construct Coastal Texas Project G-28

Another natural and structural project is currently underway by the SSPEED Center under contract to the Gulf Coast Protection District and Texas A&M University. As part of the implementation of the Texas Coastal Project, GCPD

formed a research council of three universities – Texas A&M, Rice, and TU Delft from the Netherlands. Each of these universities may submit funding requests to GCPD for funding to undertake various research projects intended to assist GCPD in meeting its goal of implementing the Texas Coastal Project.

Through the research council, the SSPEED Center has been awarded a grant to study the use of carbon credits to construct the erosion control project G-28 along the Gulf Intracoastal Waterway, using coastal blue carbon credits to fund this 30+ mile construction project. At this time, there is no funding to implement G-28, and the likelihood of significant funding in the short- to mid-term is very low.

The purpose of the grant to SSPEED Center is to determine if GCPD can utilize the construction of erosion protection to meet the requirements of the BCarbon living shoreline coastal blue carbon credit protocol. This protocol provides for the construction of living shorelines to control erosion and protect coastal marshes from the impacts of sea level rise. At the least, these living shorelines will prevent the erosion of soil filled with organic carbon, which will be released when the soil column degrades due to the drowning of the marsh from sea level rise. With living shorelines in place, erosion will be halted, and sediment will begin to be deposited, protecting soil carbon and allowing the marsh to continue to prosper. In this manner, carbon dioxide credits may be issued for each acre of marsh protected, and these credits may be purchased by buyers needing to offset carbon dioxide emissions.

As part of this research, several tasks will be undertaken. First, the potential locations for erosion control projects must be identified and evaluated against the acreage and carbon content of adjacent protected wetlands. Then, an evaluation of the approximate cost per ton for each carbon credit issued under the BCarbon protocol must be conducted. Once that cost is known, buyers must be interviewed to determine if they would be willing to purchase such credits at that price. And finally, landowners must agree to

participate in the carbon market under the terms and conditions negotiated with GCPD.

Figure 12. Image of a living shoreline protecting an existing marsh. Image from BCarbon.

If successful, this project would be groundbreaking. To our knowledge, a federal public works project has never been funded by the proceeds from the sale of carbon credits. If successful, this project may open the door to a new source of funding for future public works erosion control projects.

Learn more: https://gcpdtexas.com/press-releases/top-u-s-and-international-research-institutions-partner-to-advance-the-largest-coastal-protection-effort-in-u-s-history-coastal-texas-project/

Nature-Based Projects Utilizing Artificial Intelligence

The SSPEED Center is currently working on several projects involving the use of artificial intelligence that are focused around Earth Rules, or the rules by which the Earth has survived for the last 600,000 years. Earth Rules are simple principles of ecology and physics that govern the Earth's operation. These rules include:

1. the fact that there is no waste in the natural system;

2. that organic matter degrades into carbon dioxide which enters the atmosphere and is returned to the Earth as organic carbon through photosynthesis, creating the carbon cycle; and
3. that water evaporates from the oceans and comes onto the continents as rainfall, then returns to the ocean through runoff, springs, seeps, and river flow to return to the ocean, creating the hydrologic cycle.

These Earth Rules are presented in Figure 13 and serve as the basis for the artificial intelligence work currently being pursued at the SSPEED Center in association with Jed Anderson of EnviroAI and the Rice Ken Kennedy Institute.

Figure 13. Earth Rules poster of SSPEED Center. Image courtesy of Jim Blackburn.

The Water Intelligence Engine

The first AI project arising from Earth Rules is the water intelligence engine, an attempt to create a smart grid for our water system, similar to what we currently have for our electrical grid. Unlike our electrical grid, our water grid is highly segregated into separate silos of surface water and groundwater, with little real-time information available about all aspects of a watershed, from rainfall and drought to spring flow, through withdrawals and return flows to bay and estuarine inflows.

The goal of the water intelligence engine is to pull all of these pieces together into a comprehensive framework for the river watershed (Figure 14). Under this comprehensive framework, we hope to create a better understanding of water supplies and water use in Texas for now and for the future.

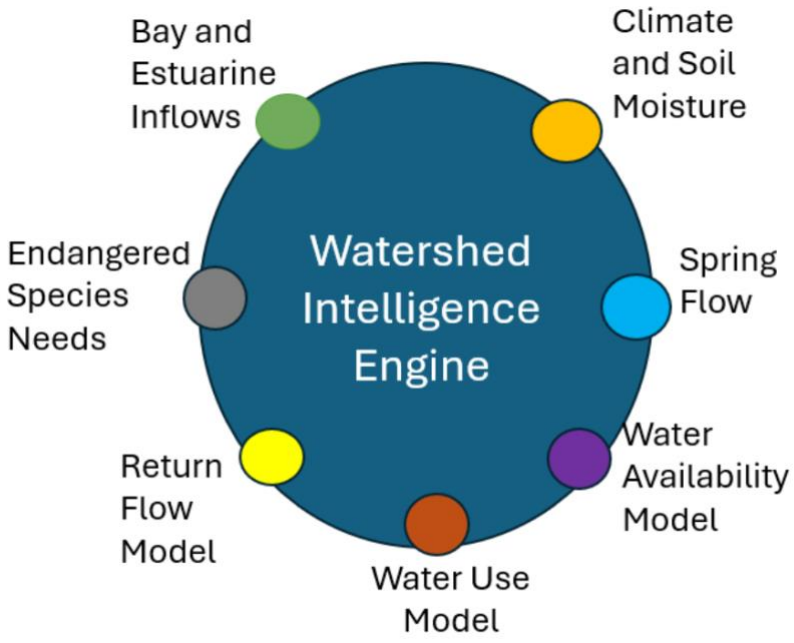

Figure 14. Conceptual diagram of the components of the water intelligence engine. Image by Jim Blackburn

The key concept here is that there is a lack of high-quality information about the state of our water in the different river watersheds. To address this, we propose creating the water intelligence engine. This will primarily consist of a large language model that will bring together various datasets, satellite data,

reports, compilations, and other sources of information, and make this comprehensive set of information available to all potential users. To the extent that calculations are required for flood modeling using HEC-RAS or bay modeling using Qual-TX, various machine learning applications or more sophisticated agents and/or surrogates may be required, as shown in Figure 15. However, for the most part, the bulk of this water intelligence engine should be built using large language models.

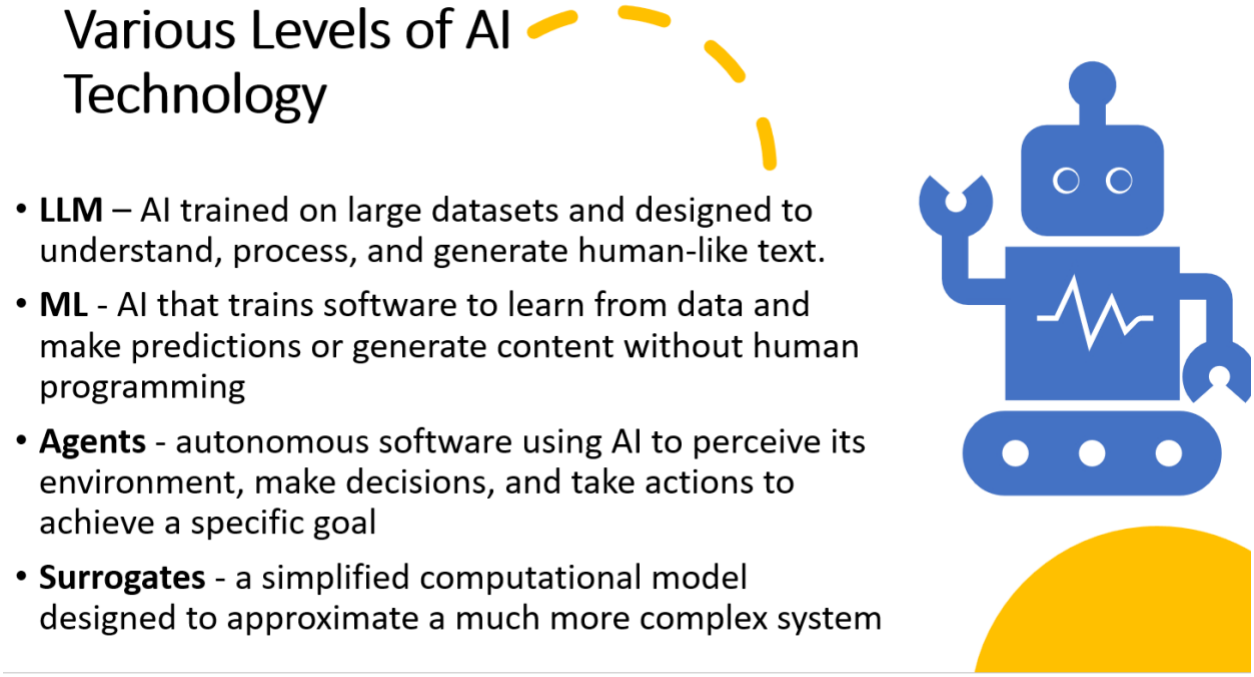

Figure 15. AI Technologies research by SSPEED Center. Image C Ordoñez

AI-Assisted Environmental Impact Analysis

Another potential application of AI being investigated by the SSPEED Center involves the environmental impact statement (EIS) process under the National Environmental Policy Act (NEPA). NEPA compliance has been the subject of recent bipartisan legislation and an 8-0 U.S. Supreme Court decision, which concluded that NEPA has become too burdensome and time and energy consuming. As a result, the Trump Administration has focused on streamlining the NEPA process by imposing time and page limits on EIS documentation and encouraging all agencies to take advantage of emerging technologies.

To this end, the SSPEED Center is preparing a submission to the GCPD to create an AI-assisted EIS process for the work that the GCPD is undertaking in association with the U.S. Army Corps of Engineers, relative to the design of both the Bolivar Roads hurricane protection gate and the beach and dune nourishment program for the Bolivar Peninsula and the West End of Galveston Island. Design work is ongoing, with contracts issued to Jacobs Engineering and HDR Engineering. As part of this work, environmental assessments and/or EIS will be developed over the next three or so years.

This AI-assisted environmental analysis engine is intended to augment the design process by offering relatively fast analyses of the impacts of alternatives and/or to assist in determining whether the resulting impacts will be significant. Additionally, this AI-EIS process is intended to assist in outreach to the public, which is a key aspect of the NEPA process. Figure 16 shows a conceptual dashboard for public access to such a product.

At this time, it was requested that this proposal be developed and submitted through the research council. Whether it will be funded is not yet known.

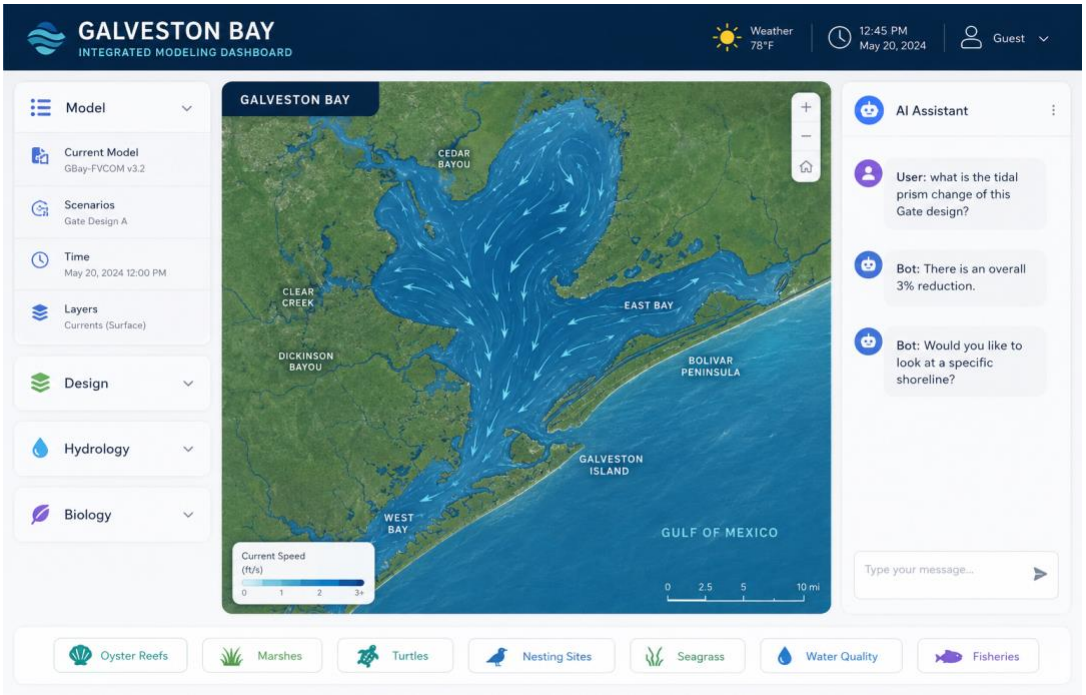

Figure 16: Concept Dashboard for the BIE User Interface. Image C. Ordoñez.

Materials Recycling AI-Engine

A third AI-assisted analytical engine under development at SSPEED Center focuses on the materials recycling industry. All waste that humans produce has embedded energy, carbon dioxide, and water use associated with the discarded product. If that product can be reclaimed and reused, there will be significant savings in energy and water use and much lower carbon dioxide emissions associated with the resulting products.

Eco-Hub, a Houston-based recycling company, has asked the SSPEED Center to develop a proposal to evaluate the energy, water, and carbon dioxide emission savings that would result from its concept to collect all solid waste from the City of Houston, mix it, and recycle it. Additionally, this proposal would include a data center connected to the recycling facility, with the goal of quantifying and applying the energy, carbon dioxide, and water savings to create the "net zero" data center of the future, such as shown in Figure 17.

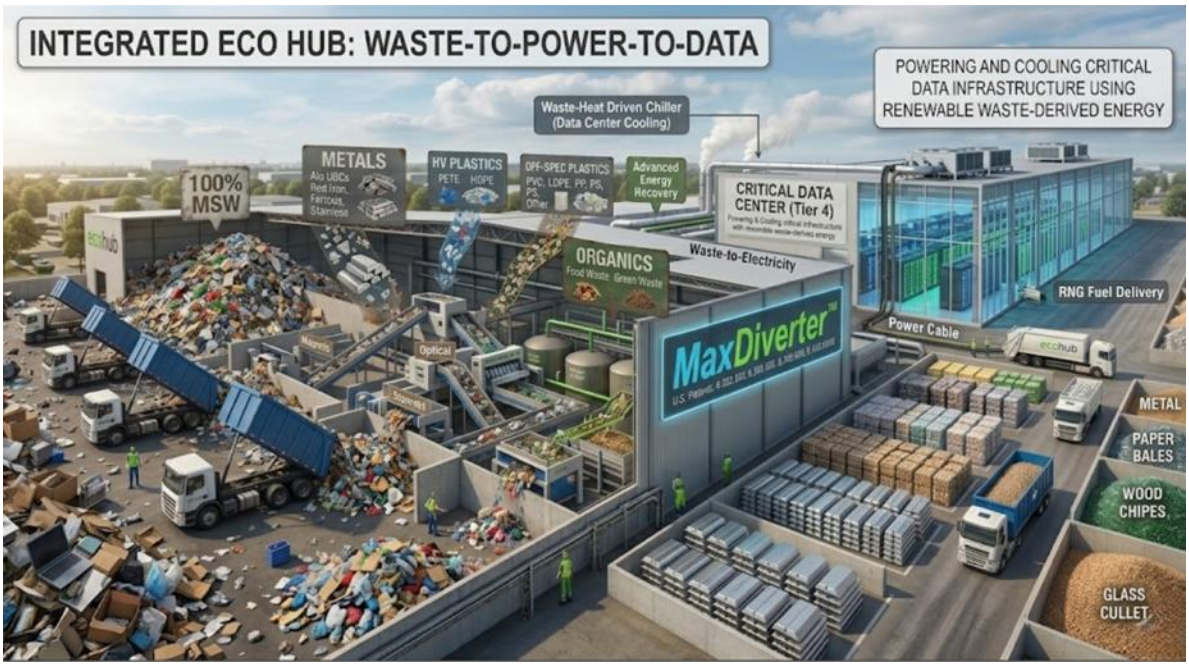

Figure 17. Concept of integrated solid waste management with associated data center. Image from EnviroAI.

Here, the SSPEED Center would develop the information system to support representations of energy, water, and carbon dioxide savings associated with

such a recycling process. For the most part, this would involve extensive life-cycle analysis within a large language context, which is then connected to conceptual thinking about issuing carbon and water credits to support the net zero emissions claims.

Conclusion

Over the last 15 years, SSPEED has been working with nature to achieve engineering solutions. From a modest start with a $750,000 grant from Houston Endowment, Inc., many research initiatives have unfolded, including a focus on nature-based engineering. This focus will only become more pronounced as Earth Rules emerge to guide both engineering and economic solutions. The SSPEED Center plans to be at the forefront of research to advance this thinking across many disciplines and over the coming decades.

Figure 18. SSPEED Center Group Picture, January 2026.