

TOWARD WETLAND PROTECTION IN THE HOUSTON-GALVESTON REGION: ASSESSING MITIGATION PRACTICES AND FACILITATING WATERSHED-BASED DECISION MAKING

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LIST OF ACRONYMS

C-CAP	Coastal Change Analysis Program
CWA	Clean Water Act
DA	Department of the Army
ESS	Ecosystem Services
FEGS-CS	Final Ecosystem Goods and Services-Classification System
FOIA	Freedom of Information Act
GTMA	Ground-Truth Wetland Mitigation Assessment
GTRI	GeoTechnology Research Institute
HARC	Houston Advanced Research Center
HCFCDD	Harris County Flood Control District
LOP	Letter of Permission
MB	Mitigation Bank
NOAA	National Oceanic and Atmospheric Administration
NWI	National Wetland Inventory
NWP	Nationwide General Permit
ORM II	Operations and Maintenance Business Information Link Regulatory Module II
SP	(Individual) Standard Permit
TCWP	Texas Coastal Watershed Program
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USCB	U.S. Census Bureau

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EXECUTIVE SUMMARY

Introduction

The population of the Houston-Galveston region is expanding at a rate greater than at any time in its history. From 2008 to 2016, Harris County added more new residents than any county in the United States (Kriel, 2017). The region's current estimated population of 6.7 million (USCB, 2017) is anticipated to increase to approximately 9 million people by the year 2040—a regional growth rate of about 100,000 people per year. Freshwater wetlands are a key component of the ecosystem of the Upper Texas Gulf Coastal Plain. Evidence gathered in a previous study by the authors (Gonzalez and Jacob, et al. 2014) strongly indicates that we may not be receiving the full measure of compensatory wetland mitigation as required under the Clean Water Act (CWA). As a result, the region is losing critical ecosystem services; the loss of which imperils the aquatic integrity of the bays and bayous that collectively drain our coastal plain. The loss of ecosystem services also impacts human populations that rely on regional wetlands and bayous. Wetlands represent green infrastructure that provides a myriad of services such as clean water and the storage and conveyance of stormwater during periods intense rainfall.

In 2016, the GeoTechnology Research Institute/Houston Advanced Research Center (GTRI/HARC) received a grant from the Texas General Land Office Coastal Management Program (CMP) to further investigate compensatory mitigation in the Houston-Galveston region and improve a regional decision support tool to be used by local governments and decision makers. The goals of the project are to (1) assess the success of compensatory wetland mitigation in the Houston-Galveston metropolitan region using ground-truthing to compare permit requirements to on-the-ground mitigation sites and (2) enhance a regional decision support tool to provide information to local governments and citizens, allowing them to access information describing potential development impacts to watersheds, wetlands and the ecosystem services that they provide.

Analysis of Clean Water Act, Section 404 Permit Data

This study assessed compensatory mitigation of permitted projects covered by CWA Section 404 permits issued by the US Army Corps of Engineers (USACE) Galveston District and in the 8-county Houston metropolitan area. GTRI/HARC and the Texas A&M AgriLife Extension Service, Texas Coastal Watershed Program (TCWP) acquired 404 wetland permit information for 835 permit records from the USACE Galveston District Office for the period 2008 to 2015 in eight counties of the Houston-Galveston region: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery and Waller. This brought the total number of permits in the study team's

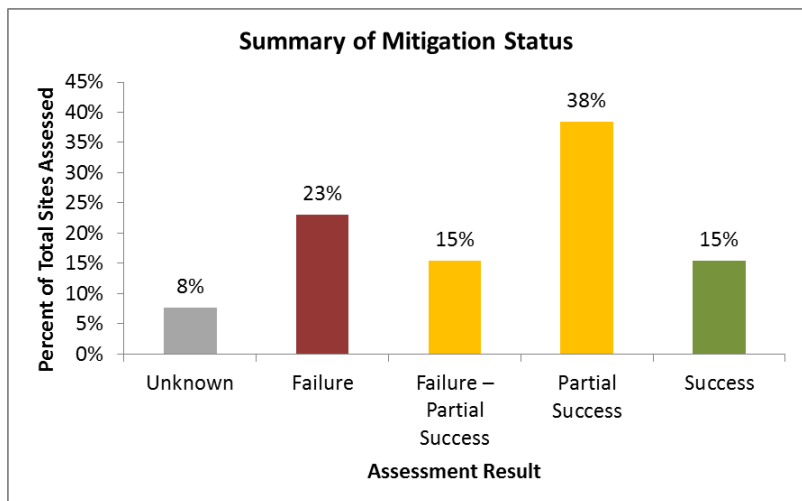
1990-2015 database to 7,887. Of the 7,887 permits, 80% were issued in three counties: Harris (2,839 permits or 36%), Galveston (2,041 permits or 26%) and Brazoria (1,397 permits or 18%). For the 1991-2015 period, permitted activities in freshwater wetland habitats lying outside of the 100-year floodplain accounted for 30% of federal permits (n=2,392) compared to 70% (n=5,490) inside the 100-year floodplain. With most regional development occurring outside the 100-year floodplain, the conversion of wetland habitat to the built environment appears to be occurring outside of the current federal Clean Water Act permitting process with little to no protections or compensatory mitigation.

Twenty-three full permit records were obtained from the USACE. Each permit was reviewed individually for impacts, mitigation requirements and documentation, inspection requirements and documentation and special requirements. Missing or incomplete information was noted as well as any deviation from the approved plans or expiration of time limits. Following thorough review, fifteen permits were in compliance, one was withdrawn and another denied. The most common reason for permit non-compliance was due to information missing from the permit record.

On-the-Ground Assessment of Compensatory Wetland Mitigation

The first goal of the project was accomplished by implementing a Ground-Truth Wetland Mitigation Assessment (GTMA) protocol. The GTMA represents a preliminary look at Clean Water Act wetland mitigation in the 8-county Houston region. The sample size was limited and only preliminary conclusions can be offered at this stage. However, the results of the study are nonetheless valid and defensible within these limitations, because of the rigorous methodology followed.

The study revealed a shortfall in the ability of the Clean Water Act compensatory mitigation program to fully compensate for lost values and functions of wetlands replaced by development. Fifteen percent of the compensatory mitigation projects examined (two out of 13) could be called unqualified successes. Three (23%) of the 13 compensatory mitigation sites



examined were classified as failures using rigorous criteria. We classified nine of the projects, or 69%, as successful to one degree or another. However, the breadth and range of what was identified as a success was broad. The two completely successful projects that were examined—one a permittee-responsible mitigation and the other a mitigation bank—both involved government agency participation.

The compensatory mitigation sites examined contained both permittee-responsible mitigation as well as mitigation banks. The USACE accepts that mitigation banks are more successful than permittee-responsible mitigation projects in terms of mitigating lost wetland function; our analysis bears this out. If we consider sites identified as partially successful and successful, then four out of five (80%) mitigation bank projects that we looked at were successful. Conversely, three out of eight (38%) permittee-responsible mitigation were identified as being partially or completely successful. None of the mitigation bank projects were total or partial failures, but five out of eight (63%) of the permittee-responsible mitigation sites were total or partial failures.

One disturbing outcome for the mitigation banks was the number of sites where no access was granted. Two mitigation banks out of the five assessed would not provide access to the study team. However, one site was assessed remotely by utilizing aerial photography and was determined to be a partial success. Another important issue associated with the mitigation banks is that of concentration of wetland mitigation into areas that are smaller than the areas where permitted impacts occur (service areas). Maintenance of water quality and other ecosystem services is dependent on wetlands being widely distributed across regional watersheds. Concentration of wetlands into very small areas inside large service areas greatly reduces the role wetlands can play in maintaining the aquatic integrity of regional bays and bayous.

The main conclusion to be drawn from this assessment is that the Clean Water Act compensatory mitigation system in place for ensuring the aquatic integrity of our waterways does not appear to be consistently replacing lost values and functions of the wetlands that are destroyed by development.

Local Government Decision Support Tool

Decisions regarding development decisions and resulting wetland impacts often fall to county and municipal decision makers. Given that much of this activity falls outside of the jurisdiction of the Clean Water Act, it is important for local decision makers to have access to data and information that supports decisions resulting in avoidance of wetland impacts. Information

about existing permits, wetland coverage, impaired streams, mitigation bank service areas and impervious surface percentages are not readily available to some stakeholders. Therefore, GTRI/HARC created a simple, online GIS interface that provides access to datasets that can facilitate wetland impact avoidance and shed light on the potential impacts of wetland loss in the lower Galveston Bay watershed. More than 200 surveys were sent out to regional stakeholders and comments were analyzed. This was followed up with a training webinar. The resulting mapping application is an updated and improved *Galveston Bay Watershed and Wetland Permit Planning Tool* which can be accessed freely online at https://gis1.harcresearch.org/wetland_tool_wab/.



The *Galveston Bay Watershed and Wetland Permit Planning Tool* calculates acreage of wetlands impacted based on the NOAA (2010) Coastal Change and Analysis Program (C-CAP) dataset as well as wetland type per the National Wetland Inventory (NWI) habitat classification. Location in relation to the 100-year floodplain (2009), associated Clean Water Act 303(d) impaired streams and mitigation bank service areas that overlap with a potential project are also shown. The tool provides the percent impervious surface coverage within the watershed and notifies the user of potential impacts on surface water quality: <10% - minimally impacted; 10-30% - impacted; 30% imperviousness – degraded (Schueler 1992; Arnold Jr. and Gibbons 1996). Results can be exported as a shapefile or .csv file for import into data analysis programs.

Ecosystem Services

Natural habitats such as freshwater wetlands not only provide value in the form of supporting ecological diversity and fish and wildlife populations; freshwater wetlands also provide real value to the human populations that live around them. Ecosystem services (ESS) are benefits that humans derive from nature in the form of provisioning of goods such as food and fiber, regulating services such as the nutrient cycling and the maintenance of water quality, supporting services such as food resources for wildlife populations and cultural benefits that include aesthetic and spiritual benefits. The physical loss of wetland habitat and wetland function translates into a loss of ecosystem services for society.

Using the USEPA's Final Ecosystem Goods and Services Classification System (FEGS-CS), the project team identified seven groups of 24 beneficiaries that benefit from ecosystem services provided by freshwater wetland habitats. For the same seven categories of ecosystem service beneficiary groups, 37 specific ecosystem services are associated with the existence of functioning wetland habitats. While it is difficult to assign a monetary value to ecosystem services provided by wetlands, we know that residential, agricultural and commercial fresh water supplies, flood risk reduction, along with recreational activities are worth many millions of dollars to the regional economy. Based on the FEG-CS, one can easily see that all aspects of society in the Houston-Galveston region benefit from functioning wetlands. As such, this vital green infrastructure has value as natural capital and should be deployed as a technological solution for services such as flood risk reduction and provision of water treatment alongside gray infrastructure (January-Beyers et al., 2016).

Conclusion

In the lower Galveston Bay watershed, the majority of development falls outside of federal jurisdiction and the inevitable resultant wetland loss is therefore often uncounted and unmitigated. Impacts and mitigation that do fall within the federal jurisdiction of the USACE are difficult to track and it is nearly impossible to



determine the replacement of wetland function without on-site access to mitigation sites and diligent assessment of vegetation, hydrology and soil conditions. For this reason, local decision makers must have tools and information at their disposal to avoid wetland impacts and protect valuable ecosystem services provided by the green infrastructure that wetlands represent. On-the-ground inspections of mitigated wetlands in our region are essential to determine the existence wetland function that can continue to serve the watershed.

INTRODUCTION

The goals of the ***Wetland Protection in the Houston-Galveston Region: Assessing Mitigation Practices and Facilitating Watershed-Based Decision Making*** project are to (1) assess the success of compensatory wetland mitigation in the Houston-Galveston metropolitan region using ground-truthing to compare permit requirements to on-the-ground mitigation sites and (2) enhance a regional decision support tool to provide information to local governments and citizens, allowing them to access information describing potential development impacts to watersheds, wetlands and the ecosystem services that they provide. The work described in the final report builds upon a previous NOAA project of special merit (NOAA No. NA12NOS4190021; GLO No. 13-079-000-7102).

Under the current grant, the GeoTechnology Research Institute, Houston Advanced Research Center (GTRI/HARC) and the Texas A&M Agrilife Extension Service, Texas Coastal Watershed Program (TCWP) updated

and analyzed a database of 7,887 federal Clean Water Act section 404 wetland permits (1990-2015; in eight counties of the Houston-Galveston region). For the 1991-2015 period, permitted activities in wetland habitats lying outside of the 100-year floodplain accounted for 30% of federal permits (n=2,392) compared to 70% inside the 100-year floodplain (*Figure 1*). The vast majority of permitted wetland activities in the region occur inside the 100-year floodplain. With most regional development occurring outside the 100-year floodplain, they appear to be occurring outside of the current federal permitting process with little to no protections or compensatory mitigation.

To facilitate the conservation of wetland habitats in the region, TCWP and GTRI/HARC further analyzed the status of compensatory mitigation in the Lower Galveston Bay watershed. We investigated the methodology used by the US Army Corps of Engineers (USACE) to assess

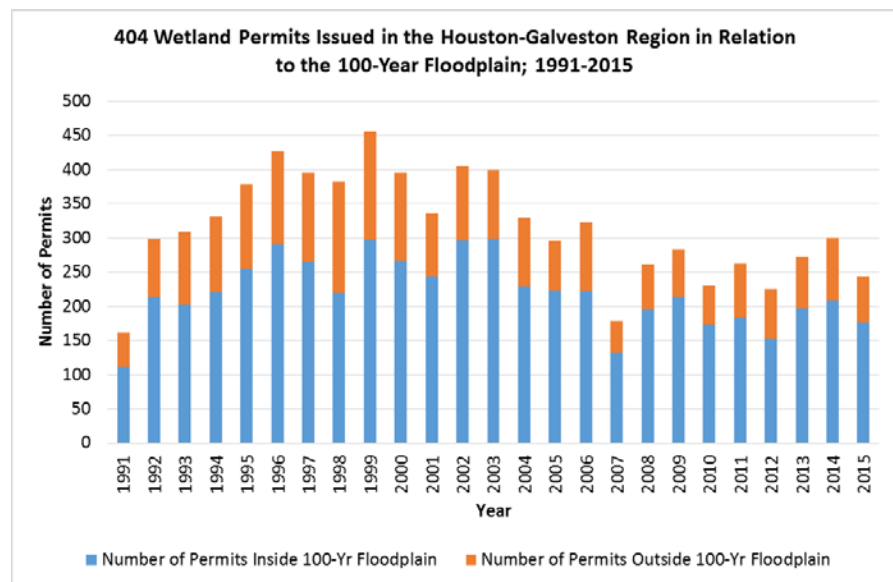


Figure 1. Thirty percent of 404 wetland permits issued in the Houston-Galveston Region lie outside the 100-year floodplain.

wetland sites and consulted local wetland experts and the scientific literature describing additional evaluation metrics.

To provide updated USACE permit data and increase access to data for planning and purposes and expand its use, GTRI/HARC enhanced the [Galveston Bay Watershed and Wetland Permit Planning Tool](#) with an enhanced user interface and additional shape layers. GTRI/HARC hosted a webinar for GLO Permit Service Center staff, local planners, developers and citizens on the improved tool and its use.

The study team also downloaded the Final Ecosystem Goods and Services-Classification System (FECS-CS) from the US Environmental Protection Agency (USEPA) (2013) to determine the societal beneficiaries receiving ecosystem services from freshwater wetland habitats.

PROJECT METHODOLOGY

INVOLVEMENT OF REGIONAL STAKEHOLDERS

The project team convened two stakeholder webinars. The initial stakeholder webinar was held on May 27, 2016 and was attended by an advisory team versant in wetlands and compensatory wetland mitigation, including representatives of Texas A&M University at Galveston, Texas A&M Agrilife, Texas Parks and Wildlife Department, Bayou Land Conservancy and Lee College. Project goals and objectives were outlined and discussion centered on compensatory wetland mitigation site metrics in an effort to identify those that can be productively monitored.

A final stakeholder webinar was held on June 13, 2017 and was attended by representatives of the Texas General Land Office, City of Houston, City of Dickinson, Texas City, City of Nassau Bay, City of Seabrook, City of Galveston, as well as other stakeholders. The updated *Galveston Bay Watershed and Wetland Permit Planning Tool* was presented, including improvements obtained via a survey sent to a stakeholder to more than 200 regional municipalities and state and federal agencies.

REVIEW AND COMPARE WETLAND MITIGATION SUCCESS METRICS

GTRI/HARC and TCWP conducted a review of the scientific literature on existing metrics to assess success of wetland mitigation projects. We reviewed the hydrogeomorphic-based functional assessment used by the USACE (1987, 2011) and compared it to a list of metrics

compiled from the scientific literature (*Appendix A*). The general USACE guidelines define the process used by the local district to assign compensatory mitigation for permitted activities in cases where impacts are unavoidable. The 2003 Memorandum to the Field from the US Army Corps of Engineers Regulatory Branch, the Compensatory Mitigation Plan Checklist (USACE, 2003; *Appendix A*) outlines specific performance standards to determine compensatory mitigation.

From the performance standards set forth by the USACE Regulatory Branch and utilizing existing information from the wetland assessment (wetland delineation methods, US Army Corps of Engineers 1987, US Army Corps of Engineers 2011), *Table 1* describes the basic USACE metrics for evaluating compensatory mitigation. Using the chart and quantifying values for each major feature (e.g. hydrology, vegetation and soil), the table provides a basic tool to evaluate compensatory mitigation projects in those instances where mitigation is required and completed. These metrics were considered for the on-the-ground assessment of mitigation sites conducted by the project team (Ground-Truth Wetland Mitigation Assessment; GTMA).

Table 1. Criteria for Evaluating Compensatory Mitigation.

Source: US Army Corps of Engineers, 1987 and Environmental Protection Agency, 1990

Feature	Test	Indicator
Hydrophytic Vegetation	Rapid Test	All dominant species across all strata are rated as Obligate (OBL), Facultative Wetland (FACW), or a combination of the two
	Dominance Test	More than 50% of the dominant plant species across all strata are rated OBL, FACW, or Facultative (FAC)
	Prevalence Test	Has a prevalence index of 3.0 or less, the prevalence index ranges from 1 to 5 and is lower the greater the OBL cover is, and higher the greater the Obligate upland (UPL) cover is
Hydrology	Group A - Observation of surface water or saturated soils	A1: Surface water
		A2: High water table
		A3: Saturation
	Group B - Evidence of recent inundation	B1: Water marks
		B2: Sediment deposits
		B3: Drift deposits
		B4: Algal mat or crust
		B5: Iron deposits
		B7: Inundation visible on aerial imagery
		B9: Water-stained leaves
		B13: Aquatic fauna
		B15: Marl deposits
		B6: Surface soil cracks
		B8: Sparsely vegetated concave surface
	B10: Drainage patterns	
	B16: Moss trim lines	
	Group C - Evidence of current or recent soil saturation	C1: Hydrogen sulfide odor
		C3: Oxidized rhizospheres along living roots
		C4: Presence of reduced iron
		C6: Recent iron reduction in tilled soils
		C7: Thin muck surface
		C2: Dry-season water table
C8: Crayfish burrows		
C9: Saturation visible on aerial imagery		
Group D - Evidence from other site conditions or data	D2: Geomorphic position	
	D3: Shallow aquitard	
	D5: FAC-neutral test	
	D8: Sphagnum moss	
Hydric Soil	Soil horizon analysis completed by soil expert	

CLEAN WATER ACTION, SECTION 404 WETLAND PERMIT DATA ACQUISITION

Through a Freedom of Information Act (FOIA) request, HARC requested an updated set of the USCAE's Operations and Maintenance Business Information Link Regulatory Module II (ORM II) geospatial database for all regulatory actions in the 8-county region from 2008-2015 (to append to the 1990-2012 dataset acquired under the previous grant). The project team focused on acquiring permit records beginning with the 2008 time period. Beginning in 2008, the USACE digitalized records of 404 wetland permits (as opposed to paper copies or microfiche records). The digitized permit records are summarized in the ORM II database utilized by all USACE districts throughout the U.S.

The USACE ORMS II data update spans a time period from January 2008 through December 2015 for the following eight counties in the Southeast Texas study area: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery and Waller. The database contains five permit action types: Letter of Permit (LOP), Nationwide General Permit (NWP), Programmatic General Permit (RGP), Regional General Permit (RGP) and Individual Standard Permit (SP).

The ORM II dataset of 2,079 permits (2008-2015) was appended to the original dataset dating back to 1990. The total number of permits in the dataset totaled 7,887. However, for the purposes of analyses, we began with 1991, the first complete data year in our record. ORM II data are useful for determining number of permits, year and location of permitted activity. But more specific information that would allow a quantitative assessment of compliance is not available for every permit in the ORM II database and requires full permit records. For example, information regarding acreage of permitted impacts, acreage (or functional equivalent) of required compensatory mitigation and the actual compliance record was lacking or did not always match what was found in the full permit record which must be obtained through a FOIA request. This was consistent with our previous finding based on ORM II data acquired for records prior to the execution of 2008 digitization practices.

FULL 404 PERMIT ACQUISITION

In order to expand the subset of the CWA 404 permit actions created under the prior grant, analyze impacts to wetlands and assess compensatory mitigation of the impacted wetlands, the project team continued to focus on Individual Standard Permits (SPs) and Nationwide General Permits (NWPs). These two categories continued to represent the majority of permits with compensatory mitigation requirements (according to the ORM II dataset). The SP and NWP permit subset was then randomly sampled by developing a Python script in ArcGIS to ensure a representative sample of permits. Furthermore, because of the lack of evidence of mitigation for a majority of permits in the ORM II dataset, it was decided to specifically sample an even

number of permits from those with evidence of mitigation and those without in order to determine if any patterns arose. The final sample subjected to the random sampling method consisted of 4 groups of 25 permits:

- 25 permits randomly selected from SP's documented as mitigated,
- 25 permits randomly selected from SP's *not* documented as mitigated,
- 25 permits randomly selected from NWP's documented as mitigated,
- 25 permits randomly selected from NWP's *not* documented as mitigated.

The project team's goal was to request 100 fully-documented permit files according to associated DA number (the common field that uniquely identifies each permit) via Freedom of Information Act request (FOIA) (see *Appendix B*). FOIA requests for full permits commenced in January 2016. Due to federal limitations regarding the required response times allowed for FOIA requests, the project team was advised by USACE personnel to limit requests to 3-4 permits per FOIA request (compared to ten permits per FOIA request under the prior grant). Because of long response times, we were able to request and analyze 27 full permit records.

Of the 27 received permits received, 33% represented NWPs and 66% represented SPs. Five of the eight counties in the study area (excepting Waller, Chambers and Liberty Counties) were represented by at least one permit. Of the 27 full permits received, 14 required some form of compensatory mitigation with ten being permittee responsible, three being mitigation bank and one permit requiring preservation of conservation lands off-site from the permitted activity.

Review of the full 404 permit records resulted in the creation of a summary for each permit (see *Appendix C*). Each permit summary includes information pertinent to the analysis along with contextual information about the circumstances surrounding the permitted action. Information in the summary includes date and type of permit, temporary and permanent impacts to jurisdictional and non-jurisdictional wetlands, type and quantity of compensatory mitigation actions, whether there was documentation of compensatory mitigation and any requirements and accompanying documentation of special conditions present in the permit. Compliance with the permit requirements was assumed unless general or special conditions were not met.

For the purposes of this project, compliance means that all of the general and special conditions associated with a particular permit were documented as complete and that all required inspections and reports have been completed within the timeframe allotted by the permit. Not all permits assessed were expected to be complete as of the end of the study

period (December 31, 2015). In the case where mitigation was ongoing at the end of the study period, compliance was assessed based on permit requirement deadlines established up to December 31, 2015.

ON-THE-GROUND MITIGATION ASSESSMENT

The Ground-Truth Wetland Mitigation Assessment (GTMA) is an initial, preliminary look at CWA Section 404 compensatory mitigation in the 8-county Houston-Galveston region. As stated above, the sample size was very limited and only preliminary conclusions can be offered. The results of the study are nonetheless valid and defensible within these limitations because of a rigorous assessment methodology that was followed. As detailed above, permits with compensatory mitigation requirements were randomly chosen from the ORM II dataset and when access to the site was provided, on-site evaluation were conducted by TCWP staff.

Vegetation was characterized by the TCWP by collecting data describing vegetation structure and individual plant species presence and percent cover in 100 square meter (m²) Vegetation (Veg) Plots that were placed representatively within the tract. Plots 10 m by 10 m in area were demarked using flags. Cover of various biotic and abiotic surface materials were collected in each Veg Plot. A minimum of 5% of the total restoration site was inventoried to compile enough vegetative data from which to draw inferences. A comprehensive list of species represented in the plot was compiled prior to data collection. This list was amended as previously unobserved species within the plot were discovered. Pictures of the site and the sample plot were taken along with any notable site features. Data collected in each sample plot included:

- Species percent cover,
- Species wetland status,
- Species average height class,
- Percent open water,
- 3 water depth measurements,
- Soil core collected, and
- Observed hydrology

ONLINE GEOSPATIAL TOOL

GTRI/HARC updated the *Galveston Bay Watershed and Wetland Permit Planning Tool* to better serve coastal wetland data and other watershed-based information to stakeholders. More than 200 surveys were sent out to regional stakeholders and comments were analyzed and

improvements made. The mapping application was updated and redesigned to improve the user experience. The Galveston Bay Watershed and Wetland Permit Planning Tool can be accessed at https://gis1.harcresearch.org/wetland_tool_wab/ . A webinar was hosted on June 13, 2017 and the recorded webinar is now accessible from the HARC [website](#) (and via Vimeo: <https://vimeo.com/217865905>).

ECOSYSTEM SERVICES

GTRI/HARC downloaded the Final Ecosystem Goods and Services Classification System (FEGS-CS) from the USEPA (2013) website. The FEGS-CS defines specific ecosystem services and beneficiaries and is meant to provide a consistent foundation for practitioners that wish to “measure, quantify, map, model, and/or value a standard, but complete, set of ecosystem services”. The downloaded dataset details approximately 50 ecosystem services associated with wetland habitats.

DISCUSSION

ORM II DATA RECORD

The consensus of the regional experts we spoke with was that wetland assessment is a complicated and time-consuming process to do well, which poses significant challenges for any agency or municipality who wishes to ensure that wetlands are being mitigated properly and that wetland functions are not being lost. Analysis of the ORM II dataset can provide a regional overview, but the details of wetland impacts and mitigation are still difficult to verify, even in the more recent records from 2008-2015 that are based on digitized permit files. Analysis of full wetland permits is costly and time consuming as each permit requires a written FOIA request and typically a 20-business day response time from the USACE.

The relative distribution of permits across the 8-county region has remained relatively stable since 2008 (*Figure 2*). Most permits between 2008 and 2015 (72%) fell within the 100-year floodplain (*Table 2*). This is consistent with previously analyzed permits dating back to 1991 (*Figure 1*).

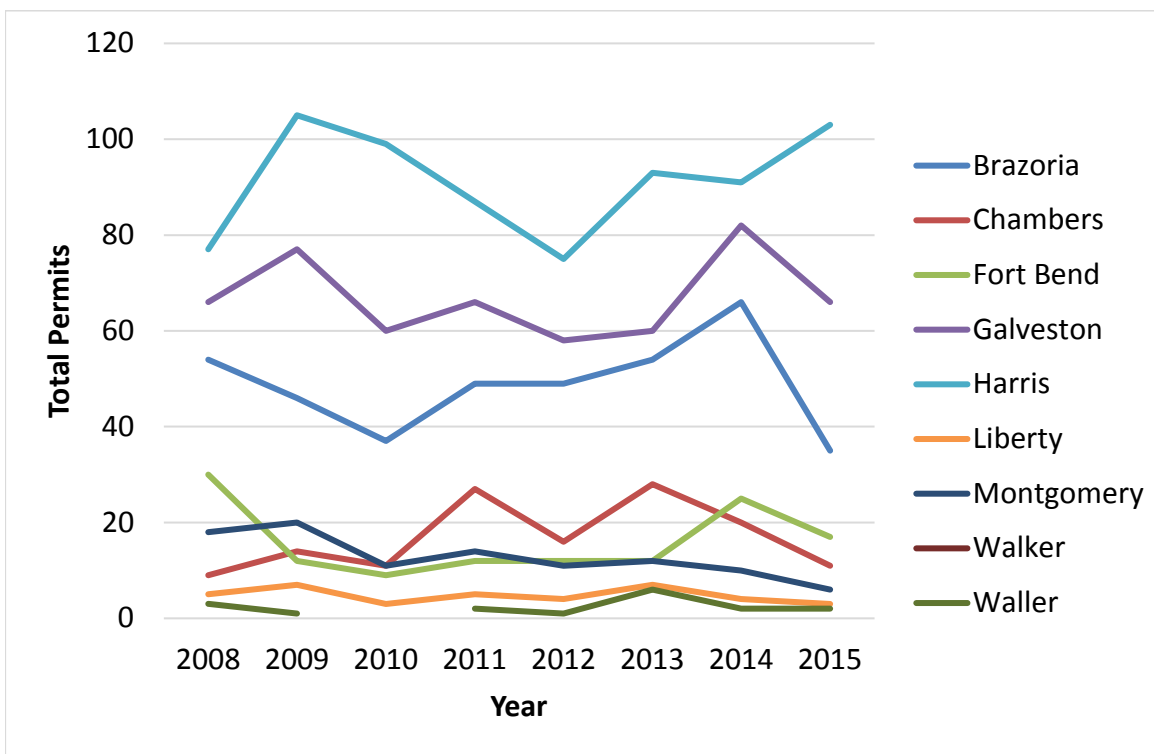


Figure 2. Number of Clean Water Act 404 Permits issued by county; 2008-2015.

Table 2. Floodplain status of ORM II data record 2008-2015.

100-Year Floodplain Status	Full Inventory (n=2,079)	Percent within Category
Inside Floodplain	1,500	72%
Outside Floodplain	579	28%

DETAILED COMPLIANCE ANALYSIS OF THE FULLY-DOCUMENTED PERMIT RECORDS

Twenty-three full permit records were obtained from the USACE. As each permit was individually reviewed for impacts, mitigation requirements and documentation, inspection requirements and documentation and other special requirements. Missing or incomplete information was noted as well as any deviation from the approved permit plans or expiration of time limits. Following thorough review, fifteen permits (65 %) were found to be in compliance, one was withdrawn and another denied. The most common reason for non-compliance was due to information missing from the permit record. Required compensatory mitigation and impacts as detailed in the full permit records are summarized in *Table 3*.

Table 3. Impact and mitigation summary for 23 full permits reviewed.

	Acres				Credits	
	Impacts	Created	Enhanced	Preserved	Purchased	Owed
Wetland	38.5	28.2	1	11.5	0.8	0.9
Riparian	28.4	36.7	--	--	--	--
Upland/forest	36.2	31.4	--	--	--	--
Open water	12.1	38.0	--	--	--	--

In ten permits, the impact, authorized fill and acres listed in the ORM II record did not match the full-permit. Most of the non-compliant permits were missing documentation of completion of mitigation, inspection, and/or monitoring. It was extremely difficult to determine if mitigation was carried out correctly and it was impossible to determine whether full wetland function was achieved from the full permit record without on-the-ground inspections.

GROUND-TRUTH WETLAND MITIGATION ASSESSMENT

The scope of this project limited the number of sites could be physically accessed. The purpose of this project was not to do a comprehensive evaluation, but rather to determine types of data that could be collected and whether or not we could actually collect data from which we could draw valid conclusions. On that score, this project was a success. In spite of the limited number of samples we could collect and the limited amount of time we could spend at each site, we were able to collect solid data from which we could draw solid, albeit limited conclusions. We have opened a window on this process and have determined that we could, with a relatively modest increase in resources, perform a sound and robust analysis that could enable policy makers to put in place a viable system that would protect the ecological integrity of our regional wetlands and water bodies for many generations to come.

Four permits existed in locations that were not accessible by the field team, leaving 13 permits for site review. The small sample size means that we could not infer that the percentages discussed below are reflective of the entire population of compensatory mitigation projects in the 8-county region. However, given that this is the first quantitative assessment involving rigorous sampling of compensatory mitigation projects in the Houston region, the results of this project do open up at least an initial view into how well the region’s compensatory mitigation system is working.

We employed a dichotomous method to evaluate and rank wetland mitigation projects, as either a failure or success based on the data collected in sample plots. Success was determined using the official three-fold definition of a wetland (Tiner, 1989): hydrophytic vegetation (plants

submerged partially or completely in water), evidence of hydrology and soil indicators deemed consistent with those of wetland hydrology.

We conducted a conservative assessment in that if a site was “reasonably wet” with recognizable wetland plants and hydric soils, the compensatory mitigation site was deemed a success (S). Failure (F) was determined to be a substandard compensatory mitigation site from the standpoint of wetland establishment, representing a lack of any evidence for wetland mitigation (i.e., there was no evidence of an attempt to establish a wetland). Three (23%) of the 13 sites examined were classified as failures using these criteria (see *Figure 3, Figure 4 and Table 4*).

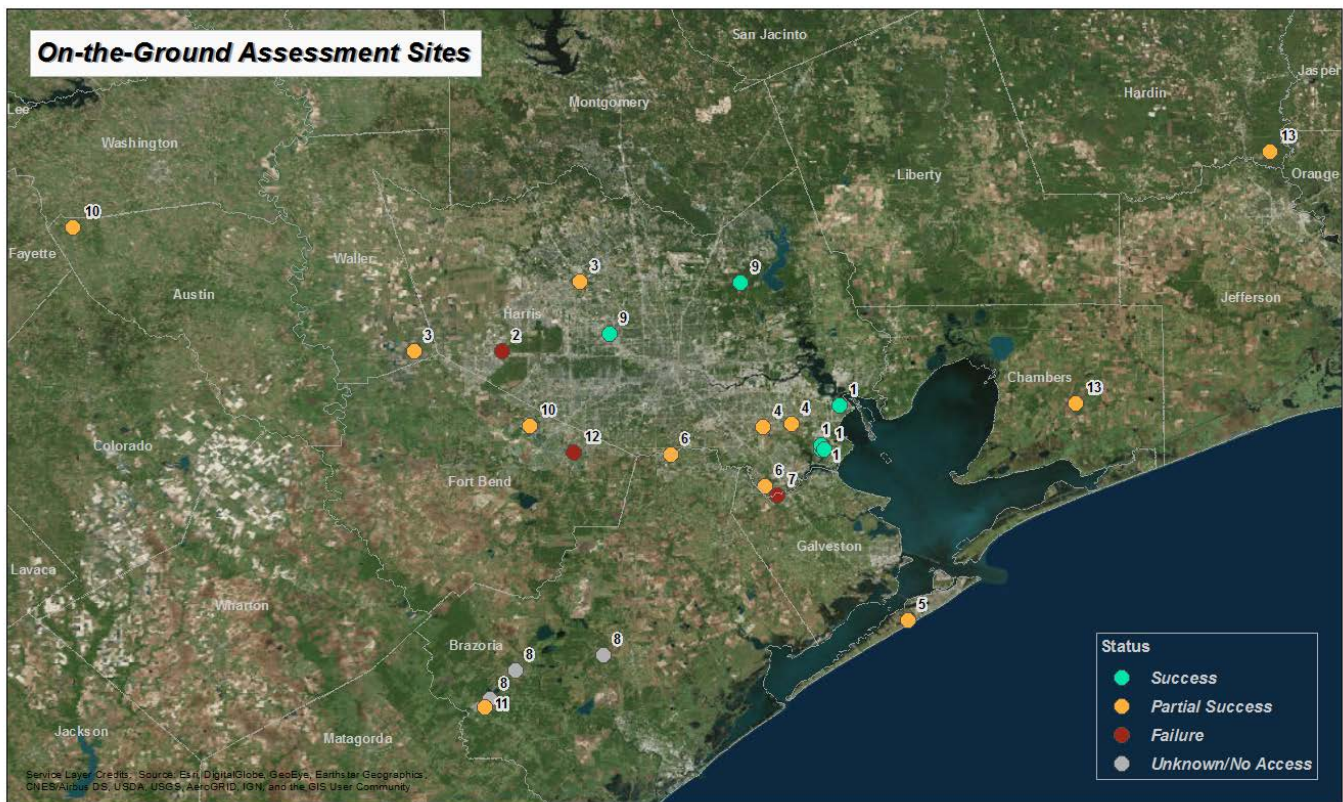


Figure 3. Map detailing locations of 13 ground-truth wetland mitigation assessment sites. Colors coincide with those in Table 5.

Determination of success on the other hand, was a little more difficult. Sites that were not assessed as a failure of mitigation included a range. Some sites minimally met criteria for a wetland, while some were identified as fully functioning mature wetland projects. Holding to the dichotomous methodology above, we classified nine of the projects, or 69%, as successful to one degree or another. However, the breadth and range of what was identified as a success was broad (*Table 5*).

We employed a “partially successful” (PS) category to describe those projects that met some measures of success. Two projects rated low on the success scale and were identified as failure-partial success (15%) (F-PS). This meant an attempt at mitigations had been made and some version of a wetland was present on a dedicated site. One can combine the F and F-PS categories to obtain a failure rate of 38%. But even if all sites outside of those identified as failures were deemed successful, this still means we have a 23% failure rate. A 23% failure rate does not result in “no net loss” of wetland functions and values; this represents a red flag.

Table 4. Summary results of the ground-truth wetland mitigation assessment.

	Unknown	Failure	Failure-Partial Success	Partial Success	Success	Total
Number	1	3	2	5	2	13
% of Total	8%	23%	15%	38%	15%	100%

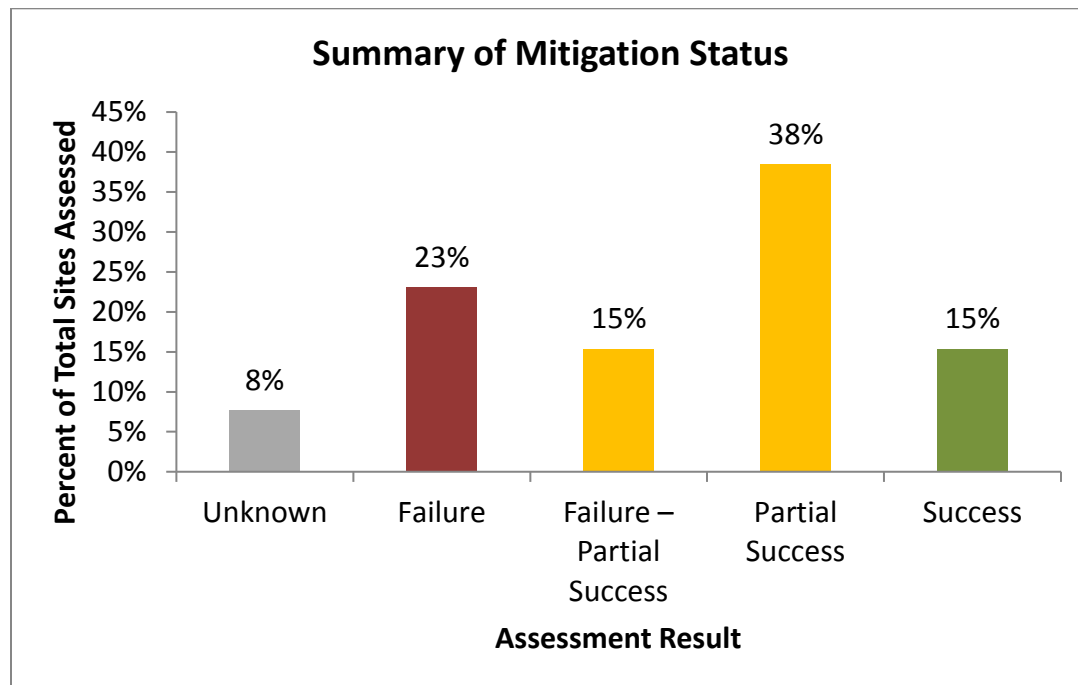


Figure 4. Summary results of the ground-truth wetland mitigation assessment.

Given the small sample size, one can state the failure or success rate as a range. The results of this study then suggest that at best the expected success rate of wetland mitigation in this area might be as high as 69%. At worst, 77% of the projects are failures. Successes might thus range from 23% to 69% of the total.

Table 5. Detailed results of the ground-truth wetland mitigation assessment. (Status: U=Unknown/No Access, F=Failure; PS=Partial Success; S=Success; Type: P=Permittee responsible; M=Mitigation Bank)

Map Label	Mitigation Type	Assessment Result	Comments
1	P	S	A healthy stand of <i>Spartina alterniflora</i> thrives at the mitigation site today.
2	P	F	No documentation nor field evidence of mitigation in Addicks Reservoir. On-site preserved wetland no evidence of required enhancement.
3	P	PS	No access given. Depressions on the mitigation site appear to be more like ponds than wetlands. Most show open water aerial photo signature. No significant stands of wetland vegetation in the depressions. Very little wetland functionality appears to have been provided.
4	P	F-PS	No record of a required conservation easement (a city council resolution approves use as a mitigation area). A berm appears to have been built for the mitigation area. No evidence of significant wetland functionality.
5	P	PS	Cattail dominated constructed depression
6	M	PS	Fairly low quality wetlands in a very concentrated pattern unlike any natural pattern.
7	P	F	Topsoil replaced and then converted to stormwater detention with no wetland.
8	M	U	No access provided to mitigation site despite repeated attempts. An entry for the purchase of 6 credits in documented in the RIBITS ledger for the bank. Status of mitigation could not be verified.
9	M	S	Straightforward impacts and mitigation. Easy to trace.
10	M	PS	Mitigation site is far from impact site. Mitigation is in an area not threatened by development in the long term.
11	P	F-PS	Vegetation on mitigation site not consistent with a mature wetland.
12	P	F	Eroding very narrow wetland fringe. Not designed for long-term stability.
13	M	PS	Donation of an existing tract in a deep bottomland. No real off-setting of wetland fill at impact site.

The compensatory mitigation sites examined contained both permittee-responsible mitigation as well as mitigation banks. The USACE accepts that mitigation banks are more successful than permittee-responsible mitigation; our analysis bears this out. If we consider sites identified as PS and S in Table 5 as successes, then four out of five (80%) mitigation bank projects that we looked at were successful. Conversely, only three out of eight (38%) permittee-responsible mitigation were identified as being partially or completely successful. None of the mitigation bank projects were total or near total failures (F or F-PS), but five out of eight (63%) of the permittee-responsible mitigation sites were total or near total failures. See *Figure 5* below.

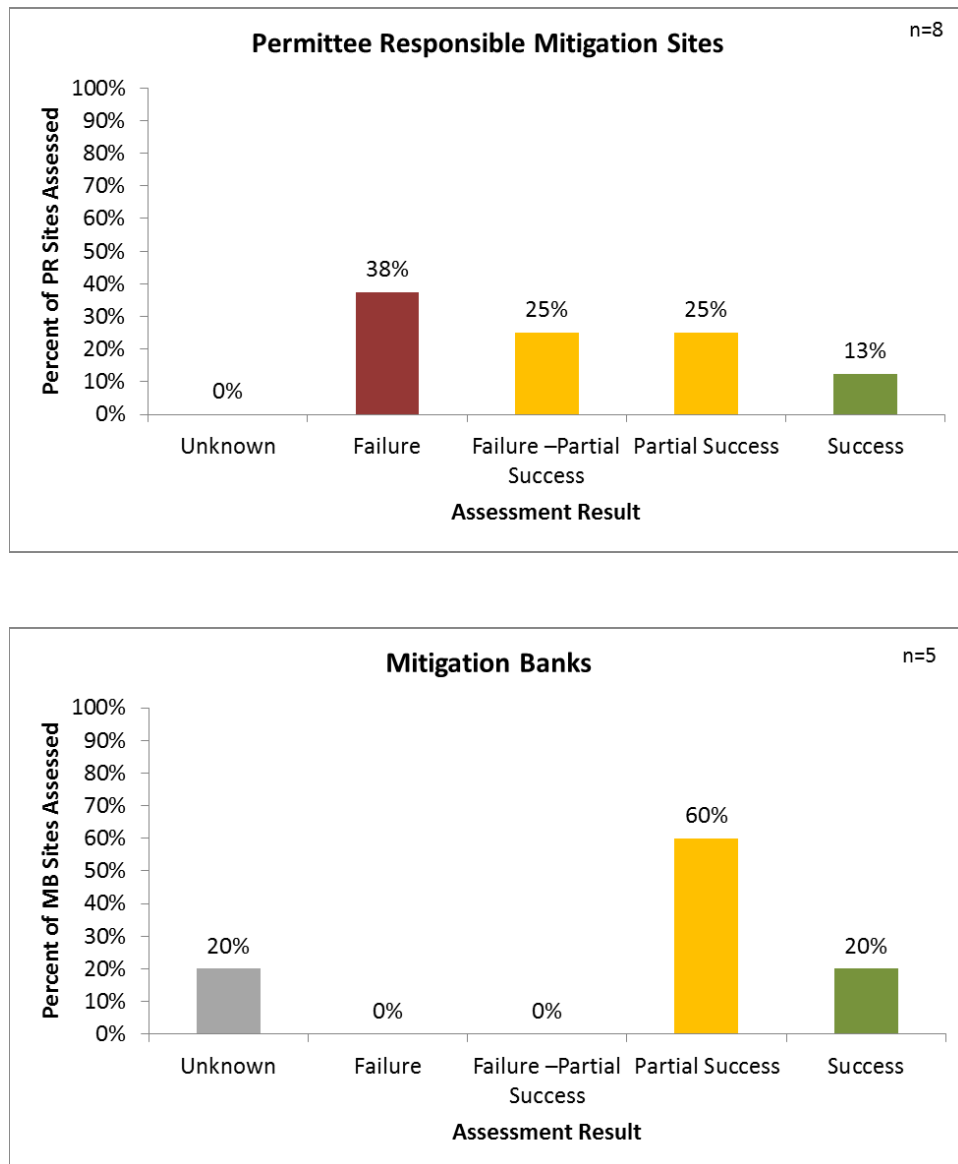


Figure 5. Assessment results of the ground-truth wetland mitigation assessment for permittee responsible compensatory mitigation sites and mitigation banks.

One disturbing outcome for the mitigation banks was the number of projects where no access was given. The table shows one project under the mitigation banks in this category. There were actually two projects (or 40%) where access could not be obtained, but on one of these we could see utilize aerial photography to determine that the site could be a partial success. The number is disturbing because while these projects are located on private property, the work is done for the public good and these areas should therefore be subject to some transparency and public inspection.

The two fully successful projects that were examined—one a permittee-responsible mitigation and the other a mitigation bank—both involved government agency participation. One permit mitigated wetland fill on private property, but the compensatory mitigation was carried out by U.S. Department of Agriculture (USDA) employees on submerged lands managed by the State of Texas. The successful mitigation bank project was carried out by the Harris County Flood Control District (HCFCD) at their Greens Bayou Mitigation Bank in northeast Harris County.

An important issue associated with mitigation banks is that relatively small areas of wetland mitigation are concentrated in large service areas (the geographic area within which permitted impacts can be compensated in an associated mitigation bank). This results in the mitigation of smaller areas compared to area of the location where the wetland impacts originally occurred. Additionally, the size of service areas can be so large that wetland impacts are mitigated outside of the subwatershed (i.e., HUC 12) where the impact originally occurred. Wetland loss is mitigated because wetlands are part of the aquatic ecosystem. Maintenance of water quality and other ecosystem services is dependent on wetlands being widely distributed across regional watersheds (and subwatersheds). Concentration of wetlands into very small areas greatly reduces the role wetlands can play in maintaining the aquatic integrity of our bays and bayous and associated ecosystem services.

The main conclusion to be drawn from this work is that the Clean Water Act compensatory mitigation system in place for ensuring the aquatic integrity of our waterways does not appear to be consistently replacing lost values and functions of the wetlands that are impacted by development.

ONLINE GEOSPATIAL TOOL

Under the prior grant, GTRI/HARC designed an online mapping application to facilitate watershed-based decision making. The application was well-received, but required updating to better serve the target audience of county and municipal planners and other associated local

government stakeholders involved in making local permitting decisions for new development in the region.

More than 200 surveys were sent out to regional stakeholders and comments were analyzed and improvements made. The mapping application was updated and redesigned to improve the user experience. The Galveston Bay Watershed and Wetland Permit Planning Tool can be accessed at https://gis1.harcresearch.org/wetland_tool_wab/.

As seen in *Figure 6*, potential development project sites in the Houston-Galveston region can be:

- 1) Searched by address,
- 2) Drawn in using a computer mouse, or
- 3) Uploaded as a shape file; locations can now be bookmarked and background maps can be changed.

A variety of map elements can be drawn and edited, including boundaries and color. The location of the project boundary can be compared to available information describing existing wetlands, stream water quality and impervious surface at the watershed scale (*Figure 7* and *Figure 8*).

GTRI/HARC updated the *Galveston Bay Watershed and Wetland Permit Planning Tool* to better serve coastal wetland data and other watershed-based information to stakeholders. We began by surveying stakeholders about their familiarity with the original tool, its ease of use and any additional information that would be desirable in the revamped tool. We then added the updated ORM II dataset along with new data layers and enhanced the interface to be more user-friendly. A webinar was hosted on June 13, 2017 and the recorded webinar is accessible on the HARC [website](#) (also via Vimeo: <https://vimeo.com/217865905>).

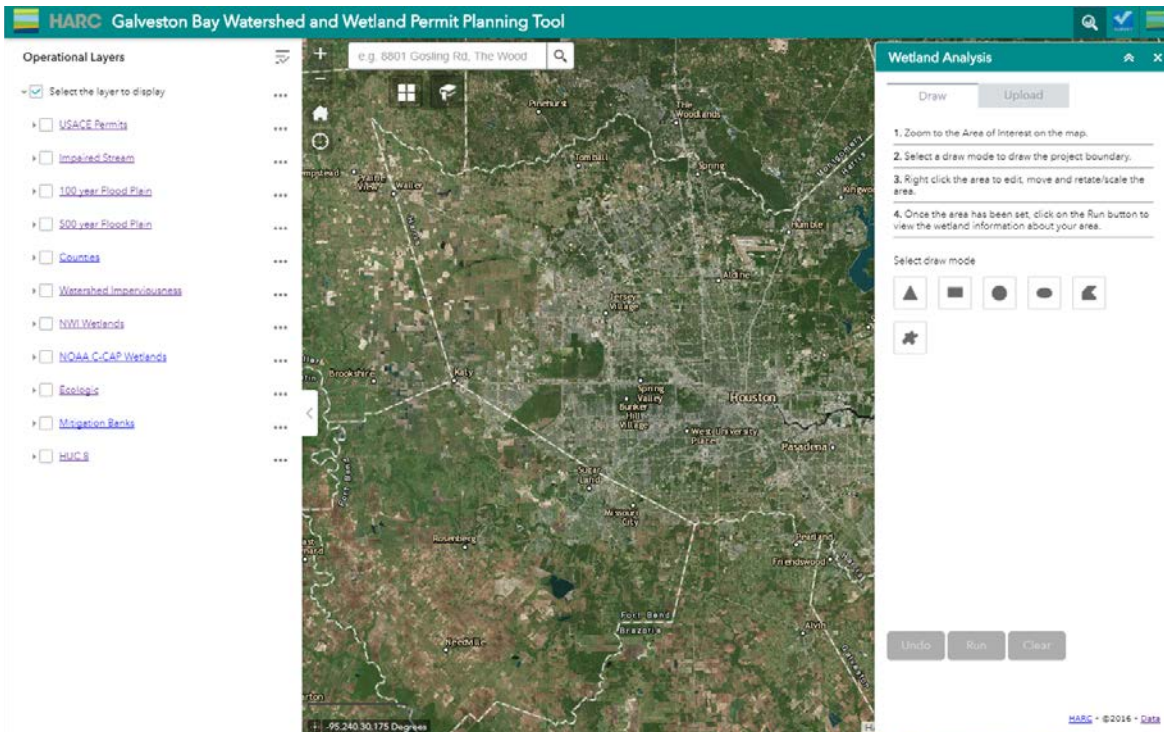


Figure 6. Screenshot of Galveston Bay Watershed and Wetland Permit Planning Tool and input interface.

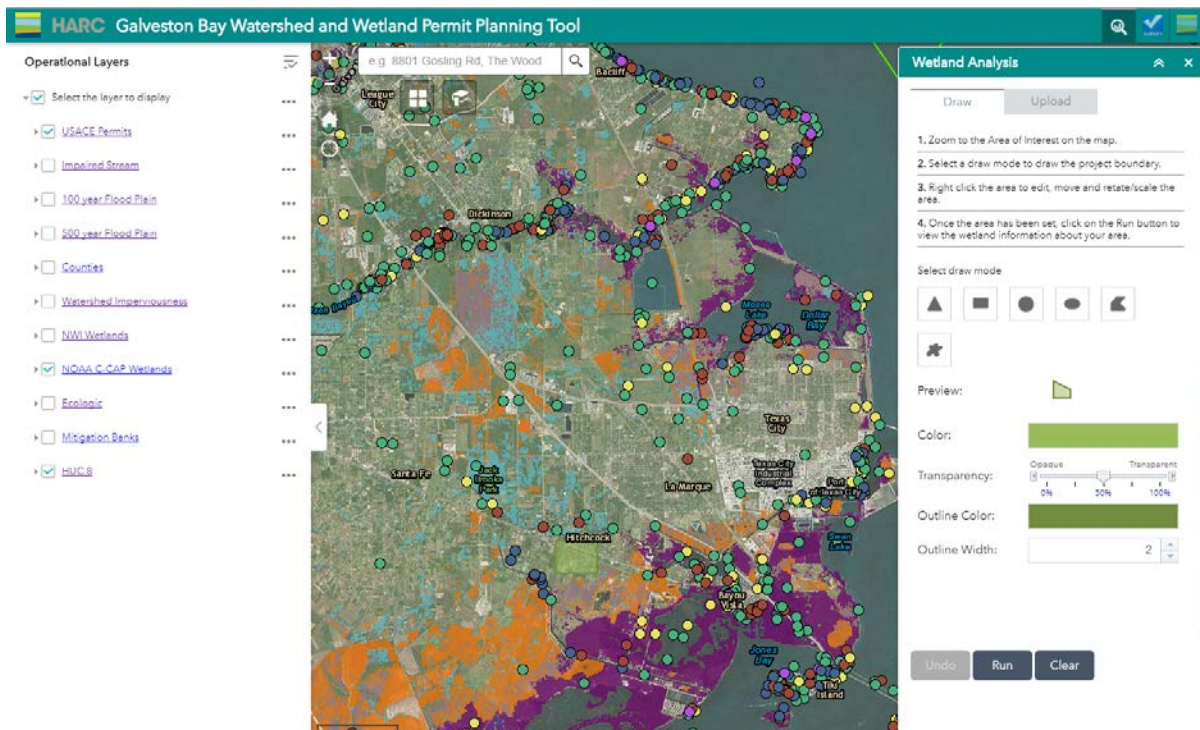


Figure 7. Screenshot of Galveston Bay Watershed and Wetland Permit Planning Tool showing available map layers (left) and updated analysis window (right).

The analysis box displays results (Figure 8) that alert users to the estimated acreage of the project and the existence of any CWA 404 wetland permits. The tool also calculates acreage of wetlands impacted based on the NOAA (2010) Coastal Change and Analysis Program (C-CAP) dataset as well as wetland type per the National Wetland Inventory (NWI) habitat classification. Location in relation to the 100-year floodplain (2009), associated Clean Water Act 303(d) impaired streams and mitigation bank service areas that overlap with the project are also shown. The tool also provides the percent impervious surface coverage within the watershed and notifies the user of potential impacts on surface water quality: <10% - minimally impacted; 10-30% - impacted; 30% imperviousness - degraded (Schueler 1992; Arnold Jr. and Gibbons 1996). The results can be exported as a shapefile and as a .csv file for import into analysis programs such as Excel.

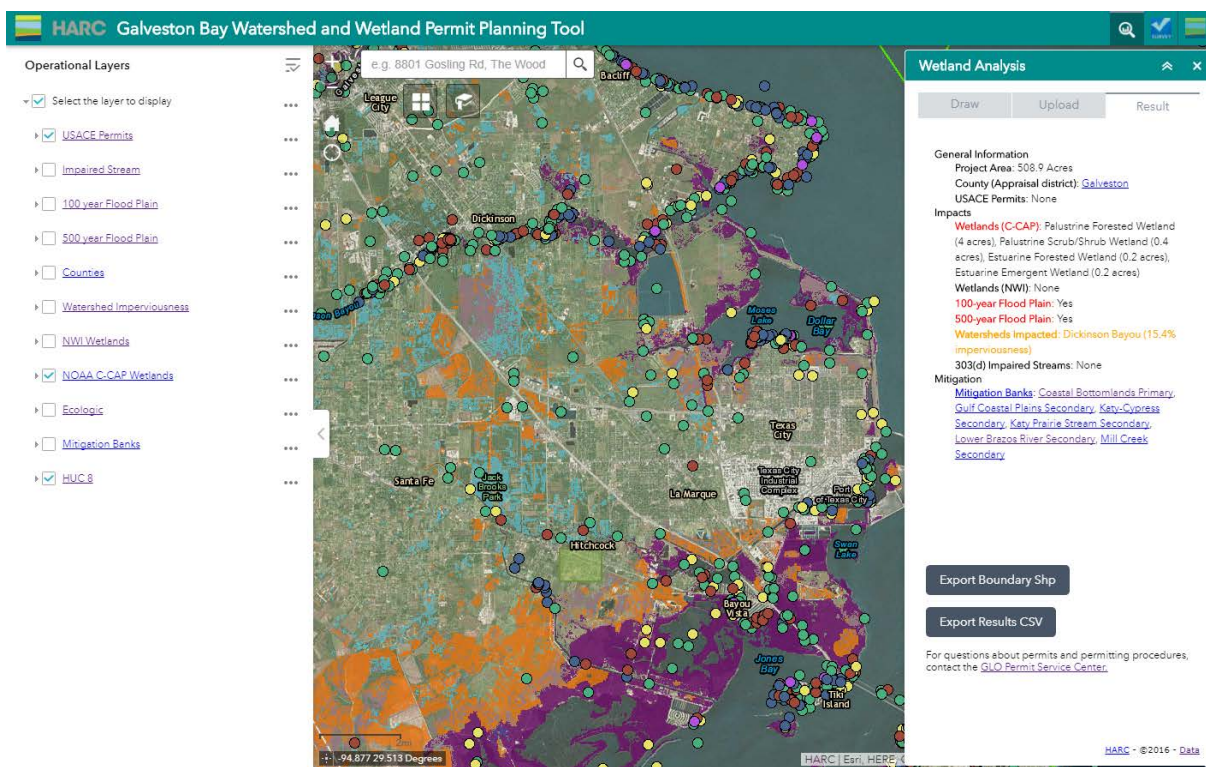


Figure 8. Screenshot showing calculations based on polygon drawn in Figure 6.

GTRI/HARC’s previous analysis of county government permitting processes in the 8-county region resulted in a determination that four counties in the region give some consideration of development impacts to wetlands in their permitting processes. Additionally, local land use permitting occurs at the municipal level in incorporated areas. With more than 118 municipalities in the 8-county region, each with different technological capabilities and regulatory requirements, we hope that the geospatial tool will help bridge the gap that exists

between the federal wetland permitting process and local land use decisions. With the improved tool and webinar explaining its use, municipality and county governments may be better situated to make decisions about the protection of wetland ecosystem services on a watershed level.

ECOSYSTEM SERVICES

Natural habitats such as freshwater wetlands not only provide value in the form of supporting ecological diversity and abundant fish and wildlife populations, freshwater wetlands also provide real value to the human populations that live around them. Ecosystem services (ESS) are benefits that humans derive from nature in the form of provisioning of goods such as food and fiber, regulating services such as the nutrient cycling and the maintenance of water quality, supporting services such as food resources for wildlife populations and cultural benefits that include aesthetic and spiritual benefits. The physical loss of wetland habitat and wetland function translates into a loss of ecosystem services for society.

Using the USEPA’s FEGS-CS, GTRI/HARC sought to map the provision of ESS in the Houston-Galveston region. While FEGS-CS do not supply that level of geospatial detail, the dataset does provide a detailed data framework for aligning freshwater wetland habitats with the beneficiaries and type of ESS. According the FEG-CS, seven groups of 24 types of beneficiaries benefit from ecosystem services provided by wetland habitats (*Table 6*).

Table 6. Beneficiaries of ecosystem services associated with wetland habitats. Source: FEGS-CS (USEPA, 2013).

Agricultural	Learning
Aquaculturists	Educators and Students
Farmers	Researchers
Irrigators	Recreational
Livestock Grazers	Anglers
Commercial / Industrial	Boaters
Food Extractors	Experiencers and Viewers
Fur / Hide Trappers and Hunters	Food Pickers and Gatherers
Industrial Dischargers	Hunters
Resource-Dependent Businesses	Waders, Swimmers and Divers
Timber, Fiber and Ornamental Extractors	Subsistence
Government, Municipal and Residential	Food Subsisters
Military	Timber, Fiber and Fur / Hide Subsisters
Residential Property Owners	Inspirational
Waste Water Treatment Plant Operators	Artists
	Spiritual and Ceremonial Participants and Participants of Celebrations

Table 7. Ecosystem services associated with wetland habitats. Source: FECS-CS (USEPA, 2013).

Agricultural
Water quality provided by the environment for cultivating aquatic organisms
Non-cultivated vegetation for livestock consumption
Opportunity provided by the environment for cultivating aquatic organisms
Suitable conditions (i.e., land) in which to grow annual or perennial crops or livestock
Water for growing and maintaining crops
Water suitable for livestock consumption
Wild pest predators that provide opportunity to grow crops
Wild pollinators that provide opportunity to grow annual or perennial crops
Commercial / Industrial
Edible organisms (i.e., birds, mammals, reptiles, flowers, plants, etc.) for commercial use or sale
Non-cultivated fiber for commercial use or sale
Non-cultivated ornamental products or by-products used ornamentally for commercial use or sale
Non-cultivated timber (i.e., trees) for commercial use or sale
Opportunity for placement of infrastructure and reduced risk of flooding and erosion
Opportunity to discharge into the environment
Water quality provided by the environment for commercial / industrial use
Organisms (i.e., mammals and reptiles) that provide fur or hides for commercial use or sale
Government, Municipal and Residential
Medium for discharging [treated municipal wastewater] into the environment
Water quality provided by the environment for municipal use
Opportunity for placement of infrastructure and reduced risk of flooding and erosion
Suitable conditions for training activities
Learning
Opportunities to understand, communicate and educate
Research opportunities
Recreational
Edible organisms (i.e., birds, mammals, reptiles, flowers, plants, etc.) picked or gathered for personal use
Fish in waterways for recreational capture
Landscape that provides a sensory experience
Medium and conditions for recreational boating
Opportunity and conditions for wading, swimming, and/or diving
Opportunity for recreational boating
Opportunity to view the environment and organisms within it
Organisms (i.e., birds, mammals, reptiles, etc.) that can be hunted
Organisms (i.e., birds, mammals, reptiles, flowers, plants etc.) that can be viewed
Sounds and scents that provide a sensory experience

Table 7 continued.

Subsistence
Edible organisms (i.e., birds, mammals, reptiles, etc.) that are hunted for personal use (i.e., not for sale)
Edible organisms (i.e., flowers, plants, etc.) or associated products that are gathered for personal use
Organisms (i.e., mammals and reptiles) that provide fur or hides used for clothing/warmth
Timber used for infrastructure, housing, roofing, and/or fuel for personal use
Inspirational
Landscape or natural materials that provides a sensory experience or can be directly used in art
Opportunity and conditions for spiritual and ceremonial practices and celebrations

For the same seven categories of ecosystem services user groups, 37 specific ecosystem services are associated with the existence of functioning wetland habitats (*Table 7*). While it is difficult to assign a monetary value to ecosystem services provided by wetlands, we know that residential, agricultural and commercial fresh water supplies, flood risk reduction, along with recreational activities are worth many millions to the regional economy. Based on the FEG-CS, one can easily see that all aspects of society in the Houston-Galveston region benefit from functioning wetlands. As such, this green infrastructure has value as natural capital and can be deployed as a technological solution for services such as flood risk reduction and water treatment alongside gray infrastructure (January-Beyers et al., 2016)

CONCLUSIONS

The population of the Houston-Galveston region is expanding at a rate of about 100,000 people per year and expects to have a population nearing 9 million people by the year 2040. In the 8-county region (the Lower Galveston Bay watershed), the majority of land use development falls outside of federal CWA jurisdiction and the inevitable resultant freshwater wetland loss is therefore often uncounted and unmitigated. Impacts and mitigation that do fall within the federal jurisdiction of the Clean Water Act and USACE are difficult to track and nearly impossible to assess in terms of wetland functions without on-site access and diligent assessment of vegetation, hydrology and soil conditions. In this study, thirty-five percent of full permit records analyzed were found to be non-compliant (a 65% compliance rate), and mitigated wetland acres recorded on the permits did approximately equal the permitted wetland impacts. For this subset of permits, it would seem that no-net-loss was achieved in theory. The actual conditions of those wetlands, however, are impossible to discern from the paper (or digital) permit record.

For this reason, on-the-ground inspections of mitigated freshwater wetlands in our region are essential if we are to determine whether mitigated wetland function maintains the ecological integrity of our waterways, wetland habitats and associated ecosystem services. Our team's review of mitigation metrics yielded a comprehensive list of indicators of wetland condition, but that level of site assessment takes time and considerable expertise to execute. Considering the difficult and time-consuming work that on-the-ground inspections require, we are not surprised that more compensatory mitigation projects required by CWA 404 wetland permits are not inspected. Unfortunately, it is the local watersheds and human beneficiaries that will suffer from the loss of ecosystem services as a result of non-compliant permits, unmitigated impacts and net functional wetland losses.

The most successful compensatory wetland mitigations occur at mitigation banks, but by concentrating these higher quality wetlands, our region has left large areas underserved by wetland ecosystem services. We conclude that the Clean Water Act compensatory mitigation system does not appear to be able to ensure the aquatic integrity of our waterways via fully-functional wetlands. Functional wetland loss is continuing across the region, even with the federal goal of no-net-loss.

Functional loss of jurisdictional wetlands and non-jurisdictional wetlands impacts numerous ecosystem services, including regional water quality and the ability to store and slowly release stormwater under the current regulatory system as it implemented in the Houston-Galveston region. Surveys and interest in our regional decision support tool demonstrate a desire on the part of local planners, developers and citizens to know more about the federal wetland permit process and impacts to freshwater wetlands.

Greater protection for jurisdictional wetlands and the ecosystem services they provide will require additional resources for the assessment of compensatory mitigation at the federal level. Greater protection for nonjurisdictional wetlands will require resolve on the part of local governments to avoid wetland impacts associated with development and the provision of additional resources to ensure that local decision makers have the necessary information to make those determinations. Only the future can tell whether resources will be brought to bear for greater protections for our regional freshwater wetlands.

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Appendix A. Bibliography of Mitigation Metrics

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Appendix B. Full Permits Requested from USACE via FOIA

FOIA	Date Requested	Date Received	permit AKA	DA_NUMBER	ACTION_TYPE
B	6/20/2016	7/29/2016	16747	SWG199101859	SP
B	6/20/2016	7/29/2016	19803	SWG199300525	SP
B	6/20/2016	7/29/2016	20314	SWG199500655	NWP
C	8/11/2016	9/27/2016	1.48E+09	SWG199702926	NWP
C	8/11/2016	9/27/2016	18770	SWG199802493	SP
C	8/11/2016	9/27/2016	22406	SWG200100844	NWP
C	8/11/2016	9/27/2016	23966	SWG200302731	SP
D	9/29/2016	10/13/2016	24259	SWG200302773	SP
D	9/29/2016	10/13/2016	23934	SWG200501402	SP
D	9/29/2016	10/13/2016	18427	SWG200600484	NWP
D	9/29/2016	10/13/2016	NA	SWG200601098	NWP
E	10/14/2016	11/7/2016	24384	SWG200601851	SP
E	10/14/2016	11/7/2016	24389	SWG200601888	SP
E	10/14/2016	11/7/2016	NA	SWG200602574	NWP
E	10/14/2016	11/7/2016	NA	SWG200700768	SP
F	11/8/2016	12/1/2016		SWG200700849	SP
F	11/8/2016	12/1/2016	NA	SWG200700913	SP
F	11/8/2016	12/1/2016	NA	SWG200700990	SP
F	11/8/2016	12/1/2016		SWG200701025	SP
G	12/1/2016	12/15/2016		SWG200701447	SP
G	12/1/2016	12/15/2016		SWG200701512RC	SP
G	12/1/2016	12/15/2016		SWG200701814	SP
G	12/1/2016	12/15/2016		SWG200701892	SP
H	12/16/2016	1/11/2016		SWG200701955RN	NWP
H	12/16/2016	1/11/2016		SWG200701989	NWP
H	12/16/2016	1/11/2016		SWG200800019RC	SP
H	12/16/2016	1/11/2016		SWG200800103	NWP

Appendix C. Summaries of Full Permits

Below is a one-page list for each permit detailing actions and mitigation, including acres of impacts and mitigation and compliance.

DA Number	SWG-1991-01859	
# of Actions	5	
Type of Action(s)	Amendment, Time extension	
Date Originally Issued	7/27/1983	
Permit County	Galveston	
Date of Most Current Modification	9/15/1987	
Permanent Wetland Impacts	0.06	acres
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	Not Required	acres
Type of wetlands impacted		
Type of Mitigation		bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?		
Mitigation is successful and finished based on the administrative record?		
Any Inspections?		
In Compliance/Reason	Yes	Yes/No

DA Number	SWG-1993-00525		
# of Actions			
Type of Action(s)			
Date Originally Issued	9/10/1993		
Permit County	Galveston		
Date of Most Current Modification	4/28/2014		
Permanent Wetland Impacts	1.837		acres
Permanent Other Impacts	None		Unit
Jurisdictional vs non-jurisdictional impacts			
Compensatory Mitigation Amount			acres
Type of wetlands impacted			
Type of Mitigation	PR		bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?			
Mitigation is successful and finished based on the administrative record?			
Any Inspections?	Yes		
In Compliance/Reason	Yes		Yes/No

DA Number	SWG-1995-00655	
# of Actions	3	
Type of Action(s)	Time extension, 2 amendments	
Date Originally Issued	9/12/1995	
Permit County	Harris	
Date of Most Current Modification	6/28/2000	
Permanent Wetland Impacts	None	acres
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	Not Required	acres
Type of wetlands impacted		
Type of Mitigation		bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	Not Required	
Any Inspections?	No	
In Compliance/Reason	Yes	Restoration project to convert 108 acres from shallow water to emergent marsh construction of temporary water-control levee and weir.

DA Number	SWG-1997-02926	
# of Actions		
Type of Action(s)		
Date Originally Issued	4/26/2010	
Permit County	Galveston	
Date of Most Current Modification		
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	None	acres
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	Not Required	acres
Type of wetlands impacted	None	
Type of Mitigation	None	Notes
Compensatory Mitigation Amount	None	credits
Type of Mitigation	None	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	Not Required	
Any Inspections?	No	
In Compliance/Reason	No	According to google earth the work was started or completed before permit was issued. No notice of project completion on file.

DA Number	SWG-1998-02493	
# of Actions	10	
Type of Action(s)	Amendments	
Date Originally Issued		
Permit County	Harris	
Date of Most Current Modification	7/1/2013	
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	None	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	Not Required	acres
Type of wetlands impacted		
Type of Mitigation	Not Required	Notes
Type of Mitigation	Not Required	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	Not Required	
Any Inspections?	No	
In Compliance/Reason	Yes	

DA Number	SWG-2001-00844	
# of Actions		
Type of Action(s)		
Date Originally Issued	10/21/2009_(first permit); 4/8/2011 (second permit)	
Permit County	Galveston	
Date of Most Current Modification	4/8/2011	
Temporary Wetland Impacts		Unit
Permanent Wetland Impacts	21.53	acres
Temporary Other Impacts		Unit
Permanent Other Impacts	6.69 open water	acres
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount		acres
Type of wetlands impacted		
Type of Mitigation	On site- PR	Notes
Compensatory Mitigation Amount		credits
Work appears to be completed based on the administrative record or latest Google Earth Imagery?		
Mitigation is successful and finished based on the administrative record?	No	
Any Inspections?	No	
In Compliance/Reason	No	No follow up in the admin record. No evidence that monitoring has been performed or that the required success criteria have been fulfilled. No evidence that a deed restriction was obtained. No evidence provided that indicates mitigation has been completed in the record

DA Number	SWG-2003-02731	
# of Actions		
Type of Action(s)		
Date Originally Issued	3/20/2010	
Permit County	Montgomery	
Date of Most Current Modification		
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	None	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	28.4	acres/riparian habitat
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	36.7	36.7 acres of riparian habitat to be restored or preserved. 8.3 acres is preservation and 28.4 acres is riparian habitat restoration
Type of wetlands impacted		
Type of Mitigation	On site	
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	No	
Any Inspections?	No	
In Compliance/Reason	No	No follow up included or any indication that the mitigation has been conducted. No monitoring reports are included nor has any information that would indicate the mitigation met the specific success criteria that is detailed in the permit.

DA Number	SWG-2003-02773	
# of Actions		
Type of Action(s)		
Date Originally Issued	3/18/2007	
Permit County	Montgomery	
Date of Most Current Modification		
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	3.798	acres/waters of the U.S, specifically wetlands
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	64	Preserve 64 acres in a conservation easement. 15.25 acres of wetlands and remaining upland communities.
Type of wetlands impacted		
Type of Mitigation	On site/ preservation	
Compensatory Mitigation Amount		credits
Work appears to be completed based on the administrative record or latest Google Earth Imagery?		
Mitigation is successful and finished based on the administrative record?	Yes	
Any Inspections?	Yes	
In Compliance/Reason	Yes	Deed transferred, conservation easement completed 5/5/2009

DA Number	SWG-2005-01402	
# of Actions		
Type of Action(s)		
Date Originally Issued	9/7/2005	
Permit County	Galveston	
Date of Most Current Modification	3/26/2012	
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	0.36	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	0.72	acres/dune swale wetlands
Type of wetlands impacted		
Type of Mitigation	On-site	Notes
Compensatory Mitigation Amount		credits
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	Yes	
Any Inspections?	No	
In Compliance/Reason	No	No notification of construction, no notice that the mitigation success criteria has been completed. No deed restriction in file.

DA Number	SWG-2006-00484	
# of Actions		
Type of Action(s)		
Date Originally Issued	11/2/2006	
Permit County	Harris	
Date of Most Current Modification	4/16/2013	
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	None	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	1.05	acres/JD waters
Jurisdictional vs non-jurisdictional impacts		
Type of wetlands impacted		
Type of Mitigation		Notes
Compensatory Mitigation Amount	Coastal Bottomland Mitigation Bank at a ratio of 2.86:1	credits
Type of Mitigation	Mitigation Bank	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	No	
Any Inspections?	Yes	
In Compliance/Reason	No	2) Purchase of credits was never able to be verified and project construction is documented in the file, no follow up after compliance inspection determined special conditions were not met

DA Number	SWG-2006-01098	
# of Actions		
Type of Action(s)		
Date Originally Issued	8/11/2006	
Permit County	Harris	
Date of Most Current Modification	4/30/2009	
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	None	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	Not Required	acres
Type of wetlands impacted	None	
Type of Mitigation	None	Notes
Compensatory Mitigation Amount	Not Required	credits
Type of Mitigation	None	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	None	
Any Inspections?	No	
In Compliance/Reason	Yes	

DA Number	SWG-2006-01851	
# of Actions		
Type of Action(s)		
Date Originally Issued	2/16/2009	
Permit County	Harris	
Date of Most Current Modification		
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	None	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	Not Required	acres
Type of wetlands impacted	None	
Type of Mitigation	None	Notes
Compensatory Mitigation Amount	None	credits
Type of Mitigation	None	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Partial not completed	
Mitigation is successful and finished based on the administrative record?	Not Required	
Any Inspections?	No	
In Compliance/Reason	Yes	

DA Number	SWG200601888	
# of Actions	4	
Type of Action(s)	Amendments and time extensions	
Date Originally Issued	12/17/2007	
Permit County	Galveston	
Date of Most Current Modification	10/28/2011	
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	1.57	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	13.9	Preserve 11.5 acres of tidally influenced wetlands with a deed restriction; create 2.4 acres of additional high marsh wetlands.
Type of wetlands impacted		
Compensatory Mitigation Amount		credits
Type of Mitigation	permittee responsible	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Work has been started not completed	
Mitigation is successful and finished based on the administrative record?	No	
Any Inspections?	No	
In Compliance/Reason	No	No deed restriction on file, no evidence of follow up or mitigation monitoring

DA Number	SWG-2006-02574	
# of Actions		
Type of Action(s)		
Date Originally Issued	2/12/2007	
Permit County	Brazoria	
Date of Most Current Modification		
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	None	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	Not required	acres
Type of wetlands impacted	None	
Type of Mitigation	Not required	Notes
Compensatory Mitigation Amount	Not required	credits
Type of Mitigation	Not required	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	Not required	
Any Inspections?	No	
In Compliance/Reason	Yes	Yes/No

DA Number	SWG-2007-00768	
# of Actions	1	
Type of Action(s)	Permit extension	
Date Originally Issued	3/11/2008	
Permit County	Brazoria	
Date of Most Current Modification	10/8/2013	
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	None	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	None	acres
Type of wetlands impacted	None	
Type of Mitigation	Not Required	Notes
Compensatory Mitigation Amount	Not Required	credits
Type of Mitigation	Not Required	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?		
Mitigation is successful and finished based on the administrative record?	Not Required	
Any Inspections?	Yes	
In Compliance/Reason	Permit withdrawn due to no activity.	Yes/No

DA Number	SWG-2007-00849	
# of Actions		
Type of Action(s)		
Date Originally Issued		Applied for after the fact permit 4/25/2007
Permit County	Fort Bend	
Date of Most Current Modification		
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	1.6	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	7.58	acres
Type of wetlands impacted		
Compensatory Mitigation Amount		credits
Type of Mitigation	On-site	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?		
Mitigation is successful and finished based on the administrative record?	Wetland ponds were constructed but no follow up on plantings or the success of the plantings. Don't see the permit itself actually being issued in the file. Cannot find a final permit date.	
Any Inspections?	No	
In Compliance/Reason	No	No, follow up on success criteria and monitoring.

DA Number	SWG-2007-00913	
# of Actions		
Type of Action(s)		
Date Originally Issued	10/21/2014	
Permit County	Fort Bend	
Date of Most Current Modification	6/10/2014	
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	2	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	34.43	acres of jurisdictional areas
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	69.38	acres
Type of wetlands impacted	Freshwater mostly forested wetlands	
Type of Mitigation	On site	Construction of 31.38 acres of mostly forested mitigation nearby and planted with 600 or more trees up to 1 inch in diameter. Small part of mitigation will be emergent marsh habitat. 38 acres of Big Creek stream bottom jurisdictional area will be mitigated by construction of 38 acres of new stream bottom in the same location.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?		
Mitigation is successful and finished based on the administrative record?	No follow up	
Any Inspections?	No	

In Compliance/Reason	Yes	Mitigation appears to have been completed but no follow up was conducted
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DA Number	SWG-2007-00990	
# of Actions		
Type of Action(s)		
Date Originally Issued	3/31/2015	
Permit County	Fort Bend	
Date of Most Current Modification	3/31/2015	
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	0.8	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	1	acres
Type of wetlands impacted	Jurisdictional	
Type of Mitigation	on site	Enhancing a 1 acre low quality herbaceous wetland through the planting of various tree species; 2:1 mitigation ratio.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	No	
Any Inspections?	No	
In Compliance/Reason	No	No evidence of monitoring requirements having been met. No documentation in the file stating that the mitigation has been completed or that the success criteria have been reached. No follow up.

DA Number	SWG-2007-01025	
# of Actions	4	
Type of Action(s)	amendments	
Date Originally Issued	11/23/1984	
Permit County	Galveston	
Date of Most Current Modification	2/26/2015	
Temporary Wetland Impacts	None	Unit
Permanent Wetland Impacts	None	acres
Temporary Other Impacts	None	Unit
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount		acres
Type of wetlands impacted		
Compensatory Mitigation Amount		credits
Type of Mitigation	none	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Not discernable	
Mitigation is successful and finished based on the administrative record?	Not Required	
Any Inspections?	No	
In Compliance/Reason	Yes	

DA Number	SWG-20070-1447	
# of Actions		
Type of Action(s)		
Date Originally Issued	6/30/2009	
Permit County	Galveston	
Date of Most Current Modification		
Permanent Wetland Impacts	4.5	acres
Permanent Other Impacts		Unit
Jurisdictional vs non-jurisdictional impacts	4.5	Jurisdictional
Compensatory Mitigation Amount		acres
Type of wetlands impacted		
Type of Mitigation	Creation	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	No	
Any Inspections?	Yes	On 2/16/2010 client claimed project not built and unsure when project will be started.

In Compliance/Reason	No	<p>A further compliance inspection was conducted and it was determined that the permit is not in compliance because the permittee did not construct the drilling pad, access road or production facility as stated in the authorized plans. Unauthorized configuration. This ended up causing additional impacts to 3.07 acres of wetlands for a total of 4.5. No record stating that construction had started. Mitigation construction not complete within 18 months. Monitoring and maintenance not conducted as stated. Determined by the core to be out of compliance.</p>
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DA Number	SWG-2007-01512RC	
# of Actions		
Type of Action(s)		
Date Originally Issued		
Permit County	Harris	
Date of Most Current Modification		
Permanent Wetland Impacts	1.429	acres
Permanent Other Impacts	1.659	acres/ Jurisdictional waters total
Jurisdictional vs non-jurisdictional impacts	0.23	jurisdictional waters
Compensatory Mitigation Amount		acres
Type of wetlands impacted		
Type of Mitigation	Mitigation Bank	Greens Bayou
Work appears to be completed based on the administrative record or latest Google Earth Imagery?		
Mitigation is successful and finished based on the administrative record?	Yes	credits
Any Inspections?	No	
In Compliance/Reason	Yes	Confirmed that 0.699 of credits were purchased.

DA Number	SWG-2007-01814	
# of Actions		
Type of Action(s)		
Date Originally Issued	Denied	
Permit County		
Date of Most Current Modification		
Permanent Wetland Impacts		acres
Permanent Other Impacts		Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount		acres
Type of wetlands impacted		
Type of Mitigation		bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?		
Mitigation is successful and finished based on the administrative record?		
Any Inspections?		
In Compliance/Reason	Permit Denied	Farming fish for consumption. Permit was denied by the core and blocked by TPWD because they would not allow inshore aquaculture. Permit withdrawn: 6/1/2009.

DA Number	SWG-2007-01892	
# of Actions		
Type of Action(s)		
Date Originally Issued	8/10/2009	
Permit County	Galveston	
Date of Most Current Modification		
Permanent Wetland Impacts	1.42	acres
Temporary Wetland Impacts	1.73	acres
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	5.56	acres
Type of wetlands impacted	Jurisdictional wetlands/high saltmarsh	
Type of Mitigation		1.44 acres of wetlands created on-site and GBF paid to create 4.12 acres as off-site, permittee responsible mitigation in pierce marsh
Work appears to be completed based on the administrative record or latest Google Earth Imagery?		
Mitigation is successful and finished based on the administrative record?	Yes	GBF conformed that mitigation was performed as required. On-site mitigation also confirmed as completed.
Any Inspections?	No	
In Compliance/Reason	Yes	appears to have met requirements

DA Number	SWG-2007-01955RN	
# of Actions		
Type of Action(s)		
Date Originally Issued	7/8/2010	
Permit County	Harris	
Date of Most Current Modification		
Permanent Wetland Impacts	0.156	acres
Permanent Other Impacts	0.25	acres jurisdictional waters
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	0.16	credits
Type of wetlands impacted		
Type of Mitigation	Greens Bayou Mitigation Bank	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	No	Harris County will mitigate by purchasing credits from Greens Bayou mitigation bank. Purchase of 0.095 credits from the GB bank prior to start of construction.
Any Inspections?	No	
In Compliance/Reason	No	Permittee to submit verification prior to the start of construction. NO verification of credits being purchased in file. No follow up after determination was made.

DA Number	SWG-2007-01989	
# of Actions		
Type of Action(s)		
Date Originally Issued	4/3/2008	
Permit County	Ft. Bend	
Date of Most Current Modification		
Permanent Wetland Impacts	0.022	Concrete splash pad and pipe placement are shown to impact less than 0.02 acres of JD waters and 0.002 acres of JD wetlands.
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	Not required	acres
Type of wetlands impacted		
Type of Mitigation	Not required	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	Not required	
Any Inspections?	No	
In Compliance/Reason	Yes	Yes/No

DA Number	SWG-2008-00019RC	after the fact permit
# of Actions		
Type of Action(s)		
Date Originally Issued	11/15/2011	
Permit County	Galveston	
Date of Most Current Modification		
Permanent Wetland Impacts	None	acres
Permanent Other Impacts	None	Unit
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	Not Required	acres
Type of wetlands impacted		
Type of Mitigation	Not Required	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?	Yes	
Mitigation is successful and finished based on the administrative record?	Not Required	
Any Inspections?	No	
In Compliance/Reason	Yes	Yes/No

DA Number	SWG-2008-00103	
# of Actions		
Type of Action(s)		
Date Originally Issued	3/11/2008	
Permit County	Harris	
Date of Most Current Modification		
Permanent Wetland Impacts	None	acres
Permanent Other Impacts		Place 18 cubic yards of fill into Armand Bayou to construct the proposed outfall structure. Construction of one outfall structure and concrete slope paving into 0.022 acres of JD waters.
Jurisdictional vs non-jurisdictional impacts		
Compensatory Mitigation Amount	Not Required	acres
Type of wetlands impacted		
Type of Mitigation	Not Required	bank, permittee responsible, etc.
Work appears to be completed based on the administrative record or latest Google Earth Imagery?		
Mitigation is successful and finished based on the administrative record?	Not Required	
Any Inspections?	No	
In Compliance/Reason	Yes	Yes/No