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Re: Department of the Army Individual Permit Application (SWG-2018-00560)
Proposed Permittee Responsible Mitigation Plan Summary
Port of Houston Authority
Houston 4 Project
Harris County, Texas

RES is providing the enclosed information regarding the proposed compensatory mitigation associated with U.S. Army Corps of Engineers (USACE) Individual Permit Application submitted for the proposed Houston 4 Project (Project), located in Harris County, Texas. This information provided herein has been assembled to aid the USACE in the continued processing of the submitted permit application and to provide an overview of the Permittee Responsible Mitigation (PRM) Plan currently being developed to provide compensatory mitigation for impacts to waters of the U.S. (WOUS) as a result of the construction of the proposed Project. A detailed mitigation plan will be submitted separate of this summary. Assessment of the proposed impacts to WOUS, including wetlands as a result of the proposed project is based on the results of an Approved Jurisdictional Determination (AJD) conducted for the Project Site by the USACE (SWG-2018-00043).

ABBREVIATED MITIGATION PLAN SUMMARY

The implementation of the PRM Plan summarized herein will compensate for the functional capacities lost from these unavoidable impacts to WOUS, including wetlands. The following sections provide details related to the Project site history, stream mitigation, wetland mitigation, and replacement of their ecological functions.

Impact Site History

The impact site is located near the confluence of Greens Bayou and Buffalo Bayou, both exhibit tidal influence. Geologically, the site is predominately located on the Beaumont Formation but the southwestern portion of both the impact site and Bulk Material Handling properties are located on Holocene alluvium deposition. Due to this geology, the site has fairly high topographic relief along this gradient with an approximately 10 to 16-foot slope from Pleistocene terraces to Holocene alluvium. Typical elevations in the northern portion of the Project are between 20-26 feet above sea level while the southern portion is only 5-6 feet above sea level.

Based on an analysis of the 1919 Deepwater and 1920 Fauna Topographic maps, the site was largely forested and contained an extensive stream network draining Pleistocene terrace

flatwoods. It appears that the Holocene-deposited alluvium was largely emergent marsh and, based on 1944 aerial analysis, was likely a combination of salt flats and sparsely vegetated estuarine emergent marsh likely dominated by turtleweed (*Batis maritima*), Virginia glasswort (*Salicornia depressa*), wolfberry (*Lycium caroliniana*), and sea oxeye daisy (*Borrichia frutescens*).

The 1944 aerial analysis also revealed the site had been recently logged due to a paucity of trees and visible logging roads. The construction of the east-west railroad that now divides the property had initiated. There also appears to be internal roadways being constructed on the adjacent Bulk Material Holding property and that southern portions of the impact site property were being harvested for fill material for facility construction. By 1953, the entire Holocene alluvium portion of the site had been highly degraded by surficial disturbance, installation of drainage ditches, and fill material harvesting. Additionally, the southern portion of stream W-029/030 had been channelized and the confluence with Greens Bayou had been shifted southward. The construction of the now Port of Houston Authority (POHA) Greens Bayou facility was initiated. The portion of the property north of the railroad appears savannah-like on aerial imagery. Several of the site's wetlands can be seen by darker soil saturation/inundation signatures and streams W-015 and W-027/30 are visible.

The next available aerial image available is from 1978. North of the railroad track, the site is largely forested with minor patches of herbaceous vegetation. The Bulk Material Handling facility dock, rail infrastructure and loading facilities are being constructed and it appears that portions of the impact site adjacent to the facility are being utilized for fill material for construction. The access road also appears to be serving as a levee to pond water behind it. Buffalo Bayou has been widened significantly. In the 1989 aerial, there is further expansion of the Bulk Material Handling facility and the construction of two pipe yards on the southern portion of the impact site property adjacent to Buffalo Bayou. As the aerial imagery progress to current conditions, the most noticeable changes to the area include the additional expansion of bulk material storage (which currently is exporting coal), expansion of rail car storage, and the construction of another pipe yard adjacent to Penn City Road. The expanded bulk material storage area levee has resulted in the impounding of water to the north of this feature and has led to the creation of a large wetland mosaic characterized by Chinese tallow (*Triadica sebifera*) monocultures with pockets of open water and cattails (*Typha domengensis*) contingent on inundation depths.

STREAM MITIGATION AND REPLACED ECOLOGICAL FUNCTIONS

The USACE identified four streams within the Project area, including W-015, W-027/W-030, W-049, and W-056). Streams have five primary functions described below:

1. Hydrology- transport of water from the watershed to the channel. Parameters that are utilized to measure this function include precipitation/runoff relationship, channel forming discharge, flood frequency, and flow duration.
2. Hydraulic- transport of water in the channel, on the floodplain, and through sediments. Parameters that are utilized to measure this function include velocity, shear stress, stream power, bank height ratio, entrenchment ratio, rating curves, and groundwater/surface water exchange.
3. Geomorphology- transport of organics and sediment to create diverse bed forms and dynamic equilibrium. Parameters that are utilized to measure this function include sediment transport capacity, channel evolution, streambank erosion rates, percent riffle

and pool, depth variability, substrate distributions, large woody debris transport and storage, riparian vegetation density and composition.

4. Physiochemical- temperature and oxygen regulation, processing of organic matter and nutrients. Parameters that are utilized to measure this function include dissolved oxygen, temperature regulation, pH, conductivity, nutrient processing, organic processing, and turbidity.
5. Biology- biodiversity and the life histories of aquatic and riparian life. Parameters that are utilized to measure this function include primary and secondary production, macroinvertebrate communities, fish communities, riparian communities, and landscape pathways.

Existing W-015 Conditions

Stream W-015 on the northwestern portion of the Project site is relatively pristine, undisturbed, natural, ephemeral/intermittent channel that arises from the adjacent forested wetland W-012 and overland sheet and subsurficial flows from flatwoods. It is 1,752 feet long within the Project area. It exhibits moderate sinuosity with a confined valley. Downstream of the Project area, W0-15 confluences with W-027/30, where its flows are impeded by a culvert adjacent to Greens Bayou that greatly slows water transport frequency and results in localized ponding. Stream W-015 is mapped on the 1915 and 1920 topographic maps as a dotted blue line. It provides drainage for Pleistocene terrace forested areas southward toward active Holocene soils and floodway. Stream W-015 and adjacent Wetland W-012 are visible on the 1944 aerial imagery as an evident channel and darker signature due to soil saturation. As the site revegetated to current conditions, much of the area returned to likely historic Pleistocene terrace flatwoods conditions with canopies dominated by willow oak (*Quercus phellos*), water oak (*Q. nigra*), bottomland post oak (*Q. similis*), southern red oak (*Q. falcata*), loblolly pine (*Pinus taeda*), blackgum (*Nyssa sylvatica*), sugarberry (*Celtis laevigata*), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), American elm (*Ulmus americana*), cedar elm (*U. crassifolia*) and green ash (*Fraxinus pennslyvanica*).

W-015 forms at the confluence of three small ephemeral channels, with bankfull widths of 1-2 feet, and flows southward. The upper portion of the channel does not have a well-defined valley and receives ample overland sheet flows. The lower portion of the channel has a well-defined valley where the channel exhibits moderate sinuosity and active connection to an entrenched floodplain. Banks throughout are protected by a diverse riparian forested community and the entirety of the stream is shaded. In-stream habitat consists of undercut banks, root wads, plunge pools, point bars, and leaf packs.

Due to lack of anthropogenic modification and presence of forested riparian buffer, the upper extent of W-015 exhibits high primary stream functions within the Project area. From a hydrology and hydraulic standpoint, the stream effectively conveys water downstream and has active connection to a floodplain. Banks exhibit stability and channel is able to access its bankfull bench. From a geomorphological perspective, the channel is the result of overland flows from Pleistocene terrace flatwoods draining to a topographic low spot. W-015 exhibits the ability to export organic biomass downstream. Since W-015 is an ephemeral/intermittent channel, it does not have as much functionality from a physiochemical and biological perspective. Due to short duration of floodflows, very few aquatic macroinvertebrates are capable of utilizing the channel as a potential breeding location. The presence of a forested riparian buffer likely improves localized water quality by filtering overland flows and slowing rates of flood flows.

Proposed Conditions of W-015
Multiple project designs were evaluated to avoid impacts to W-015 to the maximum extent practicable. The proposed Project avoids impacts to approximately 1,666 feet of W-015 and existing forested buffers located within the Project area. Approximately 86 feet of the W-015 will be culverted at the downstream portion of the stream adjacent to existing culverts associated with a transmission line access road and rail infrastructure. Due to the existing culverts and the limited nature of this disturbance, no mitigation is proposed.

Existing W-027 and W-030 Conditions
W-027 and W-030 were mapped as two separate features on the original WOUS delineation but functions as a contiguous feature do to a connecting culvert under the railroad. They total 1,696 feet in length within the Project site. Based on 1915 topographic map, this feature and tributaries would have drained approximately 1.6 square miles, including the entirety of the north and central portions of the impact site. Subsequently, this feature east of Penn City Road has been channelized and now serves as conveyance for several industrial facilities and the Beltway 8 frontage road. The portion of W-027/30 within the Project area has been modified in sections due to pipeline and transmission line ROW construction/maintenance, culverted by railroad construction, and realigned during pipe yard construction. South of the Project area, the feature has been channelized and culverted underneath a railroad. Based on 2017 aerials, this culvert does not effectively drain this channel, and results in perennial pooling upstream, within the central portion of the Project site.

Stream W-027/30 is a natural channel highly impacted by previous anthropogenic impacts. While historically, the channel provided relatively rapid conveyance of water downstream to Buffalo Bayou, the channel now has several flow impedances. These include channelization upstream of the Project area, diversion of flow due to roadside ditches adjacent to Penn City Road, and culverts on transmission line and rail ROWs. Based on aerial photo interpretation, the largest impact that diminishes the ecological functionality of this channel are two culverts, one at a railroad crossing and the other adjacent to Greens Bayou, that greatly slow water transport frequency and result in localized ponding for long durations in these areas.

In analyzing Stream W-027/30 with respect to the five primary stream functions, all functions have been greatly reduced due to anthropogenic impact within the watershed, riparian buffer, and in-channel attributes. Hydrologically and hydraulically, the watershed was historically all flatwoods that slowly transported water to the channel. Currently, flood flows are rapidly directed to the channel affecting all parameters of hydrology and are further exacerbated due to the series of choke points at culverts. Due to conversion of adjacent land uses and channel alteration, there is a significant change in the channel's geomorphology. The historically stable channel likely conveyed large amounts of organics and sediments downstream. Currently, the channel has limited transport capacity and experiences long-term pooling of water in several reaches. From a physiochemical function, a large amount of the stream has lost its tree canopy resulting in lower dissolved oxygen and has more point and non-point pollution sources via stormwater runoff from industrial facilities and roadways. Biologically, the channel was likely an intermittent channel with occasional perennial pools. Currently, much of the channel has perennial or long-term pools due to conveyance impedance structures. During a brief inspection, the channel did not appear to support western mosquitofish (*Gambusia affinis*) and several species of pollution tolerant macroinvertebrates such as scuds, diving beetles, and true bugs were observed.

Proposed W-027/30 Conditions

Multiple project designs were evaluated to avoid impacts to W-027/30 to the maximum extent practicable. The proposed Project avoids impacts to approximately 1,635 feet of W-015 and existing buffers located within the Project area. Approximately 50 feet of W-027/30 will be culverted south of existing culverts associated with rail infrastructure. Due to the existing culverts and the limited nature of this disturbance, no mitigation is proposed.

Existing W-049 Conditions

W-049 is a 772-foot long vegetated ephemeral ditch that was constructed in 2010 to provide increased drainage for a ditch that parallels the rail car facility and road to the north of the impact site. This feature also drains wetlands W-046 and W-048. W-046 is also a vegetated ephemeral ditch that parallels a road to the north. W-048, W-050, W-047 are depression wetlands created by previous construction activities on clay fill material. All these features have been created by anthropogenic induced activities and due to high level of disturbance and fill clays are dominated by non-native and ruderal species. W-049 and W-046 exhibit minimal stream functions except for conveyance.

Proposed W-049 Conditions

Due to the anthropogenic origin of W-049 and W-046, the permittee, during Project construction, will re-establish these ditches in a slightly different location on-site to provide continued drainage of roadside ditches to Buffalo Bayou. The primary function of this channel is stormwater conveyance, and relocation of this channel on-site will provide effective mitigation to continue floodflows from adjacent infrastructure southward to Buffalo Bayou.

Existing W-056 Conditions

W-056 is 852 feet long within the Project area. It was mapped as a stream on the 1915 topographic map. Subsequently, the upstream portion of W-056 was bisected with the construction of Penn City Road prior to 1944 which likely included a culvert under the roadway. According to a review of aerial photographs and topographic maps, in 2014, the up-stream portion of this channel was diverted via a north/south ditch constructed on the east side of Penn City Road and all flow was diverted to Buffalo Bayou, skipping the portion of W-056 that is on the Project site. Due to this diversion, W-056 receives water from a much smaller watershed resulting in insignificant flow. Anthropogenic alterations to W-056, including straightening, deepening, and leveling out slope, have resulted in sustained periods of inundation of 12 to 18 inches and the channel becoming fully vegetated by both woody and herbaceous species including Mexican primrose-willow (*Ludwigia octovalvis*), taro (*Colocasia esculenta*), hairy cowpea (*Vigna lutea*), giant ragweed (*Ambrosia trifida*), Chinese tallow, green ash, and buttonbush (*Cephalanthus occidentalis*).

Proposed Compensation for W-056 Impacts

The anthropogenic manipulations to W-056 have resulted ecological functionality more like a linear wetland than a stream. The wetland functions associated with the approximate 0.13 acres of W-056 within the Project site will be replaced by compensatory wetland mitigation as described below.

WETLAND MITIGATION AND REPLACED ECOLOGICAL FUNCTIONS

During a conversation between Jayson Hudson of the U.S. Army Corps of Engineers (USACE), Garry McMahn (POHA), Michael Long (Contanda), Justin Wiedeman (Lloyd Engineering), Mr. Hudson indicated that utilization of the SWG Riverine Hydrogeomorphic (HGMi) assessments

were inappropriate for site wetlands due to adjacency to tidally-influenced receiving waters (i.e. Greens and Buffalo Bayou below tidal). "The Riverine HGMi models are limited to the use of estimated potential impacts to wetlands that are located along floodplains and/or floodways located along riparian corridors. These wetlands share a surface hydrology connection with the waters of the riverine system at least for a portion of the time" (USACE SWG 2008). Due to the unique situation of these wetlands, Mr. Hudson suggested proposing an ecologically justified approach for offsetting unavoidable Project wetland impacts that does not use the HGMi. Therefore, the permittee will utilize an acre-for-acre, function-for-function replacement to offset unavoidable Project impacts to wetlands.

Existing Wetlands at the Project Impact Site

According to an approved jurisdictional determination received from the USACE, the Project area contains 18 jurisdictional wetlands, totaling 11.702 acres. W-056 totals 0.133 acre and was mapped as a stream, but functions more like a wetland. The combined total of the 18 wetlands and W-015 is 11.835 acres, Of these, only W-012, W-028, and W-029 appear to be naturally occurring wetlands. They occur within the northern, forested portion of the Project area. Wetland W-012 encompasses 2.78 acres and is located at the headwaters of stream W-015. Wetlands W-028 and W-029 are 0.075 combined acres and are located within the riparian area of stream W-027.

Wetlands W-032, W-033, W-031, W-034, W-038, W-040, W-041, and W-042 likely resulted from anthropogenic site modification and are typified by varied depths of inundation and prevalence of invasive or ruderal hydrophytes. Emergent wetlands are largely dominated by southern cattail, alligatorweed (*Alternanthera philoxeroides*), and torpedograss (*Panicum repens*). Forested wetlands are almost exclusively monocultures of Chinese tallow. Adjacent coal stock piling could also potentially be impacting water quality within this wetland complex (Carlson and Carlson 1994).

The W-052, W-053, and W-054 wetland complex was created by excavation of fill material for pipe yard pad construction prior to 1978, and at the time was separated from Buffalo Bayou. During the 1990s and early 2000s, this area appears to have had connection to Buffalo Bayou until a rip-rap bulkhead was installed in 2007-2008. This area primarily derives hydrology from pipe yard runoff and is dominated by common reed (*Phragmites australis*), poisonbean (*Sesbania drummondii*), eastern baccharis (*Baccharis halimifolia*), and marsh elder (*Iva frutescens*).

Invaded ecosystems typically have highly altered carbon and nitrogen cycles and altered above-ground primary production and litter decomposition found within reference sites (Liao et al. 2008). Chinese tallow is prolific at invading both herbaceous and wooded habitats and forming monocultures (Wang et al. 2011). The species grows rapidly and can reach reproductive age in as little as three years and is a prolific seed producer. Monoculture stands preclude other native species from germinating and growing. Due to the speed of leaf decomposition, Chinese tallow may also negatively impact the survivalship of several species of amphibians spawning in pools underneath monocultures (Leonard 2008; Cotton et al. 2012). In addition to altering native wetland systems, they provide very little food value for wildlife species. Since they displace native fruit and mast producers, they do not provide any forage value for frugivores or acorn consumers. A few species of birds will consume their wax covered seeds but due to lack of arthropod herbivory, they do not provide foraging habitat for insectivorous species (Renne et al. 2000). While not studied, Chinese tallow may and likely do influence the diversity of below ground communities from bacteria and fungi to larger invertebrate species such as worms and insect larvae. In summation, Chinese tallow changes the dynamics of entire ecosystems leading

to monocultures and shifts at all trophic levels of species occupying these monocultures. Additionally, the historic disturbance of the site via landscape alteration and introduction of likely saline fill, further selects for Chinese tallow, which has been shown to be able to withstand higher salinity levels than other native species (Conner et al. 1997).

On-site herbaceous wetlands are largely dominated by southern cattail, torpedograss, and common reed. Torpedograss and the *australis* subspecies of common reed (*Phragmites australis subsp. australis*) are both perennial invasive species that spread via rapid rhizomatous growth (Wilcut *et al.* 1988). While southern cattail is a native species, it exhibits the same growth pattern of the other two species (Wesson and Waring 1969). While torpedograss is often unable to maintain monocultures without periodic disturbance via fire, grazing, or mowing due to smaller growth height, southern cattail and common reed are both capable of forming dense monocultures that preclude both herbaceous and woody species. All three species preclude floristic diversity typical for emergent wetlands on the Upper Texas Coast. Common reed and cattail can form dense stands that inhibit movement of mammalian and wading bird species. Additionally, they can reduce amount of foraging habitat for smaller wetland denizens such as shorebirds, waterfowl, and wading birds (Benoit and Askins 1999).

Wetlands on the Project site are primarily located within the Federal Emergency Management Agency (FEMA) 100-Year floodplain of tidal Buffalo Bayou. Due to increased channel width and depth within the past 60 years, Buffalo Bayou downstream of tidal influence rarely has pulsed flood flows. Harris County Flood Control District (HCFCD) stream elevation sensor 2209 on Buffalo Bayou at Turning Basin was installed in 1998. Since placement of this sensor, only twice during Hurricane Ike and Harvey did Buffalo Bayou exceed its bankfull and actively utilized its floodplain. Due to increased channel size adjacent to the impact site and proximity to the San Jacinto Bayou and Burnett Bay, flood flows from Buffalo Bayou are likely very rare on the impact size. Therefore, impacted wetlands are unlikely to provide much physical or chemical ecological value to Buffalo Bayou.

The permittee has redesigned Project plans to in order to avoid all impacts to wetlands W-028 and W-029; therefore, no compensatory mitigation is proposed associated with those wetlands. Impacts to all other wetlands within the Project area (W-012, W-031, W-032, W-033, W-034, W-038, W-040, W-041, W-042, W-052, W-053, W-054, and W-056) total 11.835 acres.

Proposed PRM Site and Compensatory Mitigation

The 11.835 acres of impacts to wetlands from the proposed Project will be replaced and compensated for with 13.018 acres of wetland restoration at an off-site wetland mitigation site adjacent to Gum Gully, which is an additional 10% higher than the impact acreage to compensate for temporal loss of wetland habitat until the vegetation matures at the mitigation site.

The Mitigation Site is owned in fee title by RES. RES is the largest, most experienced ecological offset provider in the United States. RES has restored, re-established, and conserved 58,024 acres of protected lands and 294 miles of streams; preserved 9,100 acres of endangered species habitat; planted 14 million restorative trees; and established more than 400 conservation easements. RES' corporate headquarters is located in Houston, Texas, only 30 miles from the Mitigation Site. RES has a profile at: www.res.us. The Mitigation Site will be protected by a conservation easement that will be held by Bayou Land Conservancy.

A detailed Mitigation Plan will be submitted for the proposed Project. Below is a brief description of the Mitigation Site and wetland functions that is will more than off-set the impacts to wetlands and associated function proposed for impact by the proposed Project.

The Gum Gully Wetland Mitigation Site is located approximately 15 miles northeast of the Project between the towns of Crosby and Huffman, northeast of Houston (Figures 1 and 2). The approximate center of the Mitigation Site is located within the geographic limits of the United States Geological Survey (USGS) 7.5-minute quadrangle "Crosby" at coordinates 29.965051° north latitude and 95.082431° west longitude.

The Project and Mitigation Site are both within the Buffalo-San Jacinto Watershed (HUC 12040104). Precipitation sheet flow moves from northwest to southeast, across the PRM Site to Gum Gully. Gum Gully flows south to Jackson Bayou, which flows into the San Jacinto River and then Galveston Bay.

The Project and Mitigation Site are both located in the Western Gulf Coastal Plain U.S. Environmental Protection Agency (EPA) Level III Ecoregion and Northern Humid Gulf Coastal Prairies Level IV Ecoregion (Griffith et al. 2007). The entire Mitigation Site is within FEMA 100-year floodplain of Gum Gully, with portions within the designated floodway.

Restored wetlands at the Gum Gully Wetland Mitigation Site will consist of healthy emergent, scrub-shrub, and forested wetlands. Forested wetlands will be dominated by diverse native vegetation, such as oaks, hickory, sweetgum, sugarberry, green ash, and blackgum immediately adjacent to Gum Gully, a perennial stream within the Buffalo Bayou-San Jacinto watershed. Restored wetlands will provide a net increase of biological, chemical, and physical functionality within the watershed; therefore, resulting in a no net loss of aquatic resource function. The proposed mitigation site is located within the floodway of Gum Gully where restored wetlands will provide a series of primary wetland functions. These include water storage/flood attenuation and water quality enhancement through assimilation/transformation of sediments, nutrients, and toxic chemicals. Riparian wetlands are linked longitudinally, laterally, and vertically by hydrologic and geomorphic processes within a riverine system (Vannote et al. 1980 and Newbold et al. 1981). Unlike impacted wetlands, restored wetlands are anticipated to receive significant flood flows from the adjacent Gum Gully.

Pulsed floodwaters bring in nutrients and further mobilization of nutrients may occur as a result of the temporary anoxic conditions (Mitsch and Gosselink 1986). The immediate adjacency to Gum Gully will improve restored wetland's ability to increase nitrogen removal from overland flows entering the stream system, thus improving downstream water quality (Allan et al. 1997; Mayer et al. 2007). In smaller channels, forested riparian zones can moderate in-channel temperatures, reduce sediment inputs, provide important sources of organic matter, and stabilize stream banks (Osborne and Kovacic 1993). High quality wetlands adjacent to streams decrease concentrations of dissolved phosphorus and nitrate after precipitation events while allowing for slow release of chemicals during dormant periods.

Surficial and riverine flooding are the primary flooding events that impact the Buffalo Bayou watershed. Throughout the settling of the Houston region, floods have been one of the primary natural processes to lead to property damage, loss of agricultural products, and loss of human life. Regulation of flood duration and intensity has become an issue of primary importance throughout the last 100 years. Forested wetlands increase flood storage, reduce flood peaks, and increase peak travel time within floodplains (Thomas and Nisbet 2007). Due to high rates of evapotranspiration during the growing season, proposed restored wetlands will likely result in

drier soil conditions post-flooding events and increase capacity of these areas to handle subsequent flooding events (Acreman and Holden 2013).

The replacement of invasive-dominated monoculture wetlands with high quality forested wetlands greatly increases the biological integrity of the Buffalo Bayou- San Jacinto watershed. Net above-ground biomass productivity is highest in wetlands with pulsed hydroperiods, leading to approximately double the productivity of still systems (Mitsch et al. 1991). Pollock et al. (1998) found that species-richness correlated with intermediate flood frequencies associated with spatial variation via microtopographic variation in elevation. Restored wetlands will be subsoiled to 18 inches to increase site microtopography and therefore niches for encouraging site floristic richness. Location within an active floodplain also increases hydrochory (seed dispersal) rates from restored wetlands to downstream habitats (Middleton 2000).

While several of the impacted wetlands have prolonged periods of deep inundation, proposed wetlands will be seasonally inundated and saturated via sheet flow, direct precipitation, and pulsed flows from Gum Gully. The insect fauna between these two systems will be vastly different with impacted wetlands largely supporting true aquatic species that primarily feed on decaying plant material, algae, and other insects (Batzer and Wissinger 1996). The restored wetlands will likely have wetland insect communities mediated by inundation duration and frequency and will be typified by midge and predatory beetles, aquatic worms, and crustaceans (Batzer and Wissinger 1996). Additionally, due to the dominance of oaks on the restored site, high biodiversity of lepidopteran larvae is anticipated which provide valuable foraging habitat for neotropical migrants (Moorman et al. 2007; Tallamy and Shropshire 2009).

Upon arrival on the Texas coast, neotropical migrants have largely exhausted fat reserves and their primary focus is the location of high quality foraging habitat within close proximity to the coast. Kuenzi et al. (1991) found stopover duration was largely correlated with forage potential of utilized habitats. The Partners in Flight (2008) has identified wooded habitats as vital for foraging migrants. Post-Gulf lipid replenishment allows neotropical migrants to improve fitness levels required for completion of migration to breeding grounds and ensure successful reproduction efforts. Restored wetlands will provide habitat connectivity via a forested corridor that connects downstream with riparian forest along the San Jacinto River and south of Lake Houston. Additionally, the location of the restoration site provides proximity for avian species to utilize habitats currently proposed and underway as mitigation properties within the adjacent North Galveston Bay watershed.

Knight (1992) outlines the following ancillary or ecosystem services functions that can be gained by restored wetlands. Each will be introduced below then compared to proposed restored wetlands anticipated ecological functions.

1. Photosynthetic production: The majority of the wetlands proposed for impact are largely composed of monocultures of woody or herbaceous species consisting of uniform populations of similarly sized individuals. The proposed restored wetlands will include a biodiverse assortment of both hard and soft mast species of varying age classes upon maturity with diverse vertical structure.
2. Food chain and habitat diversity: Impacted wetlands are largely dominated by vegetation monocultures and support a narrow niche of fauna. Restored wetlands will support varied floristic communities and hydroperiods, thus supporting more complex trophic interactions.
3. Export to adjacent ecosystems: The high alteration of the impact site and disconnection from Buffalo and Greens Bayou overflow flooding allows little transport of organic

material into downstream waters. The mitigation site's proposed location within the watershed will allow the ability to transport high quality organic material that will eventually be utilized by freshwater and saltwater invertebrates and microbial species as a source of nutrients. These restored wetland exports will especially be beneficial to species specialized in shredding or eating periphyton on submerged woody debris exported from the site.

4. Aesthetic/recreational/educational human uses: Impact site wetlands are largely isolated within an industrial landscape. As the Houston metropolitan area expands outward, the wetland mitigation site will provide a bastion of green within a largely agricultural and suburban area. Additionally, the site can be utilized to help researchers provide answers to complex problems experienced within an urbanized watershed.

SUMMARY

Implementation of this mitigation plan will replace the ecological functionality of wetlands and streams impacted by the Project. Onsite relocation and avoidance of stream features will maintain their hydrological, hydraulic, geomorphic, physiochemical, and biological functionality within the tidal portions of Greens and Buffalo Bayous. This will be accomplished through avoiding 1,666 linear feet of W-015, avoiding 1,635 linear feet of W-027/30, culverting portions of W-015 and W-027/30 adjacent to existing culverts, and relocating all of W-049 (722 linear feet) on-site. Wetlands within the project site are largely the result of anthropogenic disturbance and are primarily dominated by ruderal and invasive species. A total of 13.018 acres of diverse wetlands will be restored off-site to mitigate 11.835 acres of wetland impacts, including W-056, which was mapped as a stream, but has insignificant flow and functions like a wetland. The mitigation acreage is 10% higher than the impact acreage as an added benefit to the ecosystem and to compensate for temporal loss of wetland habitat until the vegetation matures at the mitigation site. Compensatory mitigation is not based on HGMi calculations, as advised by the USACE due to adjacency to tidally-influenced receiving waters. The wetlands at the mitigation site will be planted with a diverse mix of hard mast-producing tree species and will be located within an active floodway of Gum Gully, which will increase the physical, chemical, and biological integrity of downstream waters within the Buffalo-San Jacinto watershed. A detailed mitigation plan will be submitted separate of this summary.

Thank you,

Andy Newman
Project Manager

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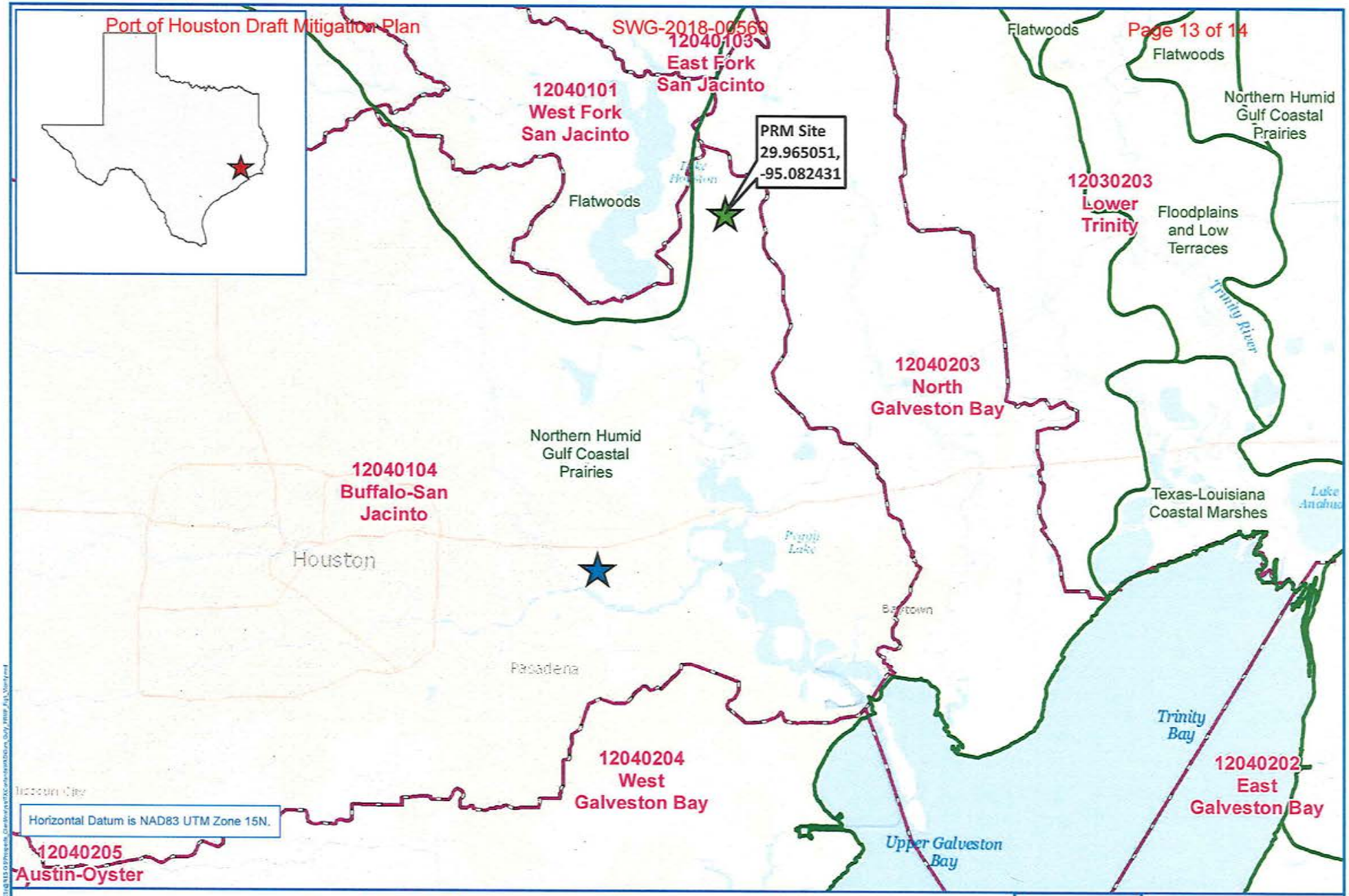

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Figure 1. Vicinity Map

Permittee Responsible Mitigation Plan
Houston 4 Project

Harris County, Texas

PRM Site
Project Site
Level IV Ecoregion
8-Digit HUC Watersheds

Date: 11/15/2018
Drawn by: BRG
Checked by: MG

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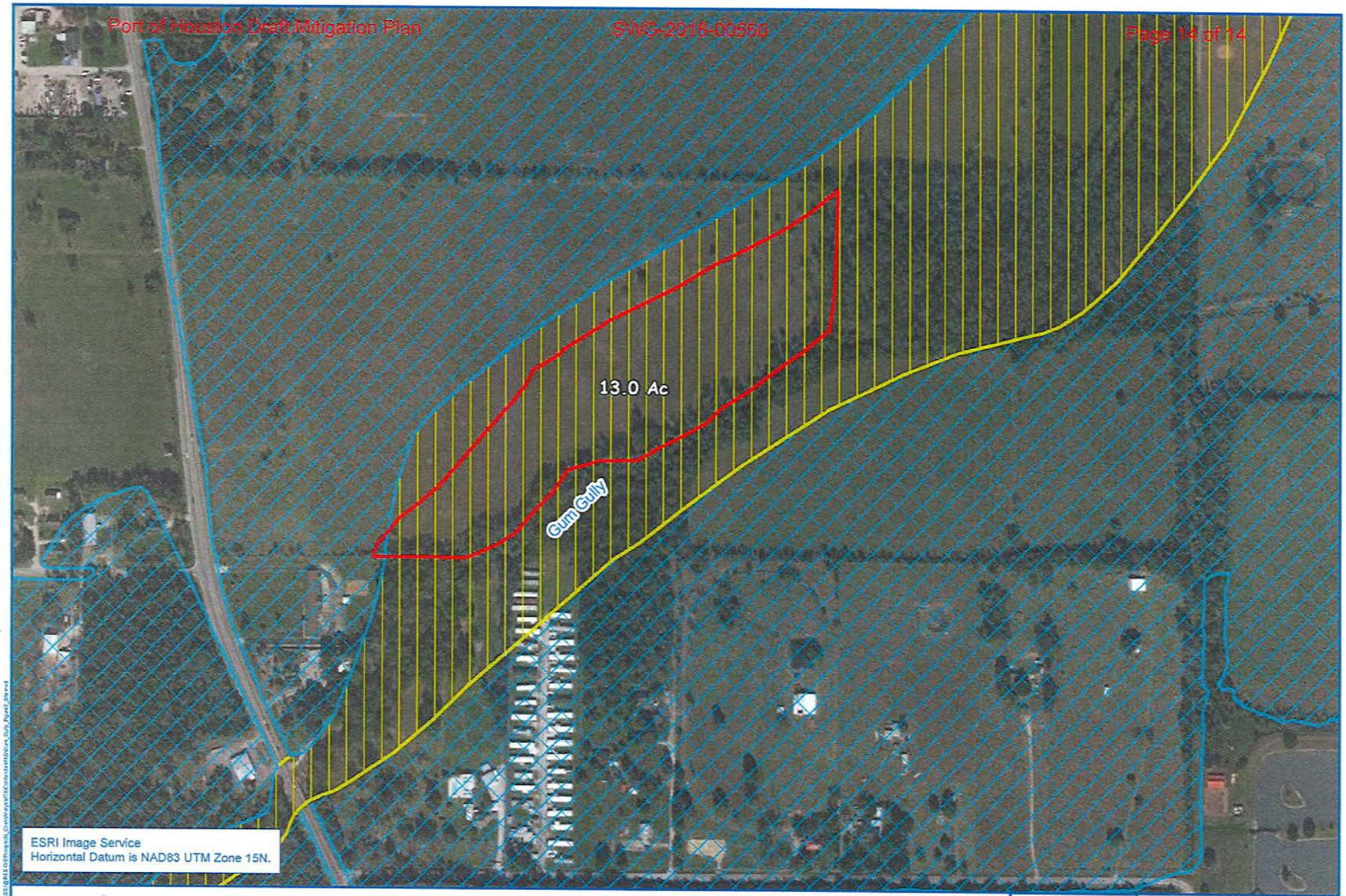

Figure 2. PRM Site

Permittee Responsible Mitigation Plan
Houston 4 Project

Harris County, Texas

Date:	11/15/2018
Drawn by:	AB
Checked by:	MG

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