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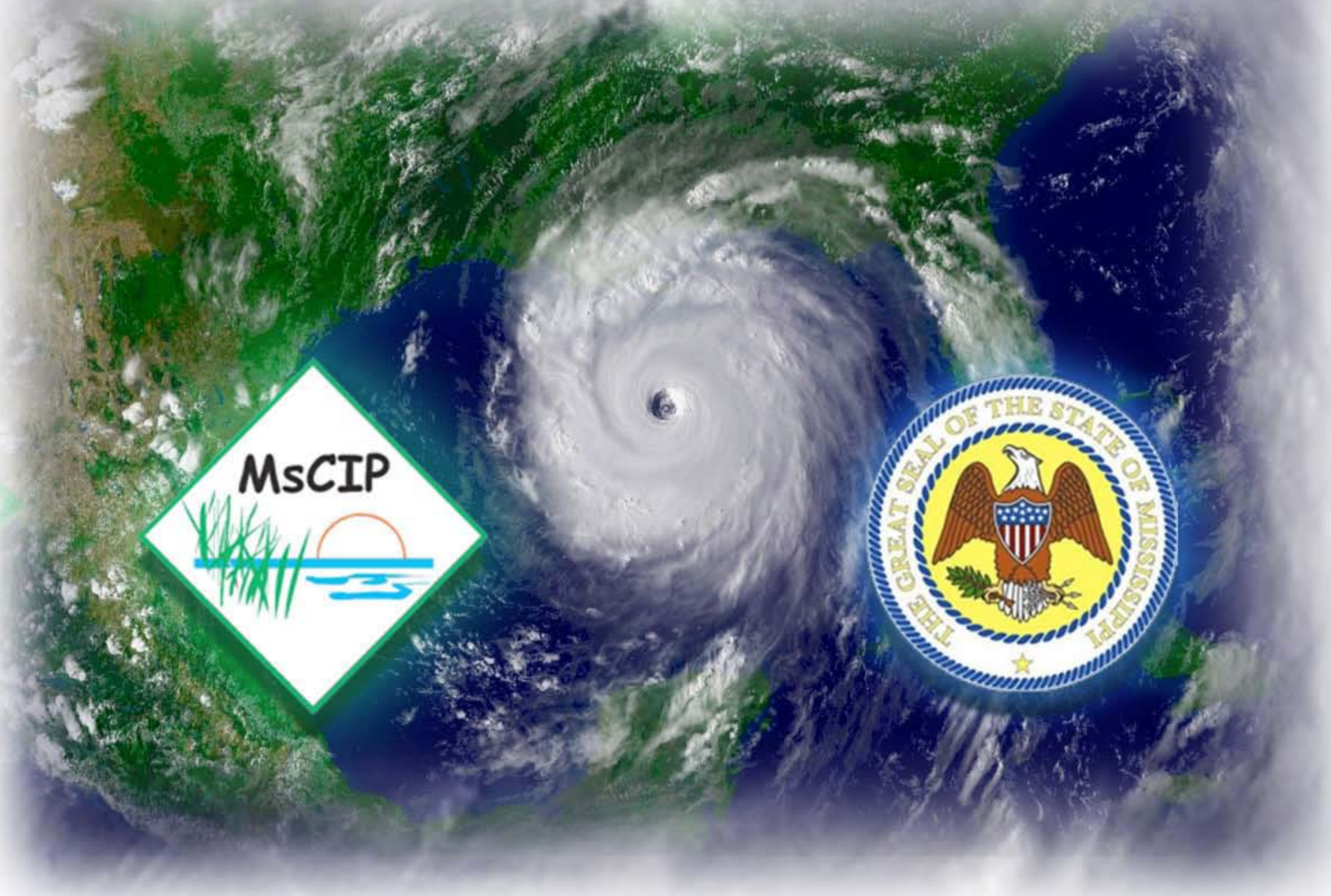
Mississippi Coastal Improvements Program (MsCIP) Hancock, Harrison, and Jackson Counties, Mississippi

APPENDIX D NON STRUCTURAL



FOREWORD

This document is one of a number of technical appendices to the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Feasibility Report and Environmental Impact Statement.

The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan Integrated Feasibility Report and Environmental Impact Statement provides systems-based solutions and recommendations that address: hurricane and storm damage reduction, ecosystem restoration and fish and wildlife preservation, reduction of damaging saltwater intrusion, and reduction of coastal erosion. The recommendations contained in the Main Report/EIS also provide measures that aid in: greater coastal environmental and societal resiliency, regional economic re-development, and measures to reduce long-term risk to the public and property, as a consequence of hurricanes and coastal storms. The recommendations cover a comprehensive package of projects and activities that treat the environment, wildlife, and people, as an integrated system that requires a multi-tiered and phased approach to recovery and risk reduction, irrespective of implementation authority or agency.

The MsCIP Study Area

The purpose of the Comprehensive Plan Report is to present, to the Congress of the United States, the second of two packages of recommendations (i.e., the first being the “interim” recommendations funded in May 2007, and this “final” response, as directed by the Congress), directed at recovery of vital water and related land resources damaged by the hurricanes of 2005, and development of recommendations for long-term risk reduction and community and environmental resiliency, within the three-county, approximately 70 mile-long coastal zone, including Mississippi Sound and its barrier islands, of the State of Mississippi.

This appendix, the Main Report/EIS, and all other appendices and supporting documentation, were subject to Agency Technical Review (ATR) and an Independent External Peer Review (IEPR). Both review processes will have been conducted in accordance with the Corps "Peer Review of Decision Documents" process, has been reviewed by Corps staff outside the originating office, conducted by a Regional and national team of experts in the field, and coordinated by the National Center of Expertise in Hurricane and Storm Damage Protection, North Atlantic Division, U.S. Army Corps of Engineers.

The report presents background on the counties that comprise the Mississippi coastline most severely impacted by the Hurricanes of 2005, their pre-hurricane conditions, a summary of the effects of the 2005 hurricane season, problem areas identified by stakeholders and residents of the study area, a summary of the approach used in analyzing problems and developing recommendations directed at assisting the people of the State of Mississippi in recovery, recommended actions and projects that would assist in the recovery of the physical and human environments, and identification of further studies and immediate actions most needed in a comprehensive plan of improvements for developing a truly resilient future for coastal Mississippi.

This appendix contains detailed technical information used in the analysis of existing and future without-project conditions, in the development of problem-solving measures, and in the analysis, evaluation, comparison, screening, and selection of alternative plans, currently presented as recommendations contained in the Main Report/EIS.

Each appendix functions as a complete technical document, but is meant to support one particular aspect of the feasibility study process. However, because of the complexity of the plan formulation process used in this planning study, the information contained herein should not be used without parallel consideration and integration of all other appendices, and the Main Report/EIS that summarizes all findings and recommendations.

Nonstructural measures are proven methods and techniques for reducing flood damages and loss of life in floodplain and coastal areas threatened by storms and hurricanes. Tens of thousands of structures throughout the coastal fringes of the United States have been protected using nonstructural measures found to be effective in preventing damages, cost effective when compared to other measures and acceptable to the general public. Nonstructural measures can be used as a stand-alone program to create disaster-resilient communities.

Prior to full implementation of the proposed comprehensive nonstructural plans discussed herein, more detailed project implementation plans would need to be prepared in close collaboration with the counties, municipalities, the state and Federal agencies for the project area. In a nonstructural program that spans multiple jurisdictions there could be imbalances in tax revenues as displaced landowners relocate to nearby communities coupled with disparities in public service capacities and unbalanced school enrollments. Agreements between jurisdictions concerning lost/gained tax revenues and adjusted public service areas as well as school enrollment adjustments must be considered before initiating a full-scale nonstructural project. In addition, recent changes in the flood insurance rate maps, establishment of new base flood elevations and enlargement of the V-zone by FEMA would necessitate adjustments of the designated hazard zones where certain measures have been specified in this Appendix. All of these ongoing changes would need to be incorporated into more detailed project implementation reports to better estimate project costs and to identify any significant changes in socioeconomic impacts prior to implementation.

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EXECUTIVE SUMMARY

The Mississippi Coastal Improvement Project area contains over 70,000 parcels of property of which a high percentage were, prior to Katrina, occupied by structures. Many of those parcels are now vacated with only slab foundations and FEMA temporary trailers remaining to show where households and businesses once stood. Redevelopment of the project area has been limited due to legal and financial issues with respect to floodplain regulatory determinations and flood insurance payments. Once these issues are resolved, redevelopment of the interspersed vacant parcels may accelerate at a feverish pace. The future-without project scenarios of the comprehensive plan contemplate full redevelopment (residential or residential & commercial mix) of the project area by the year 2012 as described in more detail in the Economics Appendix.

The nonstructural PDT, using data from the USACE Mobile District, FEMA, NOAA, county assessor's offices and local sources has formulated nonstructural measures that, working either independently of structural measures or in concert with them, provide substantial reductions in flood damages. Many uncertainties remain in the nonstructural formulation because of the lack of complete structure-specific data. More in-depth planning in collaboration with the counties and municipalities is needed to address the uncertainties regarding the cost efficiency and effectiveness of the nonstructural measures as well as potential mitigative measures needed to offset unavoidable social and economic impacts.

The primary measures identified for the project area include permanent acquisitions, floodproofing by elevation and other means, replacement of public buildings, flood preparedness and evacuation planning, public education, changes in the current municipal and county NFIP and building codes, a transfer of development rights or purchase of development rights program, changes in land use zoning, development impact fees, and redirection of new development. These measures have been combined into 8 separate plans that can be implemented by either agencies of the Federal government or collaboratively by those agencies and state, county and local governmental units. Only local jurisdictions can implement some of the measures identified in the plans through local police powers.

Seven of the 8 nonstructural plans formulated in the following pages are based upon the Advisory Base Flood Elevation (ABFE), in accordance with currently amended local ordinances, to generate comparison of project costs and benefits. The eighth plan (NSC-6) is a combination of structural and nonstructural measures evaluated through the ABFE, 20 feet, 30 feet and 40 feet levels of inundation for ringwalls and ring-levees at certain communities and the LOD 4 structural project. Total nonstructural plan costs range between $6.1 billion for acquisitions of high-hazard properties alone and $19.1B for a full range of nonstructural measures such as permanent acquisitions, floodproofing, replacements of public buildings, NFIP and building code upgrades, and use of TDR or PDR programs.

Due to the iterative nature of the planning process, LOD 4 was screened out after the Nonstructural Appendix was completed. This measure was screened out due to the high maintenance cost of the associated surge gates, which was beyond the financial capability of the local sponsor. Therefore, the discussions associated with LOD 4 in the combined structural and nonstructural plans (NSC-6d through NSC-6g) within this Appendix should be viewed only as a reference. The combined structural and nonstructural alternatives that include ring-levees and ringwalls with nonstructural measures and that are labeled as NSC-6 through NSC-6c are still valid alternatives.

Comparison of the 8 plans using metrics such as total plan cost, cost per parcel protected, AAD prevented, effectiveness, sustainability, public safety and environmental quality reveals that several nonstructural plans provide substantial benefits (including substantial non-monetary benefits or benefits for which monetary measures have yet to be defined in the plan) to the project area. Due to the lack of detailed information for the project study area, several metrics were not commensurable among the plans at this time. Despite this quantification issue, significant qualitative improvements in public safety, environmental quality, potential long-term growth, community disaster-resilience and future damage reduction point to the overall effectiveness of the nonstructural plans.

A planned feature is the High Hazard Area Risk Reduction Plan (HARP) that provides for purchase of properties located in the high-hazard zone of the three coastal counties of Mississippi. Acquisition would be in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, and would be implemented initially for 2,000 parcels .

In addition to the proposed HARP, the plan includes two additional projects: one for elevation of 25 residential structures in Waveland, MS in accordance with recent FEMA floodproofing guidelines and another for replacement of 4 municipal structures located within the high-hazard zone in Moss Point, MS as a method of reducing inundation damages. Each of these two early projects would enable testing of key processes and design techniques aimed at reducing flood damages and preventing future loss of life and essential public emergency services during hurricane events. More detailed plans for these projects would be prepared and submitted for approval at Division level prior to implementation.

CHAPTER 1. INTRODUCTION

Coastal areas of the United States are home to a substantial portion of the total population of our nation. Data published by NOAA in 2003 (“Population Trends Along the Coastal United States – 1980 to 2008”) indicated that at least 153 million Americans live within the 673 coastal counties bordering the nation – a land area accounting for only about 17% of the nation’s total land surface. This segment of the nation represents 53 percent of the total national population living and working in a continent-sized linear pattern that is subject to frequent and damaging storm events. One of those growing coastal areas has been the Gulf Coast in Mississippi.

Although coastal areas of the nation are attractive to commercial, industrial and residential developers, the consequences (as evidenced by Katrina, Rita, Ike and past hurricanes) associated with locating damageable property and unwary residents along the Gulf coast can be extreme. Despite years of regulation through the Federal Emergency Management Agency (FEMA) and other coastal zone management techniques, damageable property still remains in high-hazard areas and people still drown during surge and coastal flooding from hurricanes. Nonstructural measures can be formulated that reduce the flooding risks along the Gulf Coast, but nonstructural measures can also result in impacts to the social and economic fabric of the communities to which they are applied.

In recognition of the potential social and economic impacts of a nonstructural project, citizens of the project area have already voiced their concerns during public meetings about the affects of certain nonstructural measures upon property values for those who may not participate in the project should it be authorized and funded. In addition, there are concerns that the loss of local tax revenues through permanent acquisitions and relocation may financially cripple several of the smaller beachfront communities. Each of these concerns has merit in the planning process and will need to be addressed as more detailed planning proceeds for the implementation of the plans described in this appendix.

Collaborative planning among Federal agencies, the state, counties and municipal jurisdictions will be paramount for successful implementation of the nonstructural plans described in the following chapters. Meaningful and continuous public involvement and consensus building will also be key components of a successful nonstructural program. Few other types of flood damage reduction measures are as personal as are the nonstructural measures and resolving property and land use issues with landowners and municipal and county officials would be challenging.

As a nation we must identify strategies and measures that can be used in tandem to both discourage development in high-risk areas and encourage growth in less hazardous areas of the coastline. Some strategies and measures may be more appropriate for Federal action while others will be more attuned to local regulatory action and administration. In either case, these measures must be effective, socially acceptable, environmentally suitable and mindful of the existing neighborhood and community social and economic systems within which they would be implemented.

CHAPTER 2. NONSTRUCTURAL FLOOD DAMAGE REDUCTION

2.0 Gulf Coast Development.

According to a NOAA report published in 2003 (“Population Trends Along the Coastal United States – 1980 to 2008”), coastal population within the Gulf Coast region was projected to increase between 10 and 15 percent by 2008. Despite the damaging effects of Katrina, Rita and Wilma in 2005, areas of the gulf coast continue to grow in population and shoreline development. Some areas affected by Katrina in the project area have begun to rebound in large measure due to the reopening and success of the major employers and tourist attractions along the coast. Over 1,600 building permits for new single-family home construction were recorded within the 11 communities in the project area in 2006 (City-data.com).

In addition to the permanent households and commercial businesses that live and work along the Gulf Coast, millions of seasonal tourists visit these same coastal areas giving rise to the boom in vacation rental units, condominiums, second homes, and motels and hotels that populate the Gulf region. Tourist’s primal attraction to the Gulf coast also feeds development of a plethora of amusement and recreation related uses that congregate on various boardwalks and beachfront property adding to the potential for high damages. Added to this burgeoning of development along the coast is the presence of millions of transient tourists who may be largely unaware of the threat that hurricanes and storms present to them.

2.1 Nonstructural Measures

Flood damage reduction measures are divided into two distinct components: structural and nonstructural. Structural measures in coastal areas usually concentrate on resisting the surge and wave action of storms and hurricanes. Off-shore and onshore barriers, seawalls, levees, flood gates, pumping systems and other structural measures can provide high levels of protection to coastal development. In-place development (residential, commercial, industrial, and institutional uses) is largely untouched during implementation of structural measures with the exception of acquisitions within the construction footprint of the project features. Much has been written about the positive benefits and negative impacts of structural measures along the nation’s coastlines. Generally speaking, structural components have performed successfully during storms and hurricanes, but failures can and do occur when the design parameters of either structural or nonstructural components of a protection system are exceeded by extreme storm events.

Application of nonstructural measures or those measures directly associated with modifying the location, construction or operation of property, structures, and facilities located in hazard areas is one method of reducing storm/hurricane-related damages and saving lives that are at-risk. Nonstructural measures can be applied to both coastal and riverine hydrologic systems and have been proven to be affective in reducing damages and saving lives. Where nonstructural measures have been successfully instituted by local governments through floodplain management or other land regulation processes, the benefits and impacts of the protection process have been largely unreported. This lack of notoriety is due in part to the unit-by-unit or lot-by-lot system of protection (not very newsworthy), the relatively low cost when compared to other protection methods and the lack of massive mobilization of political or financial resources to accomplish these low-tech solutions.

Actions to either modify or remove development from at-risk areas to reduce damages can be applied in two general ways: first is to take direct actions towards the at-risk building or facility so as to modify its structural characteristics or location such that damages are reduced, and second is the application of incentives and disincentives through regulatory or economic processes that cause landowners to re-evaluate the costs and benefits of living in a hazardous location more carefully. Many existing regulatory and land valuation techniques exist that can influence individuals' choice of a building location. All of these techniques need to be considered. Nonstructural measures can be divided into several general categories including:

- Flood Preparedness
    - Hurricane/Storm identification, tracking and early warning
    - Temporary emergency evacuation and sheltering
- Modification of structures, facilities and/or the property on which they are located (a.k.a. floodproofing)
- Building construction regulations (building codes)
- Land use regulation by zoning that affects the type and location of land uses
- Floodplain management regulation, hazards zoning and insurance systems (NFIP/CRS)
- Property taxation, special development assessments and development fees
- Transfer of Development Rights and Purchase of Development Rights (TDR/PDR)
- Permanent evacuation of the hazard areas (permanent acquisition and relocation)
- Replacement of public structures and critical facilities

Each of these general categories of nonstructural measures can be applied as single measures or can be applied in combination with one another or with structural measures to address storm damages and loss of life. The range of benefits, costs and residual damages associated with application of each measure is broad. The extent and severity of social and economic impacts associated with the various measures can be likewise broad and must be identified for any plan. Depending upon the nonstructural measures selected for application and the relative percentage of each applied to the planning area, the future land use pattern of the area could be vastly different than that which existed prior to Katrina's landfall.

Finally, the ability of nonstructural measures to be implemented in very small increments, each increment producing flood damage reduction benefits (structure-by-structure), and the ability to initiate and close a nonstructural program with relatively minimal costs are important characteristic of this form of flood damage reduction. Also important is the ability to "tier" measures over long periods of project time such that a layering of measures, each one providing a higher degree of protection, is possible and given both Federal and non-Federal funding constraints probable. In order to affectively implement multiple layers of nonstructural protection within such a large project area, several tiers applied incrementally may be required before complete protection would be realized. The use of "tiering" will be discussed in more detail during plan formulation.

The following chapters will discuss the various nonstructural measures, program eligibility, nonstructural criteria, nonstructural formulation concepts and the applicability of these various measures in several alternative plans to the MsCIP project area.

CHAPTER 3. PROJECT AREA CHARACTERISTICS

3.1 General Description

The MsCIP project area consists of the Mississippi coast from the western border with Louisiana defined by the Pearl River to the eastern border with Alabama generally defined by Middle Bay. Figure 1 shows the distribution of the 11 municipal areas within the project area and several of the major connecting highways. The area is politically divided into three county governments (Jackson, Harrison and Hancock) and at least 11 municipalities. Three of the eleven municipal areas are grouped into two Metropolitan Statistical Areas (MSA). Prior to the arrival of Katrina in August 2005, the area boasted a population of over 220,000 persons. That population decreased dramatically as a result of Katrina, but is making a come back as local employment increases and the housing market slowly recovers.

Figure 1. Gulf Coast Communities (MRF graphic)

This 75 mile long coast has numerous physical features that make it a prime development location including three main inlets at Bay St Louis, Biloxi and Pascagoula, productive estuaries and wetlands, extensive beaches with flat to moderate topography adjacent to the beach area, and several off-shore barrier islands. The beaches draw millions of tourists each year to this Gulf paradise. The entertainment industry in the form of casinos and tourists attractions has spurred much growth along the beachfront areas. Numerous industries, some directly tied to the Gulf waters, populate the project area and several military and Federal Government-related complexes are dotted across the landscape providing employment and revenues to the local economy.

Several major transportation routes cross through the area including Interstate 10, Route 90 and the CSX railway line each running east-west across the area. The majority of the cultural development is concentrated south of Interstate 10 with agricultural and forested lands mainly north of Interstate 10. Each of the three major embayments associated with tributary rivers has extensive wetland areas associated with them.

3.2 Topography

Among the many characteristics of the project area that directly affect formulation of nonstructural measures, the surface elevation of the landscape with respect to the elevation of the Gulf waters is of paramount importance. Since nonstructural measures generally affect each parcel of property and each structure and facility, the ground elevation at each specific structure location is an important aspect of plan formulation. In the case of the Gulf coast, most structures are constructed on slab foundations therefore the ground surface elevation generally reflects the first floor elevation of the structure as well. For the purposes of data collection and analysis the project area was divided into 54 reaches. Using available GIS information and topographic data layers, the elevation of each tax parcel within the 54 reaches was determined. Table 1 shows the average elevation (NAVD 88) of the identified parcels (geographic center-point of each parcel) within each of the 54 reaches with respect to the Gulf surface elevation. Figure 2 is a graded-color representation of the elevations of the 54 reaches with respect to the Gulf surface. The color differences indicate the relative risks of surge inundation in the reaches. More detailed maps of the project area showing this elevation difference with respect to the Gulf waters are included at the end of this Appendix (See Figures 139 to 143).

Table 1.
Average Land Elevation by Reaches

Reach Number	Elevation	Reach Number	Elevation	Reach Number	Elevation	Reach Number	Elevation	Reach Number	Elevation
1	9.65	12	12.36	23	10.54	34	NP	45	NP
2	11.00	13	16.75	24	10.77	35	7.59	46	15.62
3	13.66	14	17.54	25	12.23	36	10.04	47	15.97
4	5.98	15	16.70	26	10.77	37	17.59	48	15.57
5	5.77	16	13.75	27	11.07	38	15.79	49	15.62
6	8.82	17	NP	28	9.47	39	15.74	50	12.47
7	12.05	18	13.60	29	11.70	40	15.45	51	9.58
8	8.81	19	6.21	30	12.20	41	12.04	52	10.29
9	8.32	20	11.99	31	8.60	42	NP	53	5.17
10	14.54	21	9.94	32	9.18	43	11.73	54	6.81
11	17.54	22	13.45	33	NP	44	NP		

NP – Due to the shape of the reach and parcels none of the identified parcel center-points fell within the reach

3.3 Urban and Community Development

3.3.1 Urban Development Patterns

As mentioned above, the project area is politically divided into11 municipalities contained within three counties. Three of the 11 municipal areas, Pascagoula, Gulfport and Biloxi form two Metropolitan Statistical Areas (MSA's) composed of Pascagoula (37700) and Gulfport/Biloxi (25060).

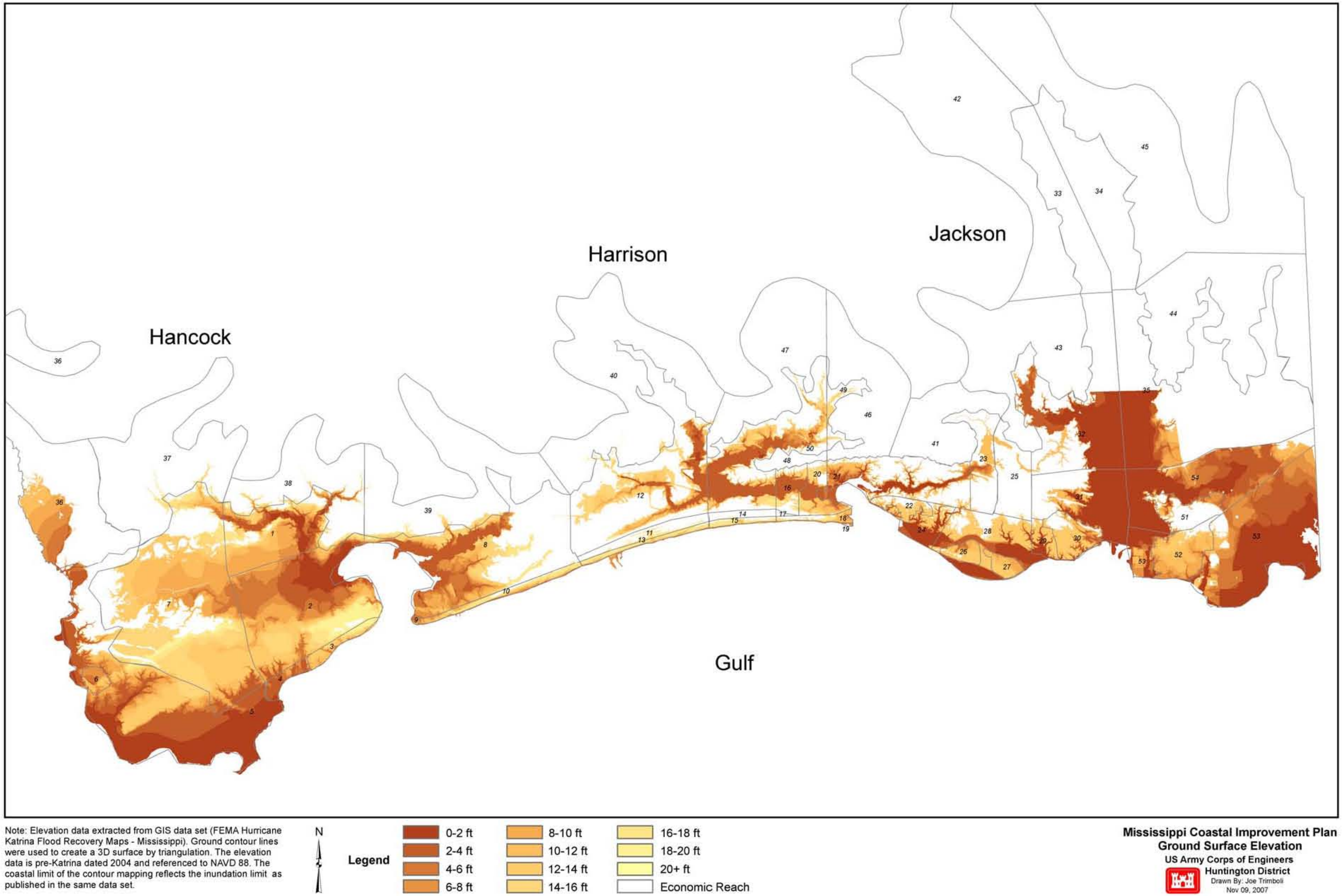


Figure 2. Land Surface Elevations of Economic Reaches w/Respect to the Gulf

MSA's are defined and redefined on a regular basis by OMB, but the basic designation of the MSA is based upon population size. MSA's combine both municipal and surrounding county populations for the purposes of Federal statistics collection. According to the 2000 Census the Pascagoula MSA had a population of 150,564 persons within its economic and social statistical area and the Gulfport/Biloxi MSA had a population of 246,190 persons within that same distinctive boundary.

That statistical designation carries weight when Federal funds are being distributed through social, infrastructure and national security programs. Figure 3 shows the MSA's of Pascagoula and Gulfport/Biloxi (dark green outlined in dark green border) and the 5 county areas included within their statistical boundaries (Picayune within Pearl River County is a separate micro statistical area not included within either the Pascagoula or Gulfport/Biloxi MSA's).

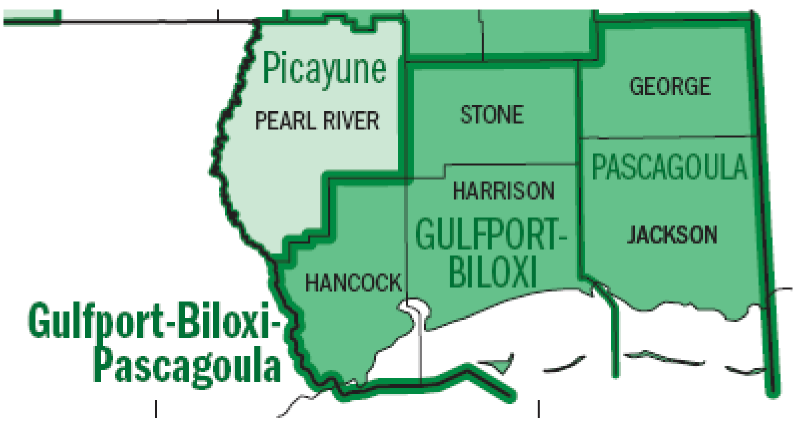


Figure 3. Metropolitan Statistical Areas within the Project Area

These more urbanized communities exhibit relatively large centers of commercial activity and a government core as well as a traditional grid-pattern street layout. All three have older central business districts that have been diminished somewhat by sprawl development that has aligned itself with adjacent transportation corridors (Route 90 and Interstate 10).

The development patterns of the 11 municipal areas are all unique to their location and topography, but most have a defined business/commercial and government center with surrounding various densities of housing and other land uses. Gulfport, Biloxi and Pascagoula have well-defined centers that are conducive to walking and transit services. Primary north-south access corridors from both Gulfport and Biloxi have resulted in a "sprawl" pattern of development emanating from those two centers.

These sprawl corridors have resulted in linear development patterns aligned with the highways. Other communities such as Bay St. Louis, Long Beach, and Ocean Springs have much smaller town centers near the beachfront and conform to a grid-pattern with less apparent sprawl. In some cases, the growing commercial districts of these municipal areas have located away from the beachfront and have aligned with Route 90 and other intersecting highways. Many of the tourist-centered commercial developments (hotels, motels, entertainment areas) migrated to the beachfront highways putting all of them in high-risk locations.

In addition to these older town centers, many of the Interstate 10 intersections bordering the project area have begun to sprout with hotels/motels, service stations, outlet stores and restaurants creating several new centers that attract travelers and offer some competition with the beachfront town centers. Several of the commercial areas near the interchanges have been annexed into the older beachfront municipal areas like Gulfport. Massive residential subdivisions (see below) have sprung up at the interstate intersections creating more flood-safe housing out of the reach of most hurricane surge events. This recent trend in residential development (north of Interstate10) bodes well for what may have to be a long-term strategy to address future hurricane damages while maintaining the robust economic vitality of the region. Should predictions regarding sea level rise (as described in the future without-project condition scenarios) come to fruition, migration away from the beachfront to higher elevations may be an absolute necessity.

3.3.2 Community Development Patterns

There are several planned development communities (i.e. Diamondhead) in the project area that feature upscale housing and recreation amenities as well as several “golf-course communities” and at least one “fly-in” community within the project area. In contrast to the older grid-pattern urban centers, these newer subdivisions, gated communities and planned unit developments display a more curvilinear pattern with multiple cul-de-sacs and looping streets. These newer community structures are more vehicle-oriented. Additionally, there are several major military or military-related facilities in the project area around which some growth (where allowed) has occurred. These relatively stable employment centers provide a boost to the local economy and an injection of highly-talented people that provide leadership and human resources to local service organizations.

There are several industries and commercial establishments that are more attached to the waterfront than other community land uses. The casino complexes and water-related industries (Ingalls, Chevron, etc.) are required either by law or by function to be at the land-water interface and must remain in that location in order to function. By law the casinos are restricted to an 800 feet wide band along the waterfront, a location which places them in harm’s way of hurricane surge, waves and winds. Major industrial employers such as Ingalls Ship Building and the Chevron Company must have facilities at the water’s edge in order to either construct vessels or maintain oil platforms. Although these locations are highly hazardous, the continued presence of these major employers in the community is of paramount importance to the social and economic health of the project area.

Both Biloxi and Gulfport have substantial central business districts immediately at beachfront locations. Both of these centers as well as Pascagoula have high densities of commercial, business and residential uses with numerous recognizable neighborhoods. Within the counties there are numerous well-defined neighborhoods (many are named) and a few isolated and unincorporated communities scattered out in the estuaries. The amenities of the Gulf Coast have attracted many hundreds of vacation and second home developments contained in grid-street patterns built upon fills adjacent to the estuaries. Several of these subdivisions have a very low density of housing compared to what would be expected given the grid-street pattern. In contrast to the many upscale vacation housing developments, there are several “fishing-based” communities (i.e. Ansley) nestled into the estuary areas that also are subject to flooding.

3.3.3 Critical Facilities

As with any normal-functioning community, there are a plethora of buildings and facilities that could be classified as “critical facilities” within the project area. Included in this category of facilities are fire stations, police stations, emergency response/management facilities, hospitals, schools, medical clinics, transportation facilities, utilities, and public administrative buildings. All of these facilities, besides being a daily necessity to community life are very critical to the safety and protection of citizens during and after emergencies. Their location with respect to their service areas and inundation limits from storms and hurricanes is of paramount importance in the formulation process.

Both community colleges and state post-secondary educational facilities are located within the project area as well. A large number of churches of many faiths are scattered among the communities and have provided physical and spiritual support to their congregations and others following Katrina. Much of the rebuilding occurring in the project area is occurring through the work of missions from allied denominations. The usual mixture of social services (welfare, children, clinics, etc.) and public services (utilities, solid waste, communications) account for numerous buildings and facilities throughout the project area – many of which are subject to inundation damages.

3.3.4 Non-Project Communities

In addition to the 11 communities included in the project area, there are numerous villages and unincorporated communities located just north of the I-10 corridor that serve as "bedroom communities" for the thousands of employees that support the tourism industry and commercial businesses along the coast. Few of these communities suffered from inundation damages due to Katrina, but damages to homes and businesses due to wind and rain were significant there as well. Although these communities may not be directly affected by the measures being formulated for the defined project area, they may be affected indirectly by certain measures such as relocations of residents along the coast through a large permanent acquisition program. A more in-depth look at these adjacent communities is included in Section 4.5.9.9.2 and Table 10 of this Appendix.

3.3.5 Historic Districts

A search of the National Park Service database for National Historic Districts identified 18 Historic Districts within the project area (see Table 2). These historic districts are located within the 11 communities discussed above. A Historic District in the United States is defined as a group of buildings, properties or sites that have been designated by one of several entities on different levels as historically or architecturally significant. Buildings, structures, objects and sites within a historic district are normally divided into two categories, contributing and non-contributing. Districts greatly vary in size, some having hundreds of structures while others have just a few significant structures.

Table 2.
Historic Districts on the National Registry

District Name	Community	County
Front Street Historic District	Pascagoula	Jackson
Krebsville Historic District	Pascagoula	Jackson
Orange Avenue Historic District	Pascagoula	Jackson
Indian Springs Historic District	Ocean Springs	Jackson
Lovers lane Historic District	Ocean Springs	Jackson
Marble Springs Historic District	Ocean Springs	Jackson
Old Ocean Springs Historic District	Ocean Springs	Jackson
Shearwater Historic District	Ocean Springs	Jackson
Sullivan-Charnley Historic District	Ocean Springs	Jackson
Biloxi Downtown Historic District	Biloxi	Harrison
Harbor Square Historic District	Gulfport	Harrison
Scenic Drive Historic District	Pass Christian	Harrison
West Beach Historic District	Biloxi	Harrison
West Central Historic District	Biloxi	Harrison
Beach Blvd Historic District	Bay St. Louis	Hancock
Main Street Historic District	Bay St. Louis	Hancock
Sycamore Street Historic District	Bay St. Louis	Hancock
Washington Street Historic District	Bay St. Louis	Hancock

Source: National Park Service Registry data

Some districts cover one or more city blocks while others contain entire neighborhoods or a defined geographic area. The 18 districts identified in Table 2 are listed in the Federal Registry. Other state and local entities may have identified other Historic Districts on the local level that are not included in the NPS database. Those locally significant districts will be identified in coordination with local organizations during more detailed planning of the nonstructural features.

A number of these historic districts are located in the inundation zones most damaged by Katrina and many of the significant structures contained within the districts have been severely damaged by that event. Efforts are currently underway to stabilize (Pilot Stabilization Program) some of the significant historic structures within the project area, some of these structures are included in the designated districts. Should nonstructural measures be formulated that would impact one or more of the Federally-designated historic districts, extensive coordination with the National Park State and the state historic preservation office (SHPO) would be required as part of the NEPA process. Measures that modify buildings or structures within the district to reduce damages (floodproofing) may be considered so long as the architectural or historical character of the structure is not significantly diminished. Options that would relocate large numbers of structures or the entire district to reduce damages would be more problematic.

3.4 Housing Resources

3.4.1 General

Residential units represent a substantial proportion of the total structure categories damaged by hurricane and storm flooding. Because of their relatively light construction (wood frame or masonry over wood frame), residential structures cannot withstand the rigors of hurricane force winds, surge and waves without attention to newer building codes (post-hurricane Andrew). Due to the preponderance of these structure types in the project area and their tendency to be located in high-hazard areas, damages to this category are significant in a major hurricane. More than 60,000 residential units were destroyed by Katrina’s fury within the project area (Governor’s Commission Report 2005).

As described above, the project area is composed of numerous communities and neighborhoods each having their own personality and character that visually and socially separates them from one another. One of the distinguishing features that separate communities and neighborhoods is the type, quality, quantity, density and age of the housing stock. The project area has a very diverse mixture of older classic-style residences, seasonal vacation cottages, upscale “mini-mansions” and various types of condominiums, townhouses and row-house resources. The more vernacular architectural types are located in the residential neighborhoods of the older urban areas but newer versions of those local architectural styles (i.e. Acadian-Creole) are being constructed in several areas of the project; some even floodproofed by elevation.

3.4.2 Housing Market and Stock Characteristics

Prior to the arrival of Katrina, the housing market in the project area was brisk with many single-family housing construction permits being issued in each of the communities. Table 3 shows the numbers of building permits that had been issued by each community for single-family home construction between 1996 and 2006.

As the table shows, the strong increases in population described in the Socio-Economic Characteristics Appendix during the past decade are reflected in the numbers of housing units being constructed. Of note are the large numbers of single-family residential units for which permits were issued in Ocean Springs, Biloxi and Gulfport during this period. In total, over 10,200 residential building permits were issued during this 11 year period. Considering that many of these new housing units may have been within the footprint of the regulatory extent of the Base Flood Elevation (National Flood Insurance Program) and constructed so as to reduce flood damages through the local ordinances, the arrival of Katrina (a much greater depth of inundation) probably affected many of these more recent residential structures.

Table 3.
Building Permits Issued for Single-Family Home Construction by Community

Years	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Community											
Pascagoula	22	9	15	30	21	12	7	13	16	30	191
Moss Point	10	16	11	22	19	32	15	28	26	29	28
Gautier	45	54	71	84	55	46	71	95	109	68	145
Ocean Springs	78	79	88	130	121	129	139	152	163	75	87
Biloxi	93	NA	NA	151	139	135	NA	224	NA	120	186
D'Iberville	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gulfport	264	265	301	406	346	271	307	291	336	228	484
Long Beach	86	68	63	116	66	76	80	82	87	62	99
Pass Christian	50	40	47	74	100	102	65	68	74	59	237
Bay St. Louis	23	34	34	39	37	37	42	45	45	0	0
Waveland	30	46	49	55	68	47	75	120	88	73	192
Total by year	**701**	**611**	**679**	**1107**	**972**	**887**	**801**	**1118**	**944**	**744**	**1649**

Source: City-Data.com NA = Data not available

This consistent rate of residential construction was not abated in 2007. Through June 2007, approximately 1,938 single-family construction permits were issued in the 11 communities and three counties. For communities that appear to be heavily developed already, this level of new residential construction indicates a very healthy and lucrative market for housing construction, mortgage financing and housing contractors in the area. Table 3 does not include building permits issued for multi-family units or condominiums, but field observations of substantial numbers of relatively new multi-family units by the team indicates a strong market in this type of residential construction as well. US Census data indicates that in 2007 (through June) multi-family building permits were issued resulting in construction of over 1,900 new units in the project area.

The 2000 Census data indicates that the average housing stock age across the project area is relatively young. Table 4 shows the relative ages of structures constructed across the project area. Despite the relatively young age of the housing, data indicates that over 6,000 structures still existed in 2000 within the project area that were built between 1900 and 1939. Built long before the use of modern building codes or floodplain management ordinances, these structures remain susceptible to flood and wind damages. Of note is the number of residential structures built during the period between 1970 and the present. Since the communities in the project area (with the exception of D'Iberville) all entered the NFIP in the early 1970's (See Table 7 on Page 44), many homes constructed in this period were subject to the provisions of the initial floodplain management ordinances. Since the year that the initial Flood Insurance Rate Maps (FIRM's) were identified, over 55,000 residential structures have been constructed in the project area.

Table 4.
Housing Unit Ages (2000-1900)

Years	200-99	98-95	94-90	89-80	79-70	69-60	59-50	49-40	39-00
Community									
Pascagoula	47	129	267	874	3094	3161	1641	1022	707
Moss Point	35	68	87	414	1493	2024	1106	607	435
Gautier	81	344	274	995	2150	652	87	28	34
Ocean Springs	263	576	360	1065	2256	1529	597	134	312
Biloxi	613	1742	1550	3253	4734	3535	3433	1823	1464
D'Iberville	294	382	232	411	851	369	337	119	74
Gulfport	542	2362	1819	4455	7507	6174	3303	1782	1649
Long Beach	185	813	297	1317	1831	1939	506	189	218
Pass Christian	96	425	167	419	682	698	333	162	331
Bay St. Louis	90	236	130	576	687	608	451	258	770
Waveland	71	287	170	751	632	713	366	202	290
Totals	**2317**	**7364**	**5353**	**14530**	**25917**	**21402**	**12160**	**6326**	**6284**

Source: 2000 US Census (Compiled by City-data.com)

Residential densities range from 1 unit per several acres to 10-20 units per acre in more urban settings. Table 5 shows the densities of housing units (single-family and condominiums) in each of the 11 communities and the relative sizes of the communities in square miles. According to the Governor's Commission on Recovery, Rebuilding and Renewal (2005), more than 134,000 homes were damaged by Katrina and at least 65,000 homes were completely destroyed by the storm. Another 50,000 had flood damages and only 35,000 of those homeowners had flood insurance. The 2000 Census indicates over 152,000 dwelling units were located within the three county areas prior to the arrival of Katrina. Of those dwelling units, 136,000 were listed as full-time occupancy and 4,600 were listed as seasonal or vacation homes. Median housing values ranged from $80,300 to $92,500 prior to Katrina.

Table 5.
Residential Housing Densities (Units per Square Mile)

Community Name	Density per Square Mile	Land Area (square miles)
Pascagoula	721	15.2
Moss Point	251	25.0
Gautier	379	12.2
Ocean Springs	609	11.6
Biloxi	582	38.0
D'Iberville	647	4.74
Gulfport	520	56.9
Long Beach	722	10.1
Pass Christian	393	8.4
Bay St. Louis	622	6.12
Waveland	511	6.8

Source: City-data.com

3.4.3 Housing Styles and Patterns

According to the Pattern Book for Gulf Coast Neighborhoods (2005), a section of the Mississippi Renewal Forum report, there are several distinctive, residential architectural styles found in the project area. Those architectural styles include Acadian-Creole, Victorian, Classical, and Arts and Crafts. Most of these styles were constructed based upon pattern books popular prior to World War II. Within those 4 general architectural categories are building types such as side-hall or “shotguns”, cottages, L-shaped, side gable, pyramid (reflects the roof profile), and townhouses (primarily in dense urban areas). These styles and building types are scattered across the entire project area within the denser urban areas (Biloxi, Pascagoula and Gulfport) as well as the more rural areas of Hancock County. More recent developments across the area reflect modern housing styles such as the one-level “ranch”, split-level, and modifications of several classical styles (Georgian, Tudor, and Greek Revival). Nonstructural measures that directly modify the building construction or add structures in close proximity to the building should be aware of the sensitivity of theses types and styles.

As described above, housing is distributed across the project area in a number of interesting development patterns. Urban housing (townhouses) is associated directly with central business districts like Biloxi and Gulfport and is arranged in distinctive and named neighborhoods emanating from the municipal center. Other concentrations of housing occur along linear streets extending from the beachfront to the CSX railway corridor from Biloxi to Pass Christian in Harrison County and in numerous neighborhoods scattered along the back bays. Much of the older housing in Hancock County is concentrated in Waveland and Bay St. Louis between the CSX railway corridor and the beachfront. Many of these older units were devastated by Katrina. Newer subdivision developments are concentrated along Route 90 with the commercial development. Several outlying, isolated communities such as Ansley and Pearlington are located in western Hancock County and are also subject to flood damages. Housing development patterns in Jackson County range from grid-block urban layouts in Pascagoula and Moss Point to the outlying, low-density subdivisions of Belle Fontaine, Gulf Park Estates and the golf course development at St, Andrews.

There are a number of exclusive housing developments scattered throughout the project area. Many of these are associated with golf course developments, airfields, or other recreation facilities (marinas). Housing units within these upscale developments are mostly single-family detached units with some single-family attached condominiums as well. The character of the housing market shifts to a more rural farm style north of Interstate 10 with many large farms and large-lot zoning areas. Some new subdivisions associated with constructed lakes or other amenities are also located north of Interstate 10. Most of these areas were not affected directly by the Katrina surge inundation.

3.4.4 Alternative Living Quarters

Although not directly associated with the housing market, but equally important to formulation of nonstructural measures is the distribution of people living in quarters other than the traditional housing discussed above. Table 6 shows a snapshot of these alternative living arrangements within the project area for communities where census data was available. The 2000 Census lists a number of alternative housing situations for people living in the 11 communities within the project area. Among those alternative housing options are nursing homes, military barracks, correctional facilities, and centers for delinquent or disturbed children and adults, hospital wards for long-term chronic conditions, college dormitories, and non-institutional group quarters.

Table 6.
People Living in Alternative Living Quarters

Alternatives	Nursing Homes	Military Quarters	Correctional Facilities	Mental Health Centers	Hospital Wards	College Dorms	Other Quarters
Communities							
Pascagoula	120	827	257	30	8	0	22
Moss Point	126	NA	16	NA	NA	NA	NA
Gautier	NA	NA	NA	28	NA	NA	24
Ocean Springs	98	NA	4	NA	NA	NA	91
Biloxi	219	2587	NA	20	416	73	108
D'Iberville	NA	NA	NA	NA	NA	NA	NA
Gulfport	243	1137	1059	31	74	93	688
Long Beach	30	NA	NA	NA	161	NA	27
Pass Christian	197	NA	NA	NA	NA	NA	NA
Bay St. Louis	157	NA	133	9	NA	NA	26
Waveland	NA	NA	NA	17	NA	NA	7
Totals	**1190**	**4551**	**1469**	**135**	**659**	**166**	**993**

Source: City-data.com, (US Census 2000). NA = not available

Although the data is incomplete for many areas (many NA's) and types of alternative housing situations (these are not popular community marketing statistics), this data shows that over 9,000 persons, many with disabilities, may be living in specialized centers within the project area at any one time. During a hurricane or storm flood emergency that could affect one or more of these centers, evacuating this segment of the population would be at best problematic. As was evident in the evacuations of hospitals, nursing homes, correctional facilities and other specialized populations during Katrina and Rita in 2005, providing the necessary transportation, security and accommodations for these groups takes pre-planning and good coordination between the evacuated area, transportation providers and the shelters. Having sufficient warning time to evacuate these individuals is critical to reducing loss of life during extreme weather events. Although such evacuations have been successful (with some problems) in the past, other options to permanently relocate these less-fortunate or quartered individuals to less flood-prone areas should be considered in the nonstructural formulation.

3.4.5 Historic Homes and Buildings

A search of the National Register of Historic Buildings database for the 11 communities within the project area identified at least 114 structures, homes, schools, libraries, churches, theaters, hotels, public buildings, taverns, railroad depots, banks, fire stations, commercial and military buildings and sites. Many of these structures were damaged by Katrina and efforts are underway through a MS Pilot Stabilization Program to save the damaged historic structures. Table 37 in this Appendix shows a listing of these historic buildings and sites in the project area. Of those listed, only "Beauvoir" in Biloxi is considered a National Historic Landmark by the NPS. The "site" listings refer to archeological sites for which nonstructural protection measures would not be considered.

In addition to those structures listed or eligible for listing in the National Register, there are a number of structures considered by the State of Mississippi and local organizations to be significant to the region's history. Although not considered important enough to be listed nationally (some may be in that process currently), their importance from a state or local perspective warrants consideration in the nonstructural planning process. Coordination with the state and local organizations to determine the locations, flood-risks, and potential protection measures for these important structures will continue during more detailed planning for the nonstructural measures.

Although unconfirmed at this level of planning analysis, it is possible that a significant number of structures listed or eligible for listing on either the National Register or on state and local historical lists are located within inundation hazard zones where nonstructural protection options (wet or dry floodproofing) may be limited by wave action and surge depths. The numbers of historic structures being considered in the MS Pilot Stabilization Program indicates that many of these precious resources were damaged by Katrina. Floodproofing historic structures by elevation may be possible but maintaining the historic and architectural significance of a structure while raising the first floor 10 feet would be problematic. For obvious visual reasons dry floodproofing such a structure by constructing a ringwall or veneer wall around the building would be limited to a very low level of protection (4 feet or less). In areas where floodproofing would not be considered (high-hazard wave/surge zones), acquisition and relocation could be used to protect the building in another suitable location, but that option would require extensive coordination with the National Park Service and the SHPO. Replicating the building site so that the historic or architectural character of the building is not significantly diminished would be difficult.

Extensive coordination with the Mississippi SHPO and the National Park Service would be required during more detailed planning and engineering studies for implementation of nonstructural measures that would potentially affect structures or sites listed on the National Register.

3.5 Other Federal Disaster Assistance Programs in Coastal Mississippi

There are at least two other significant post-Katrina Federal programs currently operating within the communities of the project area. Both the Federal Emergency Management Agency (FEMA) and the United States Housing and Urban Development Administration (HUD) have ongoing programs within the project area that are designed to reduce future damages or to compensate landowners for damages.

3.5.1. FEMA Assistance Programs

FEMA has been operating several post-Katrina programs designed to compensate landowners for storm-related damages, reconstruct and repair damaged structures and reduce future flood damages and loss of life due to hurricane surge and other storm-related threats. FEMA administers the Individual Assistance Program (IAP), Public Assistance Program (PAP), Other than Housing Needs Assistance Program, Debris Removal Program, Temporary Housing Program and the Hazard Mitigation Grant Program within the project area. Each of these programs is administered locally by The Mississippi Emergency Management Agency (MEMA). Over 350,000 individuals and families have been helped by the assistance programs. Most of these grant programs cover losses or needs over and above any flood insurance payments that may be available to the landowner and the grants are provided tax-free.

The individual assistance program provides grant funds to individuals and families for temporary housing, and the repair, replacement or reconstruction of homes damaged by Katrina. Those repairs must be made in conformance with NFIP requirements according to the local floodplain management ordinances and the funds do not cover losses to second or vacation homes in the project area. This disaster assistance program is implemented under the Individuals and Households Program (IHP) and provides grant assistance for re-establishment of households in the affected areas.

Opportunities for applying flood damage mitigation measures to damaged homes are encouraged by FEMA administrators. However for those landowners without flood insurance, but receiving disaster assistance, the mitigation measures are optional except in those instances where a structure has been determined to be “substantially damaged” as defined by the NFIP. In these cases, a landowner must comply with the NFIP requirements of the local ordinances to elevate the structure regardless of whether or not the landowner has flood insurance. For those landowners with flood insurance, any structures that have been “substantially damaged” as defined by the NFIP would be required to comply with the elevation requirements of the local ordinances. In order to facilitate compliance with local ordinance provisions to elevate structures that have been substantially damaged, funds up to a maximum of $30K are available through the “Increased Cost of Compliance (ICC)” program (a part of the Standard Flood Insurance Policy coverage) to assist landowners in elevating their structures above the BFE. Additional long-term recovery funding can be provided through low-interest loans from the Small Business Administration.

As of April 2008, over 200,000 individuals and families have received Housing Assistance payments and over 130,000 have received Other Needs Assistance grants. Total payments to these two components of the FEMA assistance program have exceeded $1.2 billion. In addition, more than $2.8 billion has been obligated by FEMA in their Public Assistance program helping to reconstruct public buildings and facilities, utilities, roads and bridges and recreation facilities.

The Hazard Mitigation Grant Program is also being administered in the project area through the Mississippi Emergency Management Agency (MEMA). This program provides grant funds to address flood damages for structures and property that are subject to repetitive flooding or were damaged by Katrina and had been identified for acquisition in the state All-Hazards Mitigation Plan. Projects must show savings greater than costs. Some of the activities that can be implemented under the HMGP to protect either public or private property from future flood damages are:

1) Acquisition of property or relocation of buildings to convert the property to open space use

2) Retrofitting structures to minimize damages from high winds, flood, or other hazards

3) Elevation of flood prone structures (elevation under the HMGP is not permitted within the designated V-zone shown in the new published DFIRM)

4) Development and initial implementation of vegetative management programs

5) Minor flood control projects that do not duplicate the activities of other Federal agencies

6) Localized flood control projects, such as ring levees and floodwalls designed specifically to protect critical facilities

7) Post-disaster building code activities that support code officials during the reconstruction process.

3.5.2. HUD Assistance Programs

The Homeowner Assistance Grant Program (a.k.a. HAP) is a disaster recovery program being implemented through the Mississippi Development Authority for those areas specifically damaged by Katrina hurricane surge inundation. The program is generally available to low to moderate income households (up to 120% of the median household income) with limited funding for higher-income households. The program is being implemented in two phases – Phase 1 for those structures located outside the 100-year flood zone established in the FIRM but were flooded by the Katrina surge and Phase 2 for those structures damaged by hurricane surge and located within the 100-year flood zone mapped in the FIRM.

The program has two components. The first component is a compensation grant of up to $150K (Phase 1) to compensate homeowners for losses to single-family, owner-occupied duplexes or mobile homes due to flooding by surge that were not covered by insurance. The percentage of the total grant available is dependent upon the insured value of the home times the percentage of damage determined in a damage assessment. Homeowners may repair, replace or reconstruct homes as they choose with the funds. No local permits for home repair or construction or evidence of the use of the funds for those purposes is required by HUD or MDA. Homeowners must comply with local NFIP requirements for elevating the structure and may apply for the second component of the program – the HUD elevation grant (see description below) – to defray the costs of elevating the home. In Phase 2 of the HAP, the compensation grant amount is limited to $100K.

Neither the compensation grant program nor the elevation grant program restricts any homeowner from rebuilding a destroyed or substantially damaged structure or elevating a damaged/repaired structure in the new DFIRM-designated V-zone. The only requirements for the compensation grant program are compliance with current NFIP guidelines as described in local floodplain management ordinances and current building codes. Any structure being elevated under either program would be raised to the new BFE established in the DFIRM flood zone mapping. In some locations the new BFE may be lower than the surge elevation that came ashore during Katrina. Residual damages during a recurrence of a Katrina-like storm as a result these elevation and compensation programs could be significant.

As of May 15, 2008, the HAP has received 19,401 applications for Phase 1 and 8,534 for Phase 2 of the program and has distributed grant funds to 20,437 of those applicants totaling more than $1.4 billion.

In addition to the Homeowners Assistance Program discussed above, the MDA is implementing, through the HUD Community Development Block Grant (CDBG) program, the Long Term Workforce Housing Program. The purpose of this program is to provide grants and loans for local jurisdictions, non-profits and for-profit organizations to provide long-term affordable housing in the three coastal counties and Pearl River County. These funds can be used to repair, rehabilitate, or reconstruct housing units for low and moderate income families and must include at least 40 dwelling units for each grant or loan request. The program projects that as many as 5,800 housing units may be created in these four counties with only local building code and NFIP local floodplain ordinance restrictions.

Among the program requirements are adherence to local building codes and the NFIP for determining first floor elevations of new or rehabilitated structures. Existing structures considered for repair or rehabilitation that suffered damages more than 50% of the structure value by hurricane surge flooding must comply with elevation requirements through the NFIP and local floodplain management ordinances.

Sections 4.5.8 and 4.5.9.7 of this appendix address the opportunities for integrating the FEMA and HUD programs with the formulated plans in this report.

Chapter 4. Identification and Preliminary Screening of Nonstructural Measures

4.1 General

There are a number of measures that can be classified as “nonstructural”. In some cases such as dry floodproofing by the use of ringwalls or ring-levees, a nonstructural measure can approximate a structural solution when expanded to protect a large contiguous complex (college campus, industry, or commercial area). When judiciously applied, nonstructural measures can result in reductions in inundation damages and losses of life to structure occupants. Corps of Engineers documents and regulations as well as the technical papers and bulletins of other Federal and state agencies that address flooding from storms and hurricanes contain lists of possible nonstructural measures. Generally speaking, each of these identified measures can be applied either singly or in combination with other nonstructural or structural measures to attain project goals and planning objectives. Screening of the measures can be accomplished in a preliminary fashion by considering lessons learned from previous nonstructural projects, potential socio-economic impacts, environmental justice issues, and political realities of implementing certain measures at the local government level.

4.2 Damage Categories

Prior to identifying potential nonstructural measures, a quick review of the damage categories to which the measures may be applied is warranted. These categories generally represent the sphere of land uses and property ownership options in the project area. These categories include:

1. Private properties occupied by residences (single-family and multi-family)
2. Private properties occupied by commercial structures and facilities
3. Public properties occupied by public buildings and facilities (Federal, state, municipal and county owned) or other damageable items
4. Private properties occupied by entertainment structures and facilities
5. Private, interspersed properties that were vacant prior to the Katrina event
6. Private properties that were made vacant by the Katrina event (total structure or facility loss.
7. Public, interspersed properties that were vacant or made vacant by Katrina.
8. Public properties occupied by industrial development
9. Private properties occupied by industrial development
10. Public utility corridors and installations (substations)
11. Public properties occupied by transportation modes
12. Private property occupied by transportation modes
13. Public parks and open space

Each of these damage categories (listed as either private or public property and attendant structures or facilities) can be addressed by one or more nonstructural measures and several categories of land use include contents damages as well. These land uses and associated structures and facilities are already addressed in county and municipal zoning ordinances, comprehensive plans and floodplain management ordinances. However, there remain a substantial number of at-risk structures and facilities subject to flood damages from hurricanes and storms.

4.3 Loss of Life Issues

Damages to private, corporate and public property along the Mississippi coast were in the billions of dollars, but the most compelling losses were those to human life in the state due to Katrina. Estimates are that more than 250 people perished during the storm in the project area and more than 60 were unaccounted for following the storm and presumed to be missing or dead. The combination of surge, waves and wind overpowered many who either attempted to ride out the hurricane or were trying to escape the storm and waited too long to avoid the surge and waves.

Many who were able to ride out Camille in 1969 believed that they could weather Katrina inside their homes only to discover too late that the surge depths far exceeded previous storms and they perished as their homes were destroyed or as they were fleeing in desperation. Personal interviews from survivors during the planning process revealed numerous people were unable to escape because key evacuation routes were submerged during the storm. Many survivors clung to roofs and trees to escape the surge flooding and waves.

Detailed information on the number of dead within each community or neighborhood, locations of the recovered bodies with respect to their place of residence and the cause of death (drowning, heart attack, impact injuries, etc.) are unavailable at this time due to the sensitivity of that information. Hopefully that information can be disclosed by state agencies during later more detailed planning so that identified high-hazard zones where permanent evacuation may be the most advantageous option and the need for timelier hurricane warnings and safe evacuation routes can be better supported for implementation.

Issues of public safety and loss of life during these extreme weather events have become more significant in the planning process since Katrina. The ability to provide timely storm warnings, safe escape routes and safe shelters is a key component of reducing future loss of life along the coast. In some cases, permanent evacuation of some coastal neighborhoods may be the best way to assure public safety and avoid future losses of life. Alternative plans that integrate various nonstructural measures for the purpose of reducing loss of life will be explored during the plan formulation process.

4.4 Goals and Objectives

The main body of the MsCIP report displays a number of project goals and objectives that address the existing conditions listed in the project study authority. Existing problems to be addressed in the study authority include: 1) hurricane and storm damage reduction, 2) prevention of saltwater intrusion, 3) preservation of fish and wildlife, 4) prevention of erosion, and 5) other related water resource purposes. From these problems, the MsCIP team in coordination with project area stakeholders and cooperating agencies developed goals and objectives that would guide the planning process and could be used to evaluate formulated measures and alternative plans. During the study process, one goal began to emerge that summarized the efforts of the team; formulation of alternative plans that as a result of their implementation, would enable the Mississippi coast to become a disaster-resilient community.

Among the many objectives developed to support that emergent goal (disaster-resilient community) are several that can be directly addressed by nonstructural measures. Those include:

1) Reduction of the potential for future storm created flood damages,

2) Reduction of the potential for future storm related threats to life and safety,

3) Reduce costs for storm related emergency services,

4) Provide environmental justice in recommended solutions,

5) Provide complete solutions (in accordance with the P&G),

6) Provide solutions “acceptable” to communities & resource agencies,

7) Provide environmentally sound solutions,

8) Provide solutions that fit within existing laws, policies, regulations, and the general plans of local governments and communities,

9) Minimize impacts to the environment, and

10) Generate opportunities for ecosystem restoration of wetland habitat.

It is for these stated objectives that potential nonstructural measures and their integrated plans are formulated and against which they will be evaluated for effectiveness, cost effectiveness, completeness, acceptability and environmental suitability.

4.5 Potential Nonstructural Measures

The nonstructural measures described below can be grouped into several general categories including:

- Flood Preparedness and Emergency Evacuation
- Floodplain Management, Floodplain Zoning, Flood Insurance and CRS
- Building Codes
- Land Use Regulation and Zoning
- Development Impact Fees, TDR, TPR, and Redirection
- Land Taxation Policies, Special Assessments and Revenue Sharing
- Floodproofing
- Permanent Acquisitions (Evacuation and Relocation)
- Replacements of Public Buildings (Critical Facilities)

In an effort to simplify the formulation of nonstructural plans and reduce repetition of evermore detailed evaluations of the measures, the following paragraphs include a description of the individual measures, how they might apply to the project area given existing conditions, costs associated with the measure, operations and maintenance costs and whether the measure should be carried forward into the more detailed project formulation process (a preliminary screening of the measures).

4.5.1 Flood Preparedness and Emergency Evacuation

4.5.1.1 General

Flood Preparedness includes a multitude of management activities and features that all contribute to a reduction of flood damages and reduced losses of life due to hurricanes and storms. These management activities can apply to the emergency operations of Federal, state and local agencies as well as to the response actions of individual property owners. During the days and hours that preceded the arrival of the identified and tracked storm known as Katrina, agency emergency operations and landowner responses were already taking place that saved countless lives and reduced property damage. That many more did not perish in the event is a testament to the fact that sound flood preparedness and emergency evacuations were successful.

Generally speaking, storm warnings and emergency evacuations fall under the purview of the National Oceanic and Atmospheric Administration (NOAA) and the Federal Emergency Management Agency that includes offices at state and local levels of planning and deployment. Although the Corps of Engineers is not a direct player in these types of flood damage reduction components, the Corps does support these activities as an important part of reducing flood damages and reducing losses of life. The following measures outline the types of storm/hurricane warnings and emergency evacuation management activities that could be implemented by Federal, state and local managers.

4.5.1.2 Research Findings

Among the many post-disaster studies of hurricane-readiness in the project area, a study conducted by the Harvard School of Public Health (2007) using a random sample of 513 residents by telephone interview revealed interesting attitudes and concerns of the local population regarding flood/hurricane preparedness. Besides the 8 demographic questions included in the survey, each respondent was asked 48 questions regarding their individual or household preparations and specialized needs for evacuation in the event of a future hurricane. Most of the respondents (95 percent) had experienced Katrina and either suffered damages to their residence or were aware of damages in the area.

Many of the respondents indicated a renewed interest in preparedness and had equipped their households with substantial resources and supplies in the event of a future storm. A majority of the respondents indicated as well that they would evacuate the area if told to do so by government officials. If an evacuation were necessary, many indicated that they would leave by personal vehicle and would stay with family or friends up to 200 miles away from the coast. For those who indicated that they would evacuate many concerns were expressed about the safety and capacity of evacuation centers to handle the evacuees. Issues of water and food supplies, safety, sanitary facilities, over-crowding, and medical care were expressed by respondents.

For those who may have chosen to remain in hazardous areas during a hurricane, the primary reasons for staying at their residences included: 1) considered home to be well-built and would be safe staying, 2) concerns about theft and damages to the evacuated home, 3) believed that the roads would be too crowded to safely evacuate, 4) believed that evacuation would be dangerous and 5) needed to take care of someone who would be physically unable to evacuate. All of these issues should be addressed as revisions to certain aspects of the evacuation system to assure that residents who may be in serious peril do not feel compelled to remain during a hurricane and those who choose to evacuate can do so safely and with limited stress.

Studies, such as the one described above, give valuable information regarding the concerns and issues confronting the project area population who would face more hurricanes in the future. Formulating a robust flood preparedness and evacuation system that addresses these concerns is one of the objectives of the nonstructural PDT. The many components of flood preparedness and potential upgrades of that system are discussed below.

4.5.1.3 Storm/Hurricane Identification, Tracking and Forecasting

Generally, the majority of hurricanes and coastal storms capable of inflicting significant damages to structures in the V-zone develop over days within the Gulf basin. Fortunately, this developmental period allows the National Weather Service and the National Hurricane Center the opportunity to provide ongoing information on the formation of the storms and their probability of making landfall at one or more areas of the Gulf Coast. The opportunity to identify the storm threat, forecast its probable movements and issue advanced warnings for temporary evacuation of high-hazard coastal areas can lead to substantial lessening of loss of life and property damages.

One can only imagine with horror the potential loss of life and property losses that would have occurred had not Katrina been so well tracked and advanced warnings issued for mandatory evacuation of portions of the Gulf coast. Regrettably many who survived Camille in 1969 decided to weather out Katrina rather than evacuate – their names were listed among the dead or missing. This sad fact points out that a flood warning and emergency evacuation program has many facets - any one or combination of which left uncompleted or unheeded can lead to disaster.

The warning and evacuation system is composed of several components: 1) Threat identification and analysis, 2) Forecasting, 3) Dissemination of threat warning, 4) Threat understanding, 5) Evacuation and 6) Sheltering. Today the ability to see the development of hurricanes and major storms within the Gulf is aided by a great number of sophisticated technology and data sources. Weather satellites, Doppler radar imaging, hurricane hunter aircraft, reports from ships at sea, reporting oil rigs, moored buoys, Caribbean weather stations, and many other proven data sources can track an approaching hurricane, tropical storm or major low-pressure system in real time and generate reliable data upon which forecasts of direction, speed, and intensity can be based. Both polar orbiting and geostationary weather satellites provide storm images in visible light and infrared, as well as showing water vapor images of these storms.

Land, ship or aircraft-based Doppler radar provides a detailed picture of rainfall intensity, speed and circulation characteristics within the storm. NEXRAD or "NEXt generation doppler RADar" is much more sophisticated allowing closer examination of rainfall intensity, storm direction and speed as well as measuring wind speeds (motion of dust particles within the storm) in the absence of rainfall. NEXRAD, with a range of more than 140 miles from the radar site, provides much better information on the intensity and speed of hurricanes and other storms in the gulf. There are NEXRAD stations in New Orleans, LA, Biloxi, MS (Kessler AFB), and Mobile, AL. Radar imagining from these three stations overlaps the entire Mississippi coastal area.

In addition to satellite imagery and land and ship based radars, the on-station telemetric data and information generated by the "Hurricane Hunter" aircraft provides forecasters a more complete picture of hurricanes and other major storms in the Gulf. The Lockheed Martin WC-130J Hercules aircraft, specially out-fitted with sophisticated instrumentation fly repeatedly through tropical storms and hurricanes to collect data such as wind speeds and barometric pressure that cannot be obtained by weather satellites. Flights into major storms begin when storms are still classified as tropical depressions and tropical storms by their barometric pressure and wind speeds.

Using Doppler radar and "dropwindsondes" that are dropped from the aircraft during the flight, readings of barometric pressure, wind speed, air and water temperature, storm direction, and speed are delivered to the National Weather Service by regular interval flights into the storm. The 53^{rd} Weather Reconnaissance Squadron of the Air Force Reserve stationed at Keesler AFB in Biloxi, MS provides these essential services within the Atlantic Ocean, Caribbean and the Gulf of Mexico.

Although severely damaged during Katrina, when the 53rd Squadron flew out of Dobbins Air Reserve Base, Keesler AFB has been repaired and the “Hurricane Hunters” continue to provide weather surveillance data for the Gulf States. These aircraft and their brave crews are an invaluable component of the early warning and emergency evacuation system in the project area.

The National Weather Service (NWS), a department of the National Oceanic and Atmospheric Administration (NOAA), operates and maintains a series of moored buoys in the Gulf of Mexico that provide a real-time stream of weather and oceanic data. The buoys range in size between 12 meter diameter discus buoys and 3 meter diameter buoys and most are tethered to the ocean floor. Other buoy types include spar buoys with multiple moorings and wandering buoys (NOMAD). Because of their size and sturdier construction, the 12 meter discus buoys are more reliable in hurricane and storm conditions resisting capsizing and wave damage to the structure and instrumentation. Figure 4 shows a 12 meter discus buoy being serviced. Larger buoys such as the 12 meter discus buoy are towed into position by Coast Guard vessels. Spar buoys although more expensive in capital and O&M costs are more stable platforms for satellite telemetry than the discus buoys. Information on air and water temperature, atmospheric pressure, wave heights and wave period, wind direction and speed, and other weather data is up-linked to communication satellites and weather stations along the Gulf.

This “hurricane DEW Line” system provides reliable data to the National Weather Service on the speed direction and strength of approaching storms, tropical storms and hurricanes. In addition to the hurricane hunter aircraft that provide atmospheric and ocean condition data from within the storm itself, these buoys relay constant data on weather and ocean conditions at the water surface. The National Buoy Data Center (NBDC) Web Site provides ongoing updates of the buoy data in the Gulf. That web address is: http://www.ndbc.noaa.gov/.

One component of this measure could be buoy system upgrades in the Gulf coordinated with NOAA. Consideration should be given to whether or not additional reporting buoys in the gulf would provide a better picture of the strength, direction and speed of hurricanes, tropical storms and other ocean phenomena that would endanger the coastal area of the state. Having better and more reliable information on the expected height of the storm surge and associated waves would assist emergency personnel in making more informed and quick decisions about which coastal inundation zones are at risk from a particular storm. The inability to correctly select which inundation zones should evacuate quickly erodes the public’s confidence in the warning and evacuation systems.

During Katrina’s relentless approach to the coast, a number of reporting buoys in the middle of the hurricane broke free of their moorings and drifted from their known positions. Although the buoys kept reporting data, without a reliable position, the NWS had no way to locate where those conditions were in relation to the eye of the storm. Consideration should be given to modifying the existing buoys through NOAA programs so that “break-a-ways” during extreme hurricane events due to huge waves or extreme surge depths will not void the valuable data being relayed to the NWS.

Based on information gleaned from NOAA online sources, the installation of the 12 meter discus buoys cost in the range of $2.5M to $3.5M per buoy depending upon water depth and towing distance. This cost includes buoy construction, installation of instrumentation, towing to the Gulf site and anchoring the buoy. Annual O&M cost for the 12 meter discus buoy is approximately $500,000. Capital and installation costs could be shared between implementing agencies or with a project sponsor and annual O&M cost would be borne by NOAA (cost data supplied from NOAA publications).

Having more precise information on the intensity, location, track and anticipated landfall of severe storms is the basis for any storm warning and emergency evacuation system. Since these measures all contribute to having more precise information on the level of threat that any particular storm or hurricane poises as well as better information to determine where and when the effects of the storm will make landfall, all of these proposed measures should be retained for more detailed formulation.

4.5.1.4 Warning Dissemination

One of the most important factors in being able to successfully and safely evacuate coastal areas is allowing sufficient time between the determinations that a particular storm's track will make landfall at designated locations along the gulf coast and fully disseminating the warning to those in the target area. These predictions are based upon numerous factors of storm speed, direction, intensity, other weather conditions (low pressure and high pressure land systems) in the region. Generally hurricane threat information is distributed to the public as "hurricane watches" and "hurricane warnings" by the NWS. According to NOAA information, a hurricane watch is an announcement by the NWS for specific coastal areas that hurricane conditions are possible within 36 hours. A hurricane warning is a public announcement by the NWS that sustained winds 74 MPH or higher associated with a hurricane are expected at a specified coastal area in 24 hours or less. These watch and warning times are not adjusted according to the strength of the hurricane as the physical radius of the hurricane-force winds from the eye of the storm is usually closely correlated with the strength of the storm (more intense the storm (Safir-Simpson scale) the larger the radius of the storm). In the case of Katrina, the radius of the storm was much larger than previous storms of that intensity (such as Camille).

Information gleaned from various web sites and the three county emergency evacuation plans indicated that at least 36 hours may be required to safely evacuate threatened zones along the coast prior to the larger storm events (categories 4 and 5). Although there is much concern over issuing evacuation orders too soon without sufficient information to accurately determine where landfall will occur, the potential for many people to be trapped on crowded roads when the storm surge arrives or to wait till that last possible moment before evacuating gives some credence to the possibility of issuing a warning in advance of 24 hours when hurricanes reach Categories 4 and 5. A considerable number of people lost their lives while fleeing from Katrina. In addition to the existing dangers of evacuating high-risk project areas, should a nonstructural plan featuring thousands of elevated structures be implemented, having sufficient time available for those households to evacuate safely will be a major component of that plan.

Due to the number of large recreation facilities and operating industrial plants that cannot be moved from high hazard areas, specific warning systems should be developed that notify these people-filled facilities on an ongoing basis about potential threatening storms and expected hazards at their specific locations. Specific evacuation procedures for each of those facilities would be prepared in close coordination with the facility management and local emergency management personnel.

One of the many warning measures that should be investigated further with NOAA and the NWS is the possibility of extending the hurricane warning time from 24 to at least 36 hours in the advance of landfall for the larger more powerful storms with hurricane force winds and surge that extend across larger areas. Especially for any hurricanes in the 3, 4 and 5 categories that affect larger areas of the coast. Based upon all accounts of Katrina's approach to the coast, its size and the extent of damages and loss of life wrought by the surge, a longer warning time may have saved lives.

Other forms of emergency notification of the population living along the coast in hazardous areas are available. Reverse 911 systems that generate phone calls to homes and businesses in selected sections of the coast that are correlated to the current emergency evacuation plans would be an effective way of issuing storm warnings or evacuation orders. In addition, these same systems could use cell phone technology (voice mail, text messaging, paging, etc.) to contact individuals with that service. In either case such notification systems could be effective in issuing evacuation orders and if repeated on a regular hourly basis in advance of storm landfall may decrease the chances for loss of life. Given the diversity of the population within the project area, hurricane/storm warnings should be issued in several languages as well as sign language on public television stations. Other warning dissemination methods should be explored that would address physically and mentally disadvantaged populations in the region as well.

Despite all of the various forms of media available to the population within the project area (i.e. television, radio, internet, cell phones, broadband, etc.), there is no guarantee that individuals will have access to the media, that the media systems will be functional at these critical times, or that individuals would be aware of impending threats from storms or hurricanes at all times. For this reason, other less sophisticated systems should be in place that would provide unmistakable evidence that there is an impending threat approaching the coast.

As a nonstructural measure, a system of sirens located across the project area could provide an emergency signal whose message would be unmistakable given sufficient education of the population of the purpose and meaning of the sirens' use. Mounted on wind-resistant poles located at intersections and serviced with underground power, the sirens could be used in conjunction with other media and communications systems to alert the population to the coming threats. For the hearing impaired, flashing strobe lights could also be installed in neighborhoods so that all segments of the population could be notified of impending danger.

Warning sirens installed on a pole mount range in costs from $15,000 to $25,000 depending upon the anticipated coverage area and required pole height. Battery backup systems are available for that price range. Costs include the siren, pole and wiring plus installation costs. Annual O&M costs are approximately $500 per siren. Flashing strobe lights range in costs from $250 to $500 installed depending upon the wattage and mounting location. Annual O&M costs for the flashing lights would be contingent upon instances of vandalism and theft and would be limited to purchase of a new strobe light and its installation.

Generally the majority of the population within the project area has access to various media (television and radio) that would be carrying information from the National Weather Service on local news stations regarding the threat levels of oncoming storms and hurricanes. However, there are sectors of the population who do not have ready access to media resources and therefore may not be made aware of these impending threats. In light of this situation, a nonstructural measure could be to distribute weather service radios that continually provide weather related information on an impending hurricane or storm event. Considering the growing diversity of the population in the project area, announcements of impending weather-related emergencies need to be broadcast in multiple languages.

The National Weather Radio (NWR) system is a nationwide network of over 900 radio stations broadcasting continuous weather information directly from a nearby National Weather Service office. NWR broadcasts National Weather Service warnings, watches, forecasts and other hazard information 24 hours a day. There are three NWR stations in the project area including Mobile, AL, Gulfport, MS and New Orleans, LA that provide full coverage of the project area through the weather radio system. The special radio receivers or scanners that pick up the NWR information can be purchased from the NWS or many other commercial outlets. For the hearing or sight impaired population, these alert systems can be connected to other alarm systems (flashing lights, sirens, etc.) in the home or business. Standard NWR receivers cost approximately $80 and could be purchased in bulk for distribution to identified sectors of the project area population that would be at risk and lacking the resources to purchase the radios. A significant number of those needing these resources could be addressed with a modest project investment at the current unit price. Annual O&M costs would be limited to battery replacements unless rechargeable batteries are chosen (slight increase in purchase cost).

The ability of emergency services agencies to quickly and decisively issue credible warning is a key element in an effective storm/hurricane warning system. Since all of these measures contribute to that system's effectiveness, all of them are carried forward into more detailed formulation.

4.5.1.5 Evacuation Planning & Public Education

Once the threat of an approaching storm has been determined by the NWS, specific steps can be taken by local communities and emergency services personnel to begin evacuating those families and individuals and their movable contents to safe areas. Emergency evacuation zones of the coastal region have been mapped based upon surge depths, wave action and FEMA flood frequency data. Those families and individuals as well as concentrations of special populations (hospitals, assisted living, schools, jails, etc.) in structures subject to inundation are notified by county or city emergency services to evacuate to safe areas designated by the counties. Specific evacuation routes have been identified by the three counties that will assist evacuees in finding the safest and quickest way to flee the approaching storms.

Each of the three counties has developed emergency evacuation plans that indicate when the various zones must be evacuated, the best available evacuation routes (streets, roadways and highways) and where safe temporary evacuation centers are located. Theses plans need to be better coordinated with Federal and state agencies and departments and better disseminated to the public at large. Telephone, short-wave and cell phone communications enable emergency personnel to coordinate these activities with local police and fire units in the cities.

One of the most important features of any emergency evacuation plan is the education of both the emergency personnel responsible who will be implementing the plan and the citizens who must respond to the emergency evacuation orders posted by local authorities. Many people perished during Katrina because of their lack of information or understanding of the deadly threat that the storm surge and waves would pose for anyone staying within the expected surge inundation zones.

Regardless of the amount or quality of pre-emergency planning and preparation accomplished prior to the next weather-related emergency, the one constant random element remains the reactions/responses of the at-risk population when mandatory or voluntary evacuation orders are issued. Reducing the potential loss of life and injuries to the evacuees depends largely upon the population's understanding of the threat and what appropriate responses to that threat will be effective for each household or individual. Knowing where evacuation routes and safe evacuation centers are located can make the difference between safety and tragedy.

In order to better equip the at-risk population, a series of training and information seminars, media presentations, and other public forums assisted with easy-to-read and understand materials could be implemented as a nonstructural measure. Information on these emergency subjects can be placed in libraries, community centers, hotels and motels, managed-care facilities, hospitals, banks, credit unions and post offices. Applicable web addresses, phone numbers, radio station frequencies, and emergency evacuation routes could be stressed in this public information. The costs of these materials would be minimal since they are already available through Federal and state agencies. Training and information seminars could be hosted by FEMA, MEMA or USACE at minimal costs.

In addition to educating and training the general population, the most effective education for the project area's future would be at the elementary, middle school and high school education levels. Education materials including textbooks, coloring books, workbooks, posters, computer programs and role-playing games could be distributed throughout the school systems to increase the awareness and understanding of all school-aged children (in a non-threatening way) about hurricanes, flooding and emergency responses to these conditions. Generally parents of children made aware of threats at school seem to respond in a more affective and positive way out of concern for their children's safety. Additional resources available through FEMA for children can be found at: http://www.fema.gov/kids.

Obviously this education process cannot be a one-time affair as new citizens move into the coastal area over time and emergency personnel change jobs, retire or move elsewhere for employment opportunities. More importantly is the fact that the project area is visited by millions of tourists each year – people who may be unaware of the potential threat from these storms and who may not have adequate transportation (such as fly-ins) to evacuate safely. Education of the public must occur on a regular basis about the threats that hurricanes and other large storms present and what steps the public can take to protect themselves and their property. Certainly this public awareness needs to be heightened with the approach of each new hurricane season. At a minimum, annual emergency drills and testing of the warning system are the measures that assure quick and affective response to these threats. Education at all levels (elementary through elderly) is important to assure public safety.

An additional concern would be for the many facilities that are inextricably tied to the water's edge either by legal restrictions (casinos and associated facilities) or by their need to operate at the water's edge (Ingalls Shipbuilders, Chevron Oil, MS Power Company, Port of Gulfport, etc.). Special evacuation plans for these major industrial and recreation facilities will need to be developed in close cooperation with the local emergency management offices and the individual facilities themselves. Costs for development of these individual plans would be shared between USACE and a non-Federal sponsor.

The effectiveness of any threat identification and warning system is inextricably tied to the timely and correct response by the general public, agencies and organizations who will be most effected by the threat. An unheeded warning or a warning not taken seriously is a formula for disaster. Since effective and ongoing education of the public to the seriousness and reliability of the warnings that may be issued in the future is the key to a successful evacuation, all of the above measures regarding public education and evacuation planning are being carried forward into more detailed formulation.

4.5.1.6 Evacuation Routes and Signage

4.5.1.6.1 Evacuation Routes

The population of the communities within the project area is increasing daily as households and commercial businesses re-establish in the area. When a hurricane warning is issued by the NWS for certain reaches of the Gulf Coast and particular areas known to be at-risk from surge inundation and waves are notified to evacuate, there would be a massive migration of people in vehicles from the coast. The massive vehicular evacuation experienced in areas of Texas during the approach of Hurricane Rita in 2005 illustrates the importance of having designated routes.

During an emergency evacuation situation, identified evacuation routes are critical to assuring that those families and individuals that are at risk in identified evacuation zones can safely and efficiently leave the danger zone(s) and seek shelter in designated areas. In addition, the evacuation routes provide efficient routes for evacuation of people by buses or other transit vehicles that may not have access to personal vehicles. Generally the routes are streets, arterial roadways and highways designated by the county emergency services agencies in cooperation with the State Department of Highways which in this case is the Mississippi Department of Transportation.

Figure 5 shows the MDOT Hurricane Evacuation Routes (in red) that extend northward from the coast. In selecting the appropriate routes, the distribution of the population within the hazard zones, highway capacity (lanes and roadway width), critical intersections, bottleneck areas (reduced lanewidths) and other parameters are all critical factors. Planned improvements to those critical components of the evacuation routes can dramatically improve the efficiency and safety of the evacuation process.

Of most importance is ongoing education of the public as to the location of the routes and the locations of designated shelters. This process can be woven into the everyday activities of the state DMV regional offices from the testing of new drivers (drivers test manuals) to the annual vehicle registration renewal, (information included in the registration package) and license renewal processes. Public service announcements (television and radio and published media) identifying the evacuation routes by highway number, name and/or by graphics could begin prior to the start of hurricane season (June) and continue on a regular basis through November.

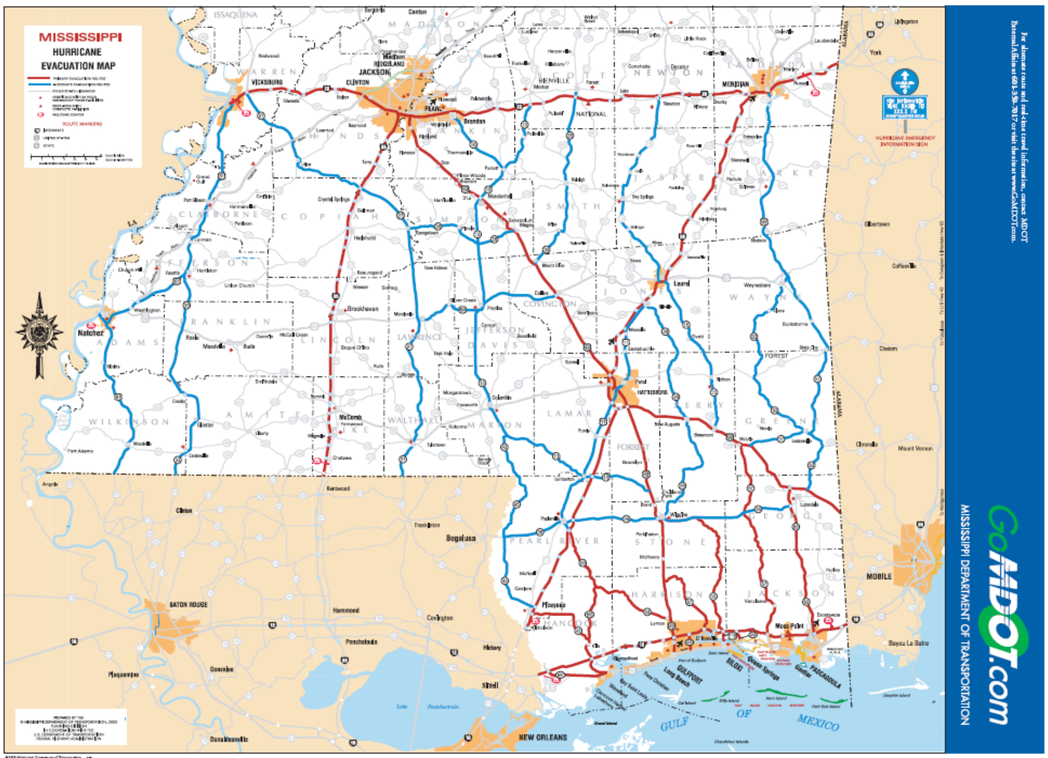


Figure 5. Evacuation Routes MDOT

4.5.1.6.2 Evacuation Route Signage

As important as selecting safe and efficient evacuation routes is the signage of the selected routes such that citizens can quickly identify the appropriate routes and be assured that they are still on an approved route as they travel away from the hazard zone. In addition to full-time residents fleeing an approaching hurricane, a great number of tourists and out-of-region visitors are living in temporary residences (rentals, motels, time-shares, etc.) in hazardous zones as well. Since hurricane season begins in June, the areas beaches and oceanfront properties may be crowded with families and individuals who are ignorant of the threat and the evacuation plans. Their unfamiliarity with the local highways and roadways can make evacuation for everyone a nightmare. Having carefully conceived and wisely installed highway signage that clearly identifies evacuation routes is of paramount importance to successful evacuation. Figure 6 shows a basic hurricane evacuation route sign using the cyclonic logo that is commonly used to designate hurricanes throughout the nation. Placement of theses signs at appropriate intersections and frequently along the evacuation routes could be initiated through a Federally-funded program (Homeland Security) using MDOT as the local sponsor and installer of the signs.

Figure 6. Hurricane Evacuation Route Sign

Costs for the signs range from $250 to $350 installed depending upon the number produced and the installation methods used. Annual O&M costs for the signage are limited to replacement of a percentage of signs due to vandalism or theft.

In addition to the standard metal post signs, other types of signage can be installed that would provide fleeing motorists with information on traffic accidents, available shelters and other important information. Dynamic information signs that flash messages to approaching motorists can be installed along major evacuation routes at strategic locations. Installation options range from smaller pole-mounted roadside signs to multi-lane towers that span 3-4 lanes of traffic. Costs for these installations range from $100,000 (roadside) to $400,000 (multi-lane tower) and annual O&M costs range from $4,000 to $7,000 for the messaging board itself. These signs could be located along the main evacuation routes from the coast to convey up-to-date emergency information to motorists.

4.5.1.6.3 Highway Routing

Reverse-flow traffic routing (also known as “contraflow”) of highways during emergency evacuations is an effective method of moving large numbers of vehicles away from the coast in a relatively short period of time. Successful implementation of this measure requires the full cooperation of the MDOT and adjacent states, and local and state police in planning and administering the reverse-flow routing of traffic during these emergencies. Pre-planning of the target routes away from the coast, modification of intersection signaling, additional turning and travel lanes, dynamic messaging boards and highway signs are all components of this measure. As in the case of other flood preparedness measures, public education is a valuable component of this measure and would require repetitive application to maintain preparedness.

Costs for additional traffic lanes, turning lanes or intersection improvements (see below) are not available without more detailed planning and coordination with MDOT. Annual O&M costs would be commensurate with annual O&M costs experienced by MDOT for lane maintenance.

4.5.1.6.4 Intersections and Modal Crossings

During a major hurricane storm event that would initiate substantial numbers of evacuations from the coast, three primary modes of transportation along the coast would be energized to move damageable assets further inland. In addition to the obvious highway routes already identified above that would attract personal cars, trucks, buses, military vehicles and other vehicles exiting the coast, CSX railway and gulf vessels would also be attempting to move valuable assets away from the coast. Where these various transportation routes intersect (at-grade crossings, bridges, overpasses, etc.) evacuation conflicts can occur. Although major highway intersections can be signaled to reduce conflicts between local and emergency evacuation traffic, at-grade railway crossings occupied by railway stock being relocated in advance of a hurricane event can effectively block thousands of fleeing motorists.

Likewise, fishing fleets and pleasure craft seeking shelter in safe anchorages within tributary rivers and embayments that result in raised drawbridges can also block thousands of fleeing families. These inter-modal conflicts can be resolved along major evacuation routes through an intentional program of expenditure by state and private companies. In addition to these inter-modal crossing conflicts, most of the evacuation routes cross multiple streams and rivers that can be reaching flood-stage as pre-landfall precipitation swells these intersecting drainage-ways. A MDOT-led assessment of all culvert sizing at small stream crossings and maintenance of debris removal in stream/creek channels would help to assure that the major evacuation routes are indeed available during an emergency.

Determining costs for eliminating at-grade crossings, drawbridges and other intersection conflicts require more detailed planning and engineering investigations than are possible given the time and resources available for this appendix. Intensive coordination with MDOT could determine capital and O&M costs for these measures.

4.5.1.6.5 Evacuation Route Resources

As Hurricane Rita so vividly pointed out to the residents of Louisiana and Texas and the rest of America through CNN news, there are a myriad of possible accidents and crises that can take place during a full-scale Gulf coast evacuation. Accidents, vehicle fires, breakdowns, medical emergencies, insufficient fuel supplies and many other on-roadway emergencies can occur during the movement of thousands of households and residents. Contingency plans that address possible needs along each designated evacuation route from the Gulf need to be prepared based upon lessons learned from Hurricane Rita and the needed resources (fuel, emergency responders, repair facilities, etc.) either put in place by state emergency offices or county emergency services or provided for through joint agreements with local resource providers. Annual emergency evacuation tests should include mock activation of these in-route resources to assure their availability in the event of a real emergency.

As in the case of other evacuation activities, determining capital and O&M costs for developing these resources along the evacuation route are not possible at this level of planning detail.

The largely successful evacuation of the Texas and Louisiana coasts preceding the landfall of Hurricane Rita in 2005 is a testament to the need for good evacuation route planning, signage and other measures discussed above. Many of the unexpected incidents that occurred during that evacuation and were highlighted on national media can be avoided and measures for that purpose are included above. Since these measures can contribute to a more orderly and safe evacuation from coastal areas, they are all carried forward into the more detailed formulation process that follows.

4.5.1.7 Evacuation Centers/Shelters

In addition to those evacuation centers that may already be listed by the local emergency management agencies, a series of alternative centers should be identified for use by the coastal population. In consideration for the numbers of people that attempted to evacuate the MS coast immediately prior to landfall by Katrina and later Rita in Texas, having an oversupply of evacuation centers available is important. Should there be a number of schools and other large facilities relocated as a part of the implementation of this comprehensive plan, then these additional “safe” resources need to be added to the list of evacuation centers. Location by GPS coordinates and mapped in GIS format would help all emergency managers and resources (police, National Guard, etc.) manage the evacuations. Additional information on the design and construction of community shelters can be found in the publication: FEMA 361 – Design and Construction Guidance for Community Shelters.

Emergency evacuation of families during Katrina and Rita identified needs for accommodations for specific populations requiring special medical care (elderly, children, chronic illness, and hostels) as well as family pets. Provision for these “special” evacuees should be considered at the identified evacuation centers.

Once identified, emergency-use agreements between local emergency managers and facility owners need to be executed for use of evacuation centers so that administrative processes or finances do not hinder the evacuation process when an emergency is declared. Annual review of those agreements as a part of the annual emergency system test would assure updating of the agreements and any financial considerations.

In addition to the identification of usable evacuation centers and execution of use agreements, provision of basic necessities for a relocated population for up to a week need to be considered. Caches of storable food, water, medical and bedding supplies need to be established at or near the evacuation centers. As with other components of the emergency evacuation system, these resources should be evaluated on an annual basis when the system is tested.

Determining costs for rental of potential evacuation centers and their supply with basic necessities requires a more detailed study of the center capacity needs and coordination with owners of available centers.

Generally speaking, sufficient, safe accommodations of sufficient capacity to handle thousands of evacuees in the face of an impending hurricane landfall are not readily available within the project area. The many hotels and motels within the project area are usually booked during a significant portion of the hurricane season and many of those are currently subject to surge flooding or wind damages. Moving north from the coast, sheltering options (hotels and motels) are limited to small communities located along the identified evacuation routes. Other sheltering options are limited to larger schools and community facilities located away from the coast. Being able to locate these optional facilities, pre-arrange for their use in the event of emergencies and assure that sufficient supplies are on hand in the event of a hurricane landfall are all key components of a safe and efficient evacuation. Since all of these measures contribute to those objectives, they are carried forward into more detailed formulation.

4.5.1.8 Safe Harborages/Anchorages

Of the many commercial enterprises that exist along the Mississippi coast, the commercial fishing and seafood industry is one of the most enduring, most profitable and most threatened by hurricanes and storms in the Gulf. Besides the significant affects that these storms can have on the aquatic life and their habitat that these industries depend upon (fish, oysters, scallops, shrimp, etc.), protecting the fleets of corporate and individually-owned fishing boats and trawlers during these damaging storms is a challenge. During Katrina, many of these large vessels were swept into the coastal forests and residential neighborhoods and the waterside infrastructure destroyed by the storm surge and waves. With the approach of large hurricanes that carry significant surge heights, damaging waves and high winds, this fleet is faced with certain annihilation if it stays within unprotected waterfront anchorages. The options are to either move laterally across the coast to eastern or western Gulf ports outside of the storms' fury or move further inland using available tributary channels. In many cases, upstream anchorages away from the coast are blocked by bridges and shallow channels and sailing either east or west along the coast to avoid the storms significantly wears on machinery and crews and increases operating costs.

A solution to this temporary relocation problem may be the establishment of safe harbors or anchorages that fleet, charter, and pleasure craft can seek temporary shelter within. In addition to the commercial fishing and private vessels, charter fishing boats, and rescue/emergency response craft could be berthed at these harbors to allow quick response rescue operations following a hurricane event. A number of these "safe-harbors" could be established within the existing embayments by special authorities or through existing Corps of Engineers' authorities such as Section 107 of the Continuing Authorities Program (CAP).

This standing authority provides an opportunity for the Corps to participate in the development of small boat harbors and navigation improvements. The current maximum limit of Federal participation in this program is $7.0 million per project (WRDA 2007). Local sponsors pay a share of the project cost based upon the depth of the harbor. At a minimum, three safe harborages could be located within the project area. In accordance with the regulations governing this program, the estimated project cost for each of the three safe harborages would not exceed $7.7 million. More detailed analysis of the safe harborages' cost and features would be developed in CAP feasibility study documentation.

Safe harbors could be designed as excavated slips or longitudinal channel-side berths with tie-ups designed to accommodate significant rises in water levels (surge inundation). Landside development would be minimal with security fencing, lighting and roadway access. Prime safe harbor sites would be located adjacent to channels or deep water within the embayments that avoid excavation within sensitive estuary habitat. Extensive coordination with natural and marine resources during site selection and excavation design and construction would minimize ecosystem impacts.

A safe harbor could be developed in conjunction with the Pearlington community redevelopment scenario as part of the required borrow material excavation along the Pearl River. Requirements for channel depth and needed dredging would need to be coordinated with the fishing industry as well as natural resources agencies. Coordination with MDOT plans for any future bridge replacements or elimination of drawbridges for evacuation purposes may benefit the safe harbor selection process. See Figure 7 for an example of a safe harborage or safe anchorage. The provision of safe harborages as a method of reducing damages to commercial and pleasure vessels was suggested in the "Potential Projects List" (item HRR1-06) developed during round one of the public workshops on the Comprehensive Plan.

Costs for safe harborages or anchorages would depend upon the expected number of evacuating vessels and their sizes, draft depths being accommodated, intervening channel deepening requirements and needed security facilities. Determination of the capital and O&M costs for these facilities would require extensive coordination with fleet owners and boating associations in the project area. Annual O&M requirements would be limited to dredging the harbor area and any modified channels between the Gulf and the harborage site.

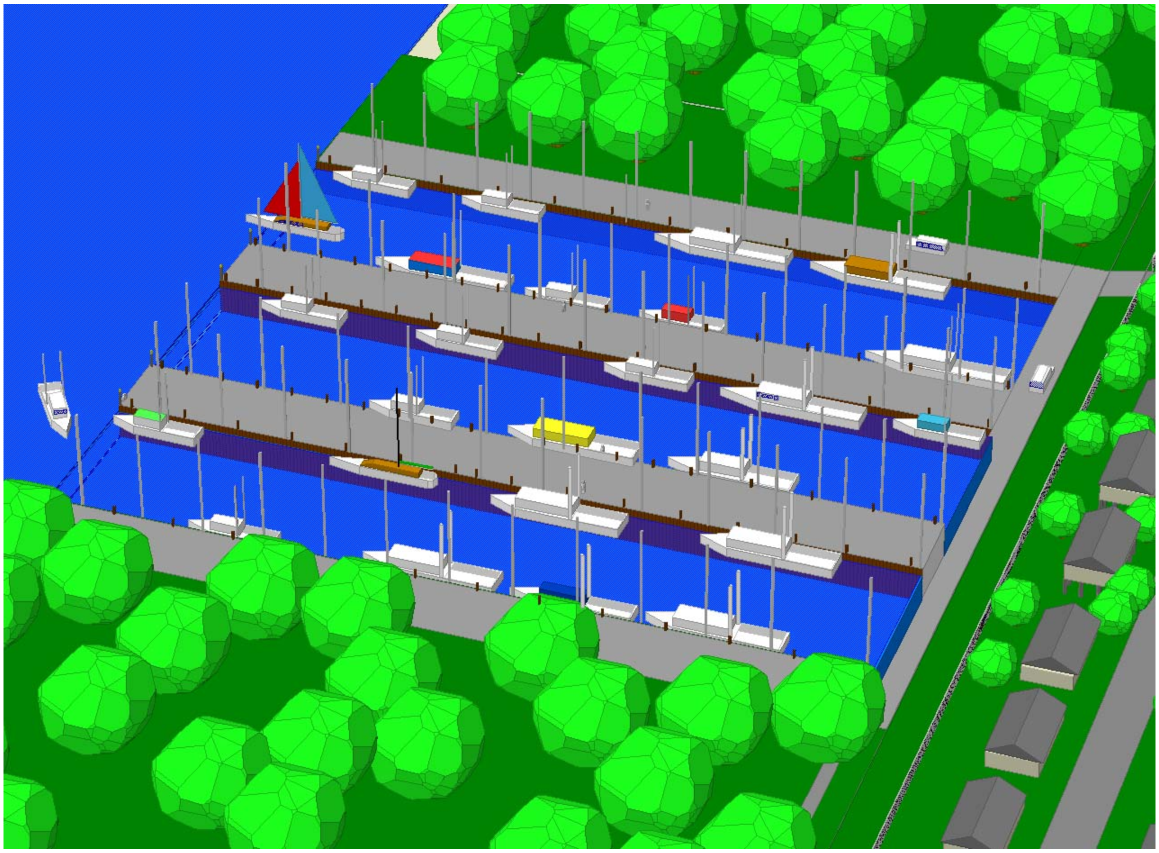


Figure 7. Safe Harborage/Safe Anchorage

The seafood and boating industries are major contributors to the region's economy and are a key component of the tourist trade along the coast. Severe losses such as occurred to the fishing fleets and recreation watercraft during Katrina pointed out the necessity of having sheltering areas for this equipment and facilities. Since safe harborages and anchorages would provide such shelter for this equipment, these measures are all carried forward into more detailed formulation.

4.5.2 Floodplain Management, Floodplain Zoning, Flood Insurance and CRS

Riverine and coastal floodplain management through the auspices of the Federal Emergency Management Agency (FEMA) is one nonstructural measure that has proven to be very effective in reducing damages to structures and losses of life. Generally floodplain management does little to reduce damages to structures grandfathered in their present at-risk location at the time of enactment of the required ordinance, but the awareness that the delineation of the flood hazard zone has upon at-risk residents may lead to retrofits of the structure under existing programs (FEMA HMGP) or other measures that can reduce damages or loss of life.

Floodplain zoning which can be viewed as a distinct overlay zone applied to a standard land use zoning map was established and is regulated by the National Flood Insurance Program (NFIP) under FEMA, an agency within the United States Department of Homeland Security. Under the floodplain zoning program, municipal and county governments can establish flood hazard zones along watercourses or ocean/gulf shorelines according to an analyses of the flood hazard by FEMA. The Flood Insurance Rate Map (FIRM) established for a municipal or county area indicates various levels of flooding, the regulatory floodway or coastal V-zone and elevations of the various flood events. The availability and cost of Federally-subsidized flood insurance to the landowner are based upon this hydraulic data.

4.5.2.1 Existing NFIP Ordinances, Zoning and Insurance

Each of the three counties within the study area and all of the municipal areas are participating in the regular program of the NFIP. Table 7 shows the progressive entrance of these governmental units into the NFIP. In 1969, Hurricane Camille ravaged the Mississippi coast resulting in over 130 deaths,

Table 7.
City and County Participation in the NFIP

Community or County Name	Initial FHBM Identified	Initial FIRM Identified	Current Effective Map	Regular or Emergency Date
City of Pascagoula	09/18/70	09/18/70	03/15/84	09/18/70
City of Moss Point	09/18/70	07/01/74	09/04/87	09/18/70
City of Gautier	09/18/70	04/03/78	08/18/92	11/13/86
City of Ocean Springs	-	09/11/70	08/18/92	09/18/70
City of Pass Christian	05/26/70	05/29/70	08/19/87	05/26/70
City of Biloxi	06/27/70	06/30/70	03/15/84	09/11/70
City of Gulfport	05/26/70	05/29/70	10/04/02	09/11/70
City of Bay St. Louis	07/01/70	09/11/70	11/16/83	09/11/70
City of Waveland	06/27/70	09/11/70	11/16/83	09/11/70
City of D'Iberville	-	08/04/88	08/04/88	11/14/88
City of Long Beach	07/17/70	06/19/70	05/04/88	09/11/70
Hancock County	-	09/09/70	08/18/92	09/09/70
Harrison County	09/18/70	06/15/78	10/04/02	06/15/78
Jackson County	09/18/70	04/03/78	04/16/93	04/03/78

Source: FEMA NFIP data

over 3,800 dwelling units destroyed and damages exceeding $900.0 million. In the preceding year, Congress had enacted the National Flood Insurance Act of 1968. Although in its infancy, the National Flood Insurance Program was beginning to assist counties and communities across the nation that suffered repeatedly from riverine and coastal flooding when Camille hit the coast. Following the catastrophic affects of Camille, the three coastal counties (Hancock, Harrison and Jackson) and all 11 municipal areas affected entered the regular or emergency program of the National Flood Insurance Program by 1978. According to FEMA data, approximately 20,200 flood insurance policies were in affect in the project area prior to the arrival of Katrina.

In the early stages of the NFIP, information on appropriate methods of protecting coastal structures (V-zone) was limited, but engineering standards for raising structures on piling or piers were available and had been proven in many cases to withstand the savage pounding of surge, waves and wind from hurricanes along the Mississippi coast. Hundreds of structures were elevated along the coast to a theoretical 100 yr storm level (Base Flood Elevation) established by FEMA. As Table 7 shows, most of the 11 municipalities and 3 counties in the study area had initial Flood Insurance Rate Maps (FIRM) in place by 1978. In the intervening 26 years between Camille and Katrina, the study area has been visited by several hurricanes and tropical storms (Cindy 05, Elena 85, Georges 98 and Hanna 05) that tested the flood damage reduction measures instituted through the NFIP.

Fortunately, none of these storms was severe enough to cause extensive damages to coastal structures. Not until the arrival of Katrina in 2005 was the Mississippi coast confronted with another powerful hurricane that would test the flood damage reduction efforts of the local population. Post-event assessments and visual images of the damages to both seemingly protected and unprotected structures indicated that not all types of protection schemes were successful in the face of a combination of significant surge depths, wave heights and high winds.

Katrina's storm track traveled squarely over the mouth of the Pearl River at the Louisiana/Mississippi border and across the unincorporated community of Pearlington in Hancock County. This track put the coastal communities of Waveland, Bay St, Louis, Pass Christian, Long Beach, Gulfport, Biloxi, Ocean Springs, Gautier, and Pascagoula at the mercy of the northeastern quadrant of the hurricane where sustained hurricane-force winds, a massive storm surge and powerful waves demolished most unprotected structures. Unfortunately, hundreds of structures raised on various types of piers and pilings were likewise demolished as the huge surge (mimicking Camille in 1969) carried battering waves to the first floors and exterior bearing walls of wood-frame structures. Hundreds of these structures raised in compliance with local coastal management ordinances and constructed according to adopted building codes were unable to withstand this onslaught. Figures 10 through 17 on Pages 67 and 68 show the remnants of structures raised to the 100yr flood elevation (BFE). Observations of the Katrina damages showed that all concrete block and brick masonry columns founded on slab foundations failed. Most failures occurred at the junction of the column and the slab. In some cases, reinforcing bars were bent or ties failed at the junction between the column structure and the slab foundation (see Figures 38 and 39 on Page 79). Generally all wooden pilings and post foundations survived the Katrina surge and waves although in almost all cases the structure was washed off the top of the raised foundation by surge and waves.

As a result of the extreme damages and losses of life caused by Katrina, FEMA immediately began to re-evaluate the current BFE and other established flood levels upon which the existing coastal floodplain management ordinances along the Gulf Coast had been founded. Based upon this re-evaluation, FEMA issued a set of "Advisory Base Flood Elevation" (ABFE) maps for the Mississippi and Louisiana coasts. The new ABFE significantly raised the previous BFE elevation along the coast and inlets to acknowledge the potential damages that could be generated by a second storm that mimicked the surge, waves and wind generated by Katrina and to provide guidance for those who would be immediately rebuilding structures and facilities along the coastal areas.

Several project area communities adopted the ABFE's as the basis for their existing floodplain management ordinances and new construction has been held for the most part to those modified base flood elevations. In some cases, the communities just increased the amount of freeboard between the existing BFE elevation and the first floor of a raised structure to compensate for the differences in the new ABFE elevations. A few communities chose to use both techniques according to the flood threats within their area. Table 8 lists those municipalities and counties in the project area that either adopted the ABFE or modified the freeboard requirements for new construction or structure elevation in their existing ordinances. In addition to adoption of the new ABFE, participation in the flood insurance by area residents increased by 165 percent to around 53,600 policies.

Table 8.
Municipalities and Counties Modifying Existing Ordinances to ABFE

Community/County Name	Adopted ABFE	Modified Freeboard Requirements
Jackson County	X	X
Pascagoula	X	
Moss Point	X	
Gautier	X	X
Ocean Springs	X	X
Harrison County	X	X
Biloxi	X (proposed adoption)	X
D'Iberville	X	X

Community/County Name	Adopted ABFE	Modified Freeboard Requirements
Gulfport	X	X
Long Beach	X	X
Pass Christian		X
Hancock County		X
Bay St. Louis		X
Waveland		X

Source: FEMA Document dated March 2007

FEMA is generating a new set of Digital Flood Insurance Rate Maps (DFIRM's) that will be published for public review and comment by the affected counties and municipal areas. The revised maps will show modified boundaries and heights for the BFE (1% annual chance event) and 500 year (0.2% annual chance event) including revised water surface elevations associated with these zones. It is possible that the revised mapping may include adjustments to the V and VE zone boundaries as well. Once comments are received from the affected county and municipal areas, FEMA will publish the new FIRM's and the local governments will modify their existing floodplain management ordinances to incorporate the new zones and any additional text changes in the ordinances.

In view of these coming changes in the existing floodplain ordinances and recent FEMA design guideline initiatives, there are two potential early-action measures that could be instituted by local jurisdictions to reduce damages to future development along the coast. Each municipality and county should adopt the new DFIRM mapping and ordinance information when published by FEMA. In addition each municipality and county should adopt the *FEMA 550 Recommended Residential Construction for the Gulf Coast* guidelines that describe building methods and flood-resistant materials to be used in elevating or otherwise floodproofing structures in the coastal and inlet inundation zones. These guidelines could be adopted as a part of the undated building codes (see Section 4.5.3 below) or by reference in the floodplain management ordinances. Use of the FEMA 550 guidelines for future coastal construction could substantially reduce damages from future storms. Costs for both of these measures are minimal and are local administrative and legal costs.

4.5.2.2 Community Rating System (CRS)

The Community Rating System (CRS) is a voluntary program for communities that participate in the regular program of the NFIP. The primary objectives of the CRS are to reduce flood losses, facilitate accurate insurance ratings, and promote the public's awareness of flood insurance. The rating system provides a list of incentive activities that would take a community beyond the basic requirements of the NFIP to provide a higher level of protection to at-risk structures. Application of the incentive activities by the community results in discounts on flood insurance premiums for all insurance holders. The rating system ranges from 10 (lowest ranking and a 0% discount on premiums) to 1 (highest ranking a 45% discount on premiums). The incentive activities are grouped into four categories including Public Information, Mapping and Regulation, Flood Damage Reduction and Flood Preparedness. As a community implements incentive activities from one or more of these categories in their community, all participating landowners receive greater insurance premium discounts. Table 9 below shows the communities and counties within the project area that are included in the CRS program and their current ratings. Of the three counties and 11 municipal areas in the project area, one county and 8 municipal areas are participating in the program.

Table 9.
Municipalities and Counties Participating in the CRS

Community Number	Community Name	CRS Entry Date	Current Effective Date	Current Class	% Discount for SFHA	% Discount for Non-SFHA	Status
285251	Bay St. Louis	10/1/95	1/01/00	7	15	5	C
285252	Biloxi	10/1/96	10/1/03	7	15	5	C
280332	Gautier	10/1/94	04/1/00	8	10	5	C
285253	Gulfport	10/1/96	10/1/01	8	10	5	C
285255	Harrison County	10/1/03	10/1/03	8	10	5	C
285257	Long Beach	10/1/00	10/1/00	8	10	5	C
285259	Ocean Springs	10/1/92	10/1/02	8	10	5	C
285261	Pass Christian	10/1/93	10/1/03	6	20	10	C
285262	Waveland	10/1/93	10/1/06	5	25	10	C

Source: FEMA documentation

An effective nonstructural measure would be to encourage the remaining counties (Jackson and Hancock) and the 3 municipal areas (Pascagoula, Moss Point and D'Iberville) to participate in the CRS and realize the discounts in insurance premiums for their participating landowners. Implementation of several of the identified nonstructural measures would significantly increase the participating communities and counties current ratings and further reduce their insurance premiums. Costs for entering the CRS and complying with the requirements are minimal and local.

4.5.2.3 Potential Modifications to the National Flood Insurance Program in Coastal Mississippi

The NFIP is a complex Federal program of floodplain zoning regulations, construction and retrofitting guidelines and flood insurance requirements that is largely administered by local jurisdictions. In general the availability of government subsidized insurance for structures located in the nation's floodplains is contingent upon a county's or municipality's willingness to establish a local floodplain management program based upon the identified flood risks and to accept establishment and enforcement of floodplain zoning ordinances. Over the years since the program first began (1970), there have been numerous modifications of the NFIP based upon changes in insurance coverage, percentage of government subsidy, experiences in enforcement of the program nation-wide and major flood damage events such as Katrina. In view of these changes, other modifications to the NFIP could be possible in the project area that would, over time, result in changes to the development pattern and therefore reduce the potential for flood damages in the project area. These modifications would be affected through Congressional legislative and Federal agency administrative actions. Some of the possible modifications to the program that can be considered as nonstructural measures are discussed below:

4.5.2.3.1 Suspension of the Flood Insurance Program

Many structures along the nation's coast are only located in a hazardous location because of the opportunity to have the costs of flood damages offset by claim reimbursements from FEMA through the NFIP. Although FEMA has established limitations on the amounts of insurance coverage (more about that feature below) and significant structure damages require certain building modifications to reduce future damages, many structures only remain on a hazardous site because of the presence of insurance. In many cases, without that insurance coverage, landowners would eventually abandon their high-risk sites for more flood-safe locations. Usually, federally subsidized home mortgages and business loans require flood insurance on the structure when it is located within a defined hazard zone. In view of this, removing the flood insurance program either in part or totally for the entire coastal area in MS would have a direct impact on individual landowner's decisions to locate or remain in these hazardous areas. The insurance program for all zones could be dropped or just in the high-hazard zones (VE and BFE zones) or the zones could be dropped in a multi-year phase-out program starting with the VE zone.

Although somewhat "Draconian" in nature, this measure would place the full burden for repairs and recovery solely on the landowner whose home or business was damaged and on public institutions in the case of damaged public buildings. Certainly, removing the flood insurance coverage for homes and businesses in these areas would impact the lending institutions which have based their financial investment in the at-risk structure on the existence of flood insurance coverage that offsets the financial losses to the property and maintains the value in case of future ownership transfers. Depending upon the reaction of the lending institutions to the loss of flood insurance, the movement away from the coast could be rather sudden as at-risk mortgages were voided or remaining mortgage balances were required of the owners.

Should the reaction of the lending institutions not be quite so sudden, in time, gradually and based upon the number and severity of future storm events, landowners who were faced with a severely damaged home or even with frequent minor damages to their home would look for other flood-safe locations. Without a specific timeline for removal of these structures from the flood risk area, there is not an accurate method of determining when the flood damage benefits of this measure may occur. Since the gradual movement away from the coastal area would be event determined and since most large hurricane events are very infrequent, flood damage reduction benefits generated through this insurance driven migration from the coast could take decades to realize.

Although from a theoretical standpoint, abandoning the NFIP for this project area would in time result in a movement away from the hazard areas and a realization of flood damage reduction benefits, the administrative and political actions required to affect such a change in the NFIP would be loathsome to local officials and political interests. The billions of dollars of investment in coastal development within the project area supported by this insurance system would be left at the mercy of Gulf storms and the financial losses could be disastrous to the local economy. Therefore, suspension of the NFIP for the project area will not be carried into the formulation process as a realistic measure.

4.5.2.3.2 Reduced or Suspended Federal Subsidy

Another NFIP-based measure would be to significantly reduce or drop the federal subsidy on flood insurance policies for structures grandfathered into the NFIP when it was enacted within each community or county. Reductions in the Federal subsidy for flood insurance have occurred in the past. Without the federal subsidy or a substantially reduced subsidy, landowners would be faced with paying the full or nearly full actuarial rate for the insurance based upon the risk level for their home or business. This increased "land rent" cost would influence many to move away from the high-hazard areas. For wealthier landowners whose structure is located in a relatively low-risk zone (i.e. 500 yr zone), this reduction or loss of the subsidy would be a moderate impact on their disposal income, but for those less fortunate with a home or business in a higher risk zone (VE or BFE zones), this loss of subsidy may result in "forced" relocation to a less expensive piece of land.

This difference in measure impact calls up issues of equity and environmental justice in its application (may disproportionately affect low-income, fixed-income and minority populations) and may not be justified for that reason. Therefore reducing or suspending the Federal subsidy as a flood damage reduction measure is not being carried forward into the formulation process as a realistic measure.

4.5.2.3.3 Skewed Premium Rate Structure

Current flood insurance rates are based upon actuarial rates founded on the risk of damages from a series of flood events. When the insurance rate is established, landowners are required to pay a set-rate monthly or annual payment to cover the risk. Unless there is some change in the insurance program or flood risk, the monthly or annual payment remains consistent throughout the term of the insurance policy. Under this flat-rate policy it is possible that an insurance provider could suffer a significant loss on a damaged property early in its coverage period that would not be covered by paid insurance premiums.

To provide more protection for the insurance provider and challenge the landowner's decision to build a structure in a high-risk zone, the insurance payment schedule could be modified to require much higher up-front payments based upon the risk. For example, if a normal policy would require an annual payment of $2,500 ($208 per month) over a term of 10 years ($25,000 total), the revised policy (as a nonstructural measure) might require $10,000 in the first year, $7000 in the second year and the balance ($8,000) over the last 8 years. Under this method, the insurance provider would recover a larger amount of the total payment sooner to cover possible early-term losses and landowners would be faced with a financial disincentive to develop in a high-risk zone. The skewed rate structure could be based upon the increased level of risk with development in the VE zone or BFE zones having greater payments up front and structures in lower risk zones (500 year) having less premiums up front.

Again like the option of increasing the landowner costs for flood insurance by reducing the subsidy, skewing the payment schedule to collect a larger percentage of the total premium up-front may have a disproportionate impact on the low-income, fixed income and minority sectors of the coastal population and brings up issues if equity in its application. Wealthier landowners could absorb the larger initial payments while low income owners would be unable to afford such payments. Adjustments to the skewed rate schedule could be made to account for disproportionate impacts on low-income and minority populations, but surge inundation and wave impacts do not take into account one's bank statement. For these reasons, measures that would adjust the flood insurance premiums payment rate will not be carried forward into the formulation process.

4.5.2.3.4 Mandatory Flood Insurance

Although not an effective method of reducing flood damages or reducing losses of life, flood insurance is an effective way of reducing the financial impacts of flood damages to landowners and public entities. Many structures exist within the project area that do not have flood insurance and were damaged by Katrina. Not only does that uninsured condition place landowners in a difficult financial position regarding repair and re-occupancy of the structure but impacts the community by loss of property value (reduces property tax revenues over time) and potentially loss of business taxes.

In most cases, new home construction and occupancy is financed by a mortgage from one of a number of various financial institutions (banks, credit union, etc.). Under Federal law, new homeowners of structures determined to be within a flood hazard zone are required to secure flood insurance to protect the investment of the financing institution. Failure by the financial institution to assure the purchase of flood insurance for the new structure exposes that company to severe financial penalties. For this reason most new home and business construction found to be in a flood hazard zone is covered by flood insurance. However, in certain circumstances where a mortgage is not required to construct the building, this flood insurance step may be circumvented by the landowner.

In addition to the financial necessity of acquiring flood insurance, all county and municipal areas that participate in the NFIP will require a floodplain permit for any structure placed or constructed in an identified flood hazard zone. That permitting requirement will normally trigger the requirement for purchasing flood insurance by the building owner. However, in some areas of the coast, the oversight and enforcement of the existing floodplain management program is not at a level that assures full insurance coverage and many structures are placed or constructed without a permit and without insurance.

In some areas either dated flood hazard mapping or the lack of sufficient mapping results in new structures being placed or constructed in heretofore unidentified flood hazard zones. These structures, located in ignorance of the hazard, remain unprotected by insurance or appropriate building methods commonly used in flood hazard zones. This problem could be reduced by updating the flood insurance rate mapping in previously unmapped areas, but funds for that FEMA-supported process are limited.

In order to assure that all new and existing construction is adequately protected from the financial losses associated with storm and hurricane inundation and waves, all structures located within defined flood risk zones could be required to purchase and maintain flood insurance on the building and its contents. This mandatory feature would need to be instituted by the state, the counties or municipal jurisdictions for the project area as a more restrictive requirement over and above what is required by FEMA on a national scale. Such action by the local jurisdictions would provide financial benefits to the at-risk property owners as an upgrade to the local floodplain management ordinances through the CRS (see above). This mandatory requirement (no exceptions and regardless of the structure financing arrangements) for flood insurance in all zones with associated severe penalties (financial or administrative) for non-compliance would at least reduce the financial losses associated with large storms and hurricanes.

Mandating flood insurance for all structures located within an identified flood zone would reduce financial losses to landowners and other charitable organizations that frequently shoulder the financial losses due to flooding. However, merely having flood insurance coverage does not in and of itself reduce flood damages or the chances of loss of life. Many insured structures and their occupants were lost during Katrina. Since the objectives of the project are to reduce flood damages, not just to recover the financial losses due to flooding, mandating flood insurance coverage on all structures is not carried into the detailed formulation process.

4.5.2.3.5 Reduction in Maximum Insurance Coverage for Eligible Structures

Currently, the maximum flood insurance coverage per structure through the NFIP is $250,000 for residential structures (plus an additional $100,000 in personal property (contents) damages) and $500,000 for commercial business structures (plus an additional $500,000 for commercial building contents). Special options are available for condominium structures whereby blocks of unit coverage at $250,000 each can be purchased with the additional $100,000 contents damages coverage for each unit as well.

These upper limits on insurance coverage promote construction of large and expensive residential structures as well as condominium units and relatively large retail and office structures in high hazard zones. A modest condominium development of 50 units located in a high hazard flooding zone could place upwards of $12.5 million dollars worth of potential structure damages and $5.0 million dollars worth of personal property damages in jeopardy of loss. The recorded insurance losses from Katrina and similar storms along the Gulf Coast are a testimony to these liberal limits placed on individual structures and contents.

An affective nonstructural measure could be a significant reduction in the insurance coverage allowed for all structure types and personal property (building contents). Were insurance coverage limits to be reduced to a more moderate level ($80,000 per residential structure with $32,000 contents coverage - same ratio of contents to structure coverage as provided presently), there would be far less expensive residential structures and condominiums located in high hazard flooding zones. Similar reductions in insurance coverage for commercial structures (for example…$100,000 per structure with $50,000 contents coverage) would significantly reduce high value commercial/business development in high hazard zones. Although flood damages would still be possible, the financial losses to the flood insurance program would be lessened significantly in time and the lower limits may steer some types of development away from the waterfront entirely.

An alternative to reducing the overall coverage limits for all hazard zones would be reducing the insurance coverage commensurate with the level of flooding threat. For example, reductions in insurance coverage could be greatest in the VE zone with lesser reductions in the BFE and 500 yr zones. This method would better recognize the varying levels of risk associated with flooding along the coast and allow substantial growth to occur in the less risky areas.

Reductions in insurance coverage could be phased in over a 5 year period allowing landowners the opportunity to adjust their structures, contents, and locations to account for the percentage of structure and content value that would actually be covered by insurance in hazard areas. Concurrent changes in mortgaging terms by financial institutions to account for the reductions in insurance coverage would further encourage development to abandon the high hazard flood zones.

Reducing the insurable limits on floodplain development so that high value development is not encouraged in high-hazard areas and thus subject to loss would be a good method for reducing the financial losses due to storms and hurricanes. Reducing the limits of insurance coverage on residential and commercial structures would not directly result in a reduction in actual flood damages due to these storms but only compensation of the landowners for their losses. This measure also does not directly result in reduced risk of loss of life and in some ways may contribute to those losses in the future. Since the project objectives emphasize reductions in actual flood damages and loss of life rather than compensation for losses, reducing the insurable limits of flood insurance as a nonstructural measure is not carried forward into the formulation process.

4.5.3.2.6 Cumulative Damages or Cumulative Improvements as a NFIP Compliance Trigger

Currently under the NFIP regulations, any structure suffering storm/hurricane damages whose dollar value is greater than 50 percent of the assessed value of the structure triggers the requirement that the structure come into compliance with the NFIP regulations and the local floodplain management ordinance. That requirement could include elevation of the first habitable floor of the structure to the base flood elevation (BFE) identified in the current FIRM. Generally that damage calculation is completed and measured on an event-by-event basis and is not cumulative over several events.

Information from MEMA indicates that the State of Mississippi requires that counties and municipalities in the NFIP gather information on the value of structure improvements in the project area. When the dollar value of those improvements exceeds 50 percent of the assessed structure value, the structure is required to meet the requirements of the NFIP and local floodplain management ordinances. In addition to this state requirement, based upon information also from MEMA, the City of Pascagoula requires under their local floodplain management ordinance that storm-related damages used to trigger compliance with the NFIP and local floodplain ordinances be accounted for cumulatively over a ten-year period. Should the dollar value of the damages accumulated over that ten-year period exceed 50 percent of the assessed dollar value of the structure, that structure must be brought into compliance with the NFIP and local ordinances regarding the elevation of the structure's first floor with respect to the BFE.

Given the potential for a series of storm/hurricane events to result in significant but not substantial damages (as defined by FEMA to be greater than 50 percent of the assessed value of the structure) to a structure, thus indicating a structure in a location where repetitive damages may be possible, using the accumulation of damages over a period of time (say ten years or the lifetime of the structure) may result in more structures being brought into compliance or more structure owners deciding to move out of areas that receive more frequent flooding.

In light of these existing requirements, a modification of the local ordinances of each of the three effected counties and 10 effected municipalities (Pascagoula already using the cumulative damages process) would be to adopt the process of cumulative damages (over a period of time chosen by the local community or county) as a trigger for requiring compliance with the NFIP and local floodplain management ordinance. According to MEMA, the state requires collecting cumulative costs of improvements for each structure, local jurisdiction information that is made available by owners through the building permit process. The fee amount for the building permit is based upon the value of the improvements and there are financial penalties for undervaluing the cost of improvements. Using the dollar value of cumulative damages as a NFIP compliance trigger in combination with improvement values would help to assure that more structures come into compliance with the NFIP and that future damages are reduced.

4.5.2.4 Training and Education of Floodplain Ordinance and Code Administrators and Officers

Each of the three counties and 11 municipalities in the project area is participating in the regular National Flood Insurance Program. Under the regular insurance program, each of these governmental units has an adopted floodplain management ordinance and floodplain zoning maps of their jurisdiction. Once adopted by the general population of the city or county, the ordinance and all of its requirements (floodplain development permits, zoning variances, mapping, etc.) must be enforced and administered by a designated individual (Floodplain Administrator, Building Administrator, Zoning Officer, etc.) or office of that jurisdiction. In some cases communities contract out these services to specialized firms in zoning and ordinance administration, but generally this work is accomplished by the hired staff of the jurisdiction (i.e. planning and zoning department, public works, community development, etc.). In some cases, staff assigned to these positions are newly hired or do not have all of the up-to-date training available from FEMA and other sources.

Interpretation and administration of the zoning ordinances and use of the flood insurance rate maps requires specific skills and training to be proficient in their application and to avoid unnecessary legal actions. In addition to the basic tenants of the floodplain management program, changes in the NFIP occur on a regular basis requiring someone at the local level to be responsible for making necessary changes in the local ordinances and mapping to maintain compliance with the newest FEMA requirements.

FEMA provides ongoing training for local floodplain management officials as well as real estate brokers, insurance agents and those seeking certification in floodplain management and administration. Training classes are offered at selected sites throughout the USA as well as in FEMA regional offices. Some training is offered on the Internet or through home study by FEMA supplied materials.

A nonstructural measure that could be implemented at a relatively low cost would be jointly sponsored USACE/FEMA training classes for local floodplain management staff, mayors, county supervisors, city councils, Chamber of Commerce, hotel/motel associations, real estate brokers, surveyors, architects, engineers, and financial institutions. This training could be held on an annual basis or as new regulation or mapping changes emerged that affected the project area.

Costs for this measure would be confined to USACE and FEMA employee labor and travel costs to attend and administer the training classes. Annual O&M costs would be repeat training costs for new floodplain managers entering the system.

Considering the relatively low cost of providing this training and the potential benefits to the coastal residents that a better educated cadre of floodplain managers and zoning administrators would generate, these measures are all carried forward into more detailed formulation.

4.5.3 Building Codes

Like land use zoning, the adoption and enforcement of building codes is a police power of local governments enabled by state legislation. Building codes normally are limited to structure design and construction methods and materials selection to meet building use requirements and both environmental and weather conditions at the building site. Structure foundations, structural integrity, site grading to promote positive drainage, and utilities are all part of a comprehensive building code. Provisions for addressing flood-prone locations in the design and construction of structure foundations are an important feature of a well-prepared code and make its use in coastal areas imperative.

Application of building code requirements to the design and construction of structures has been proven to significantly reduce damages due to inundation, wave action and winds. Generally, building codes are enacted and enforced through municipal and county ordinances. In some cases code application and enforcement occurs through city and county planning offices, community development departments or public works departments. Local adoption of building codes is encouraged by insurance companies, fire marshals, building contractors, mortgage financing institutions and real estate brokers. In flood hazard areas including V-zones, FEMA encourages all communities to enact and enforce these codes as a preventative measure in reducing insurance losses under the NFIP.

Over the years of code enactment and enforcement, a number of different code standards have been promoted. At the turn of the century, the insurance industry developed what many consider to be modern building codes in response to major urban fires in the United States. The National Board of Fire Underwriters published its National Building Code in 1905 as a model code; that is, a standard code that could be adopted by any locality. Localities could add additional construction restrictions but the basic model was the minimum standard for building construction.

During the first half of the twentieth century, three major regional model code organizations evolved. Building Officials and Code Administrators International, Inc. (BOCA) founded in 1915, International Conference of Building Officials (ICBO) founded in 1926, and Southern Building Code Congress International, Inc. (SBCCI) founded in 1940. The International Code Council (ICC) was established in 1994 as a nonprofit organization dedicated to developing a single set of comprehensive and coordinated national model construction codes. That ensuing “International Building Code” is now generally accepted as the national standard for building construction and its requirements for building construction in flood hazard zones (including V-zones) is widely acclaimed as a major step in construction technology.

As a nonstructural measure that would be effective in reducing future flood damages, each of the 11 municipalities and three counties should adopt the latest version (2006) of the International Building Code (IBC) and Residential Building Code (RBC) as their standard building codes and especially enforce those sections (or Appendices) of the codes that pertain to construction of residential and commercial buildings in flood hazard areas. Adoption and enforcement of the IBC would assure to a certain extent (with qualified inspections during construction) that structures built or additions to buildings in flood hazard zones are able to withstand the forces of water, waves and wind generated by storms and hurricanes and that water-resistant materials are being used in the construction.

Based upon a search of the city and county government Internet sites within the project area, several of the municipalities and counties have already adopted the 2003 version of the International Building Code as their standard building code. The code administration offices of each county and municipality should be encouraged to adopt the updated 2006 IBC (residential and commercial versions) which includes special considerations for flood-resistant construction. Based upon the ICC publication “Code Changes Resource Collection – 2006 IBC” dated June 2006, there have been numerous code changes between the 2003 and 2006 versions of the IBC. Many of these changes are specifically aimed at reducing damages to structures that would be located in flood hazard zones. Additional changes have been incorporated into the 2006 version of the IBC and RBC that address wind damages as well.

In addition to the adoption of the updated IBC in the project area, special education classes should be established in local Vocational/Technical Centers, universities and colleges that offer training in the use of the updated IBC to code administrators, contractors, architects, building inspectors, and landowners contemplating significant repairs to their structures that would require a building permit.

As a nonstructural measure, the recent publication of the FEMA guidelines for construction in Gulf Coast flood hazard areas should be adopted by the counties and municipalities as a part of their floodplain management zoning code and/or their building codes., The FEMA 550 *Recommended Residential Construction for the Gulf Coast* provides valuable design and construction guidelines for various types of residential buildings including building and site evaluations, construction processes, foundation designs, flood resistant materials, engineering data and information sources. In 5 chapters and several appendices this publication provides sound technical information for elevating structures in flood hazard zones.

The FEMA 550 guidelines give technical information on elevating residential structures in the V-zones although the recommendations in this nonstructural plan are strictly to avoid that practice because of the dangers posed by storm surge, waves and hurricane-force winds that would be prevalent in the V-zone. In view of the potential for storms and hurricanes larger than the design event used to formulate the nonstructural plan in this appendix, elevating residential structures in the V-zone could lead families to occupy their homes during an event that would exceed the design specifications of the construction resulting in total failure of the building foundation or walls and loss of life.

Costs for upgrading building codes is confined to purchasing the new codes from the ICC or other sources and administrative and legal costs for incorporating the codes into the existing municipal and county ordinances. Annual O&M costs for this measure are administrative (enforcement and variances) and local. Since local jurisdictions can charge fees for building permits, their costs to update and maintain the IBC and perform inspections of construction can be recovered.

The revision of existing building codes is a relatively inexpensive method of assuring that new construction, building additions or rehabilitation will be constructed in such a manner as to significantly reduce flood and wind damages to structures in the project area. Since the revision of building codes contributes to reducing hurricane and storm damages they are carried forward into more detailed formulation.

4.5.4 Land Use Regulation and Zoning

Land use regulation, more commonly referred to as zoning, is a measure frequently used by local entities (counties and municipalities) to arrange and regulate various land uses within their jurisdiction. Enactment and enforcement of land use zoning helps to avoid conflicts between uses (i.e. industrial and residential), reduce traffic congestion, maintain property values and promotes other social, economic and environmental objectives.

Zoning of private property, like building codes and other land use regulation is one of the police powers granted to local jurisdictions by the states. This method of land use control has been upheld in the judicial system (State, Federal and US Supreme Court) and has helped to shape the physical, economic and social pattern of many cities and counties in the USA. Local zoning is usually required by state enabling legislation to be preceded by a comprehensive plan for the community or county area that includes an official map or plan of the community's land uses and projected development pattern. Also, significant rezoning of property normally requires a preceding, and approved change in the approved official map in the comprehensive plan.

Title 17 of the Mississippi Code authorizes the dividing of property within any municipality or county into specific zones to accomplish the goals and objectives set forth in the comprehensive plan (or official plan) and to fulfill other purposes as described in the Code. In particular, Section 17-1-7 states *"Except as otherwise provided in Article VII of the Chickasaw Trail Economic Development Compact described in Section 57-36-1, for the purposes set forth in Section 17-1-3, the governing authority of each municipality and county may divide the municipality or county into zones of such number, shape and area as may be deemed best suited to carry out the purposes of Sections 17-1-1 through 17-1-27, inclusive. Within the zones created, the governing authority of each municipality and county may, subject to the restrictions with respect to agricultural lands and farm buildings or structures as set out in Section 17-1-3, regulate and restrict the erection, construction, reconstruction, alteration, repair or use of buildings, structures or land. All regulations shall be uniform for each class or kind of buildings throughout each zone, but regulations in one zone may differ from those in other zones."*

Zones or districts are labeled by the predominant land use type allowed within that zone such as residential, commercial or business, industrial, institutional or public, parks and recreation, transportation, vacant, and open space. Each general use zone can be further divided into density sub-zones (R-1, R-2, C-1, B-1, etc.) denoting units per acre or floor area ratios of each use type. Special overlay zones can be added to the normal zoning pattern to address sensitive environments, architectural aesthetics, economic development, environmental hazards, agricultural or historic issues or developmental programs. Zoning ordinances normally describe the types of uses allowed in each zone or district and prescribe certain other limitations or development requirements for each zone. Zoning ordinances can be used to limit development in certain high-hazard areas or areas with sensitive environmental resources.

Under the umbrella of this state enabling legislation, each of the three counties and 11 municipalities being studied in this report may (and have) established land use zoning ordinances for their jurisdictions to fulfill the goals and objectives of their comprehensive plans. As an example, Figure 8 shows the land use zoning map for the City of Biloxi, MS. The color coding identifies the various land uses (residential, commercial (business), industrial, central business district, waterfront and others) and the interfaces between the uses. In the example below, shades of yellow denote residential uses; red and orange indicate commercial uses and dark blue denotes the Biloxi central business district (CBD) at the Gulf shoreline. The designations of B-1, B-2, RM-10, etc. for each color indicate land use densities such as dwelling units per acre or as an expression of floor area ratio for commercial uses on the parcel.

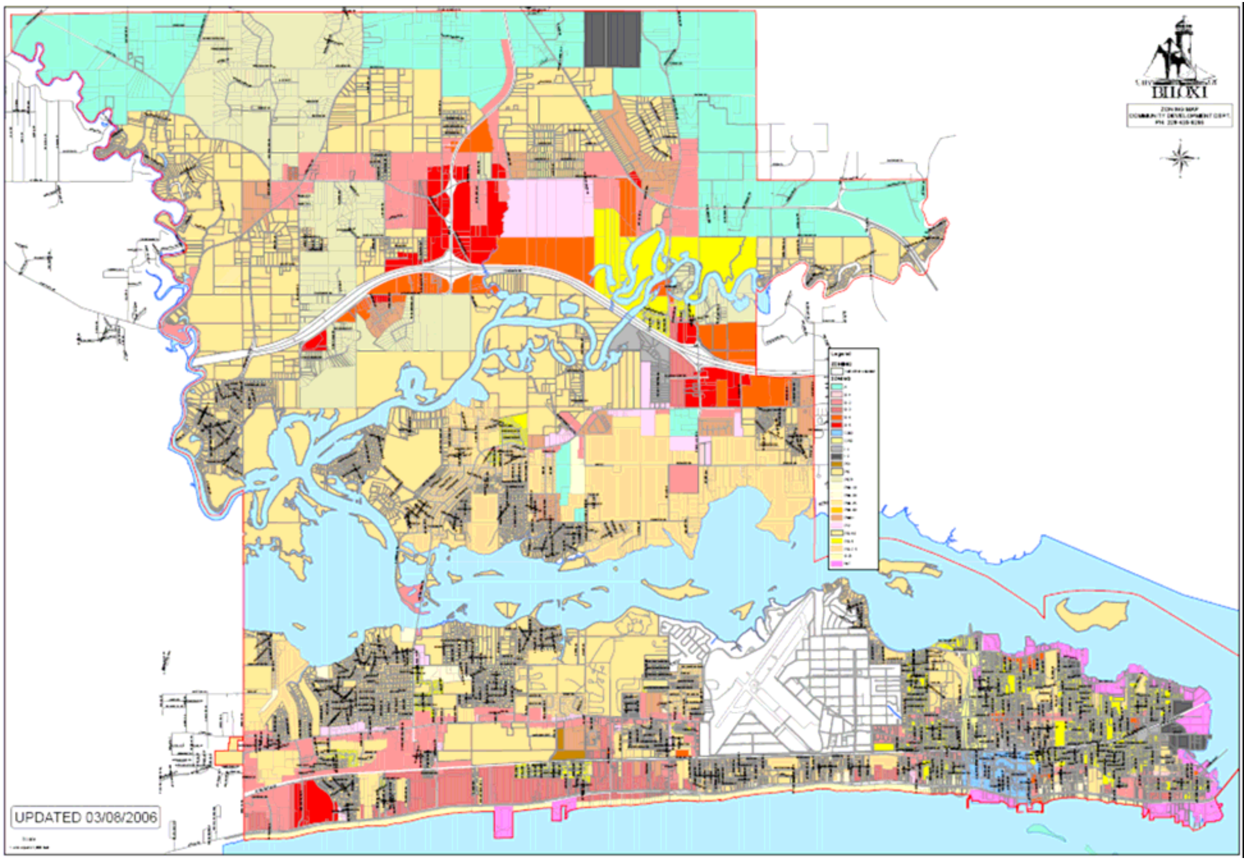


Figure 8. Biloxi Zoning Map

The courts have overturned numerous zoning ordinance determinations by communities and have stricken numerous zoning ordinances where zoning restrictions on private property have literally removed all reasonable use or economic value of the property to its owner. Courts have ruled that such Draconian zoning ordinances constitute a “taking” of private property and require reimbursement of the property value to the owner or retraction of the ordinance itself. Zoning private property that is subject to natural hazards (flooding) such that its value is significantly reduced borders on a taking that may require acquisition of the property at fair market value. See Section 4.5.2 - Floodplain Management, Floodplain Zoning, Flood Insurance and CRS on the application of zoning measures in the floodplain.

Generally speaking, land use zoning or rezoning as a measure for reducing flood damages is largely ineffective in many cases because of the amount of existing at-risk development that has been “grandfathered” into the zoning ordinance at the time of its enactment. These “non-conforming uses” cannot be totally removed through the zoning ordinance process unless they are destroyed (declared unsuitable for occupancy or a hazard) and then reconstruction is possible so long as the new structure and its use conform to the zoning district requirements. Again, overly restrictive covenants on the property would constitute a taking and require compensation of its value to the landowner. Only in the application of floodplain zoning and then only in the case of the regulatory floodway can such absolute redevelopment restrictions be upheld in the courts.

In areas where no development has taken place (interspersed vacant land) or where development has been largely removed (total loss areas), zoning or rezoning of the property could accomplish several project objectives. Property devoid of structures only retains its basic land value as dictated by market forces. That land value is influenced to some extent by the natural hazards that may endanger any development that would be constructed on the property. In the case of the study area, there are vast numbers of privately-owned tracts where the structure has been totally destroyed leaving only a concrete slab or wood pilings from the previous foundation. In these cases, rezoning the property for other land uses more adaptable to and compatible with the natural hazards may indeed accomplish several program objectives.

Zoning of high-risk properties bordering the coast and some of the inlet areas could be used to reduce the incidence of damages to certain types of development or all development. As discussed earlier, overly restrictive zoning that removes all economic opportunity of the property to its owner would be found to be a taking under the 5th Amendment and require just compensation. Attempts to rezone property previously zoned as residential or commercial uses for which the land may bear an economic return for its development or sale to park, open space or environmental uses zoning would raise that red flag of a taking.

Although a single zoning action that would prohibit all development within a specified area along the coast would significantly reduce flood damages in the project area, without full compensation of the fair market value for the property such zoning could be stricken in court. Significantly reducing the density of development from four dwelling units per acre to one dwelling unit per acre may be possible, but a court ruling may still consider that action to be a taking and the current ownership pattern may void any opportunities for actual implementation of such a rezoning change. In effect such restrictive zoning is no different than a complete mandatory buyout of the high-hazard zones.

Another option for rezoning the high-risk coastal and inlet areas may be to recognize the ability of higher density type development (development which commands a higher economic return for the property) to financially meet or exceed the restrictive building codes and extra requirements imposed by FEMA guidelines for development in these high-risk zones. While single-family homes, private-owner motels and chain restaurants generally do not have the financial resources to meet the restrictive construction guidelines or cannot be architecturally adapted to the guidelines, a mixture of high-density commercial and residential units may be able to meet those guidelines and still return a significant economic return to the owners.

Zoning the coastal areas for mixed-use commercial and residential at per-acre densities that would force building construction to be predominantly vertical combined with FEMA guidelines for first floor elevation could result in a number of multi-story buildings perched above parking garages along the beachfront. A mixture of residential condominiums, casinos, retail shopping and other associated uses perched on multi-decked parking garages would allow intensive reuse of what is now largely vacated land except for residential single-family foundation slabs and FEMA trailers.

In addition to reuse of these uneconomic properties, this form of redevelopment would generate significant tax revenues, employment opportunities, windfall profits for existing beachfront landowners and produce a significant structural wind break for development landward of this corridor. The nonstructural team observed these “wind-shadow” effects (as well as surge/wave-shadows) along the coast where more substantial building construction along the beach protected numerous residential and commercial structures located just landward of that building line – in effect a building “line-of-defense”.

More importantly than the potential benefits to intensive use of the beachfront properties through rezoning is the fact that such zoning would not be viewed as a taking requiring compensation. This rezoning would be considered as a financial windfall for existing landowners whose property would become exceedingly valuable to new developers. Similar in some respects to the TDR concept, coastal land otherwise of little value would have far higher value in this new market situation thanks to rezoning. Properties found to have potential for ecosystem restoration as wetlands could be purchased and developed as buffer areas landward of the high-density beachfront and integrated with golf-courses or other passive uses (trails, etc.).

In addition to zoning, another frequently used land regulation mechanism is Subdivision Regulations. These regulations prescribe requirements for the subdivision of land into individual lots for construction of either or both residential and commercial uses. The regulations address design and construction of all land improvements within a subdivision including platting of subdivided land, site grading, drainage, streets, utilities, site hazards, right-of-ways, easements, and lot setbacks. Developers wishing to subdivide land into individual lots for residential and/or commercial use must submit development plans (prepared in accordance with the subdivision regulations) to the Municipality or County where the site resides for approval. Usually both a preliminary plat and final plat that address all of the concerns listed in the regulations must be submitted for approval before any construction may begin.

Subdivision regulations can be modified such that the inundation threats for each lot can be delineated on the developer's submitted plat map and the regulations themselves can place certain restrictions or requirements on the developer to assure that the future landowners within the subdivision are either protected from defined inundation depths or made fully aware on their property map of the potential inundation threat on their lot. Since construction of any subdivision (where such regulations exist) depends upon approval of the submitted plat map by the local government, these restrictions and requirements with respect to inundation threats can be very effective for any new growth in the project area.

Costs for changes to zoning ordinances or subdivision regulations are local, administrative and minimal in nature compared to other alternative measures. Normally, municipal or county planning or engineering staff personnel, or planning commission or zoning board members administer zoning actions (variances, meetings, reviews, etc.) and subdivision application reviews.

Considering the level of control that these land use regulations can assert on the development and use of land within each jurisdiction in the project area, land use regulation (zoning and subdivision regulations) have been carried forward into more detailed formulation of nonstructural plans.

4.5.5 Development Impact Fees, TDR, PDR, and Redirection

4.5.5.1 Development Impact Fees

Communities nationwide use monetary development impact fees to address external costs resulting from land development projects that impact associated community services and amenities. Normally these impact fees address additional loadings on school systems, libraries, infrastructure (utilities, roads, collection services), fire, police and emergency services and other public services that support new development (especially residential and commercial development that use those services most).

Generally development impact fees have been upheld in the courts provided that they are levied fairly by an governmental entity legally able to collect such fees, that they are collected for addressing a legitimate public purpose, and that the method of collection most closely resembles the objective for the fee so as to not approximate a taking. In this case, support of a redeveloped and robust emergency services system that would be applied to many types of hazards (especially hurricanes and floods) would be a legitimate purpose for the fees. As such an emergency facility would be directly related to structures and families living on the flood-prone lots from which fees were collected, the legal nexus would be sound.

These monetary impact fees could be applied to new land development or subdivision development on a per lot basis to address municipal or county costs associated with flood emergencies and the aftermath cleanup in damaged areas. The level of fees assigned per lot would be directly related to the level of flood risk at the individual subdivided lot – greater the flood risk, the higher the fees (i.e., V-zone - $10,000/lot, A/AE Zone - $8,000/lot, B zone $4,000/lot). Developers of the subdivided sites could reduce the fees by receiving local planning commission approval on specific, bonded measures that reduced the flood hazard on the lots.

Costs for instituting development impact fees are local and administrative in nature.

4.5.5.2 Transfer of Development Rights (TDR) and Purchase of Development Rights (PDR)

Transfer of Development Rights (TDR) and Purchase of Development Rights (PDR) are land use control mechanisms predicated on the concept that landowners' rights to develop their property can be separated from other land rights (mineral, air, surface, etc.) and traded or purchased within a market-like system. Generally speaking any land use controls (zoning, etc.) that significantly decrease the market value of property or remove an opportunity to receive some economic value or use from the property have been considered a taking under the Constitution and require compensation to the landowner. TDR has been found in the nation's courts to be a legal device for transferring that portion of a landowner's rights to the property for compensation in a market-like process that avoids the "takings" issue. As the programs are strictly voluntary in nature, the takings issue is set aside. The ability of local governments to establish and operate either a TDR or PDR program is normally enabled by enactment of state legislation.

In TDR, the landowner's right to develop certain property (sending lot) that may be environmentally sensitive, historic, scenic, prime agricultural land or flood-prone, can be offered as a market item to be purchased (monetary transaction) by other landowners whose land (receiving lot) is not restricted by the same environmental, hazard or historic parameters. Normally the receiving property is provided a density bonus whereby more units of housing or commercial floor space development can be permitted on the same land area with the purchased development rights. TDR programs are popular within the United States and have been used successfully (i.e. Maryland) to reduce losses of sensitive environmental landscapes, historic buildings, and agricultural land or restrict development on hazardous property while allowing land development and the tax revenues associated with growth to increase.

A TDR program can be established by a local unit of government, such as a county within which both the sending and receiving property are located. Based upon documented parameters, sending properties are identified and values associated with the development rights are established. A number of properties in the sending area can be formed into a "sending district". Landowners of potential receiving properties (which are designated as "receiving districts") are given the opportunity to purchase (monetary transaction with the sending landowner) those rights. The owner of the sending property retains ownership of the land but is not able to develop the property under the terms of the transaction. Normally, property taxes on the sending lots are reduced substantially to reflect the loss of potential development. The sale of the development rights is documented on the property deed and encumbers the deed in future land transfers.

Establishment of a TDR program in the project area would require the enactment of state enabling legislation. Examples of that legislation are available from other states and the costs for instituting and operating the program are local and administrative. All other costs are contained within the land development rights transfer market. The establishment of a TDR program was one of the 180 suggestions offered by the public and cooperating agencies.

Purchase of Development Rights (PDR) accomplishes the same objectives as TDR but requires a unit of government (county or municipality) to purchase all or some (development easements) of the development rights of the subject property. Generally the value of the development rights reflects the appraised value of a structure type (residential or commercial) that would be permitted under existing land use zoning. The value and limited use of the land and its reduced property tax burden remains to the landowner. This development rights purchase program is unlike the TDR program in that the development rights are not resold or traded through a market mechanism, but held in a public trust and used for public uses (recreation, etc.) or left in their present land use (historic preservation, ecosystem, scenic easement). A successful PDR program is operating in Lexington, Kentucky where development rights of horse and agricultural farms surrounding the metropolitan area are being acquired to preserve the scenic quality of the landscape and forestall subdivision development outside of the municipal water and sewer service area. The value of the development rights is being established through a comparison of tax assessments displaying both with and without future development values of the tracts.

As is the case with TDR, a PDR program would require enactment of state enabling legislation. Costs for instituting the program would be local and administrative or could be operated through a non-profit organization. Costs to operate a PDR program would require sizable sums of capital with which to purchase the development rights of interspersed vacant lands in the project area. Funds could be secured from the state or through local taxes or assessments to fund the land purchases.

Both TDR and PDR could be used in the project area to acquire development rights of parcels subject to frequent inundation or that are environmentally sensitive. Properties subject to inundation by surge and waves or that are prime ecosystem habitat could be designated as the sending district and property located above the 500 year event or the Maximum Probable Intensity Hurricane surge-plain could be designated as receiving districts. Monetized property development rights could be designated in the sending district and sold by the administrating agency to eligible property owners in the receiving district – a transaction that restricts development in otherwise hazardous or environmentally sensitive areas with compensation provided through a private market process. More dense development in the receiving district would offset property tax losses in the sending district. Tax-sharing agreements between the sending and receiving districts could offset losses in the TDR sending areas.

Since both of these programs are voluntary in nature and are essentially market-driven processes, they are not easily scheduled as other more proscribed measures (acquisitions or floodproofing). Given this characteristic, both TDR and PDR may be more applicable to high-hazard, interspersed properties that were vacant prior to the Katrina event where development pressures are not as high. These properties are less likely to be redeveloped in a short period of time giving the process time to acquire the development rights. Using either TDR or PDR to restrict development of these properties would accomplish many of the planning objectives without direct Federal expenditures.

Both of these measures should be carried forward into a more detailed nonstructural plan formulation process. Requirements for state enactment of the required enabling legislation would have to precede implementation of the measure by local governments.

4.5.5.3 Land Development Redirection

Land development redirection considers that rational Federal, state, county; municipal, corporate and private landowners when confronted with ongoing natural or man-made threats that result in damages to fixed assets will over time migrate to locations that avoid such continuing losses. In situations like Katrina, where physical damages are catastrophic and there are losses of life, some migration out of necessity would occur at least temporarily. Reconstruction back within hazardous areas does occur so long as the risks of future events can be mitigated or the risks are ignored by landowners due to cultural, social or financial influences. As discussed in Section 4.5.2 above, certain loss off-setting programs such as flood insurance can delay that long-term permanent migration so long as the insurance carrier chooses to continue reimbursements for damages. As is now evident by the many court battles between landowners and insurance carriers along the coast, that continuing reimbursement for damages may be ending soon.

For public facilities (schools, fire stations, police stations, hospitals, emergency services, public works facilities, etc.) that are: 1) more expensive than residential or commercial uses to repair following damaging events, 2) that need to maintain continual services (some emergency services) to thousands of citizens, and 3) have to be repaired with either disaster mitigation money or local taxes, maintaining such facilities in hazardous areas becomes a burden on the financial and political resources of the community. Both county and municipal governments can, over time, successfully relocate certain public facilities out of hazardous areas through judicious use of funding authority in their Capital Improvement Programs.

Capital Improvement Programs (CIP) are enabled by state legislation and allow local governments to construct new facilities or rehabilitate existing facilities to serve public purposes or in some cases purchase very expensive equipment (vehicles, pumps, electronics, etc.) that would be beyond normal purchase limits under local annual operation and maintenance fund accounts. Local governments establish capital improvement programs based upon approved public facilities plans either through a comprehensive planning process or some other process provided for in the state enabling legislation. Under this CIP, a county or municipality could issue bonds, borrow funds or use tax receipts to fund replacement of public facilities that are located within hazardous flood zones and have been repeatedly flooded or are reaching the end of their useful design life. Generally, substantial redevelopment/replacement of public facilities by local governments is a long-term process due to the high costs involved and the political processes necessary to resolve service area disputes and other social issues.

Although careful exercise of land development policies, regulations and programs (such as the CIP) can result in eventual changes in land use that decrease development in high hazard zones and increase growth in less threatening areas, more direct action can be taken that accomplishes the same objectives in a much shorter time period. Specific actions that redirect growth and redevelopment into less hazardous landscapes can be supported with capital investments in land acquisition and infrastructure development and either Federal or State supported mortgaging assistance.

In a relatively stable housing market such as existed prior to the landfall of Katrina in the project area, new housing starts away from the coastal floodplain were sufficient to handle consumer demands for larger and more amenity-filled homes. Relatively new developments such as Diamondhead and other PUD’s away from the coastal floodplain were based upon an exclusive housing market demand and lack of sufficient and affordable vacant land within walking distance of the beachfront.

Prior to Katrina, residential development along the coastal floodplain was required by ordinance to adhere to FEMA regulations and the latest version of the municipal or county FIRM. Following Katrina, the establishment of the Advisory Base Flood Elevation by FEMA, disagreements on insurance settlements, lack of flood insurance and insufficient personal capital have resulted in little redevelopment of destroyed housing along the coast. Katrina and the loss of tens of thousands of homes resulted in a severe housing shortage to accommodate displaced landowners and any new arrivals. The past demand turned overnight into a housing need that did not have sufficient available flood-safe residential lots, infrastructure, construction capital, or mortgaging funds. Fortunately many of the displaced population left the area entirely reducing some of the burden on the already damaged housing market.

In order to address the shortages of available residential lots and selected commercial redevelopment that would support construction of new residences, a government-assisted program (county, state or Federal) of new redevelopment sites could assist in redirecting growth away from the coast and to flood-safe sites. This method of redirecting growth has been used successfully in other flood damaged areas where the housing market is unable for whatever reason to recover and provide needed replacement units. Adding flood-safe units to the housing market not only opens up additional resources for displaced homeowners to return to the project area but provides relocation housing for those whose property may be purchased as a result of applying either structural or nonstructural measures as part of a Corps project. Increasing the availability of reasonably priced development lots also eases the cost pressure on limited market opportunities.

Numerous redevelopment sites can be selected, planned, designed and constructed at a designated flood-safe elevation that would entice people living in FEMA trailers on property where only a concrete slab remains to move upland and away from future flood damages. Necessary site improvements (land clearing, grading and drainage) and infrastructure (utilities, roads, etc.) would be provided with mortgage assistance available through government-sponsored relocations and housing programs. These types of relocation and redevelopment projects have been successfully implemented in other regions as part of nonstructural and structural projects.

In-fill developments within existing communities that are less flood-prone could help to reduce the social and economic impacts of relocations. Several opportunities for in-fill developments were identified during the community assistance design charrettes conducted in 2005 and 2006 under the Mississippi Renewal Program. These in-fill projects would absorb a number of relocations with floodproofed structures within urban areas featuring existing infrastructure and services. Collaboration with local planning commissions and development authorities for in-fill projects would help to assure successful integration of relocatees into the existing community fabric. Care must be taken to assure that in-fill relocations do not overtax schools or other public services within receiving communities. Section 4.5.9 - Permanent Acquisitions contains a more in-depth look at infill developments as a redevelopment concept.

In some communities such as Waveland, Pass Christian and Bay St. Louis where a mandatory acquisition plan applied to high hazard properties along the coast would result in large scale relocations of the population to less-flood-prone areas, another redevelopment plan may be in order. In these special cases, relocating whole neighborhoods or communities as an intact social entity should be considered. In the absence of planned community relocation, these municipal areas would merely be dissolved in time due to a lack of human resources and a crippled economic base.

Planned community relocations would provide the opportunity to accommodate all existing flood-prone land uses into a flood-safe location in a coordinated way that would maintain many of the basic social and economic associations now thriving in the present community. Developing planned communities could also reduce the impacts of a dispersed population impacting public facilities (schools) and services (police, fire, garbage, etc.) in the destination communities.

The challenges in planning large-scale relocation communities in a developed region center on aggregating sufficient land on which to design a coherent community layout. A review of available aerial photography for the project area shows limited development opportunities of any appreciable scale south of Interstate 10 except for a few isolated parcels. Moving north of Interstate 10, there are opportunities that can be explored for relocation communities. These sites would be investigated in greater detail for their possible use as Housing and Community Redevelopment Sites as an adjunct to the permanent acquisition measures.

Obviously redirection of land development can be more successful in coastal areas that are less urban in character, where sufficient flood-free land is available for the redirected community development to occur and where recent events such as a major hurricane have resulted in significant damages to coastal structures and communities. In areas of the Gulf coast that were not directly affected by Katrina or other recent hurricanes, this strategy would be more difficult to implement given the lack of incentives or necessity to move away from these high-hazard areas. The inertial forces associated with a non-threatening, highly aesthetic coastal location are formidable. Formulation of protection strategies for these non-impacted, urban areas may concentrate on measures that emphasize protection in place rather than redirection of development.

Costs for redirection of growth in the project area would be substantial. Site acquisition, site improvement and infrastructure costs could range between $25,000 and $45,000 per subdivided lot. Depending upon the number of lots developed and the amenities provided redevelopment communities (500 units) could cost between $10.0 and $20.0 million each. Implementation of this process would take several decades depending upon funding constraints and the willingness of the project participants. In view of the potential for "tiering" of the nonstructural measures, land development redirection would fall into the later tiers of implementation.

Development impact fees, TDR and PDR and Land Development Redirection are all techniques that act as incentives or disincentives to redevelopment in hazardous coastal areas. Because they are proven methods for reducing damages to potential future growth they are carried forward into more detailed plan formulation.

4.5.6 Land Taxation Policies, Special Assessments and Revenue Sharing

4.5.6.1 Land Taxation Policies

The taxation of private property through the *ad valorem* tax process, besides being a method of raising revenues with which to operate county and municipal services, can be used as an economic system of incentives and disincentives for directing land use development. Normally, private property taxes are established based upon categories or classes of land use (residential, commercial, agricultural, industrial, and vacant) and their location within or outside of municipal areas. Property taxes are a reflection of the assessed value (a percentage of fair market value determined by the tax assessor) of the land and improvements and locational aspects of the property. Normally property is taxed at a percentage of its true assessed value. Properties are divided into taxing districts that reflect values and which taxing authorities (schools, services, etc.) apply to that location. Different millage rates are applied to each district.

Property taxes are calculated using millage rates determined by the tax assessor's office. The millage rate is determined by dividing the amount of total revenues needed to operate and maintain county and or municipal services (that portion supported by taxes) by the total assessed value of all property within the county (excluding exemptions) or a particular district. The millage rate or "mill" represents one dollar of tax per $1,000 of value of assessed value on the property. Adjustments to the rates are made based upon the property classifications and units of government (county or city) where the property is located.

Since revenues derived from property taxes are a reflection of the costs of maintaining services that support that property, additional costs for maintaining certain classes or locations of property could be defrayed by increasing the assessments or millage rates applied to those "high-maintenance" properties. In other words as the tax district budget increases due to responses to flood events, the millage rate is adjusted to capture those costs from property taxes. Properties located in flood-prone areas that require a higher percentage of public services for support could be taxed at higher rates to reflect that increased service demand. This economic disincentive on development would in time discourage growth in that area. Likewise, for certain aspects of property maintenance provided by a municipal or county that are cheaper because of their location (flood-safe), taxes on those properties could be lowered as an incentive to encourage building in those safer (less-costly) areas.

Costs to modify tax millage rates are local and administrative/legal in nature. The costs to modify the rates are not as compelling as the public reaction would be to making the changes.

4.5.6.2 Special Assessments

In addition to modifying existing millage rates for property taxes in high hazard areas, special assessments on flood-prone property could be used as a disincentive to further development. In theory, taxes from individual land uses should be set such that the costs of delivering public services to that use are offset by the annual taxes accruing to each parcel. In practice property taxes rarely collect sufficient revenues to fully capture all of those costs, but in situations where a property or properties are subjected to recurring damages (such as flooding) including damages to infrastructure that services that property, those costs far exceed the property tax revenues. In these cases, special assessments can be levied against those properties to capture additional revenues for the higher costs of services delivery, infrastructure repairs or to capture windfall benefits accruing to property due to some public improvement that services that property. A special assessment tied to the higher costs of services delivery in a hazardous taxing district would raise the tax burden on properties in that hazard area and in time redirect growth away from those higher cost properties. The special assessments would be added to the existing millage rate of that tax district to support higher costs of service delivery or repairs to infrastructure. Basically used as an additional revenue producer for the public services provider, special assessments can also act as a disincentive for future growth in hazardous areas.

Like modifying tax millage rates, the costs of enacting special property assessments are local and administrative/legal in nature. The public reaction to the assessments (perceived by many as a tax burden) would be much more problematic.

4.5.6.3 Revenue Sharing

An ongoing malady confronting many municipal governments is the rush of downtown businesses and residential growth to more rural county locations. This shift of property tax revenues from municipal to county areas further exacerbates the plight of deteriorating downtowns. This process has been occurring for many years as new transportation opportunities and development sprawl extend growth into non-municipal areas. The affects on the nation’s cities are evident everywhere as the thresholds of commercial and public services for losing and gaining communities are approached. Many unique strategies to mitigate the economic and social effects of these migrations have been implemented across the nation. Those strategies include establishment of metro-governments and revenue sharing.

In the case of the project area, use of TDR, PDR, rezoning, taxation polices, changes in the NFIP, planned acquisitions and relocations, all affective nonstructural methods of reducing damages, would in time gut the economic hearts of the existing cities on the coast. Municipal areas like Pascagoula, Biloxi, Gulfport, Pass Christian, Bay St. Louis and Waveland could experience massive reductions in private property ownership and the taxes produced by that property as development is acquired and/or redirected north towards the I-10 corridor and beyond. In an effort to offset these losses, two strategies are possible.

First is the establishment of metro-governmental structures whereby the county and municipal governments are joined into a more regional structure that can address the equitable delivery of public and social services and more evenly distribute tax revenues collected throughout the new jurisdictional boundary. Metro-governments are used across the nation to address the economic effects of sprawl and migration of business and residential taxes from municipal to county governments. Another strategy that can be instituted to defer the heavy losses of revenues associated with business and residential migration is revenue sharing. Municipal/county agreements could be negotiated whereby all or portions of tax revenues generated by relocated facilities could be shared between the receiving counties and losing municipal governments. Sharing of the tax revenues would enable municipal areas to maintain a minimum level of services to remaining households and businesses that have not been removed. At a later date when the relocation of the majority of the taxable base has been accomplished, the revenue sharing ceases and the municipal area as a separate jurisdiction is abandoned.

Although revisions to local property taxation rates and special property assessments can be formidable methods of discouraging continued land occupancy in high-hazard areas, they tend to be regressive in nature. Given the wide disparities between the income levels of occupants along the coast, increasing property taxes as a financial disincentive to maintain occupancy in a high-hazard area would fall heavily on low-income and fixed-income households. Low-income residents consistently expend disproportionate shares of their limited income to pay property taxes and other land occupancy costs than do their wealthier counterparts. Using the property tax rates to accomplish changes in the land uses and occupancy of high-hazard areas may result in environmental justice issues with a disproportionate share of the costs falling upon the low-income and fixed-income segments of the general population.

In addition, property tax rates are normally capped at certain levels set by state codes, local ordinances or through popular referendums and substantially extending those limits to accomplish a project objective may entail major revisions to already politically sensitive legislation or ordinances. For these reasons, modifications to the property tax rates and the application of special property assessments to discourage development in high-hazard zones will not be carried forward into more detailed formulation. However, should permanent acquisition and relocations of residential, commercial and institutional structures be part of a final nonstructural or combined plan, measures for sharing tax revenues between the counties and municipal jurisdictions are being carried forward in the formulation process to offset tax revenue losses.

4.5.7 Floodproofing

4.5.7.1 General

Floodproofing is a very broad term that describes an array of building construction techniques that can be used to reduce flood damages to structures. This method of protection can be applied to new building construction or can be applied to existing buildings commonly referred to as retrofitting. Structures of different construction types (wood frame, masonry over frame or solid masonry), sizes, uses (residential, commercial, and institutional) and foundation types (slab, crawl space, or basement) can be floodproofed in one of several ways described below.

Unlike permanent acquisition and evacuation (discussed below), floodproofing measures result in the continuation of the structure’s functions on-site in some modified condition so that normal functions of that structure or facility can continue (with post-flood cleanup) shortly after the conclusion of a storm event. Although this rebound capability is a plus for families and communities attempting to recover from a major storm event, the risks associated with the determination of appropriate levels of protection and both design and construction parameters are many. Full consideration of risks and uncertainty in establishing the appropriate level of protection and building design parameters is important in the formulation of the floodproofing measures.

Also important to floodproofing is a reliable and timely flood warning and emergency evacuation program so that residents of floodproofed structures can safely evacuate their protected structures. Generally speaking, occupants of floodproofed structures and facilities should not inhabit the building during a flood event. The uncertainties surrounding the prediction of surge depths, wave heights, and other deadly components of approaching hurricanes and storms are too great to risk weathering such events in an at-risk location. Regrettably when the threat of building failure is greatest, rescue is nearly impossible and any rescue attempt would place responders in extreme peril.

Floodproofing has been used extensively across the nation within government-sponsored mitigation programs, as a component of local floodplain management plans or as a private structure owner initiative for communities in both coastal and riverine situations. Thousands of homes, commercial and institutional buildings along the nation's coasts have been retrofitted or newly constructed so that the first habitable or sales floor (commercial) is elevated above a specified flood level. Initial data indicates that as many as 25,000 parcels within the project area may be eligible for structure elevation as a risk reduction measure.

4.5.7.2 Floodproofing Types

Floodproofing is generally divided into two types: 1) dry floodproofing where no water enters any portion of the structure, and 2) wet floodproofing – where water (floodwaters or clean water) is allowed to enter some portion of the structure temporarily without damages to the structural components of the building or the contents.

Methods of dry floodproofing include constructing watertight enclosures surrounding the building including veneer walls, applied sealants to existing walls and either ringwalls or ring levees that prevent water from reaching the interior of a structure and its contents. Placing fill materials on the building site as a means of elevating the first floor can also be effective although the NFIP requirements for the use of fill materials on individual lots in V-zones is very restrictive (erosion concerns). Several structures in the project area that had apparently been raised on engineered fills withstood the storm event with moderate water damages to the first floor. Ringwalls and ring-levees can also be effective methods of dry floodproofing but calculating the appropriate level of protection is full of risks and uncertainties.

Wet floodproofing can include allowing floodwaters or clean municipal water to enter portions of the structure that are so designed that immersion does not damage flood–resistant building materials or contents. The most common method of wet floodproofing is raising or elevating the first habitable floor of an existing building (a.k.a. retrofitting) or constructing a new building on a foundation that elevates the first floor above the specified flood level. Figure 9 shows an elevated residential structure that weathered the surge and winds of Katrina with minor damages.

Figure 9. Elevated Residence in Project Area

Under the National Flood Insurance Program, that specified flood level is normally referred to as the Base Flood Elevation (BFE) which normally has an annual recurrence probability of 1 percent (known commonly as the 100 year frequency flood event). Structures can be elevated to higher levels providing greater levels of protection and further reducing risks, but the BFE is the minimum level specified by FEMA to be in compliance with the NFIP.

In accordance with the NFIP and regulations promulgated by FEMA, many structures in the project area had been wet floodproofed by elevating the structure on wood pilings, piers, masonry columns and other foundation types thereby elevating the structure's first habitable or sales floor to or above the BFE. Areas beneath the raised first floor whether enclosed or not remained subject to flooding. The majority of structures was residential uses and was wood frame or masonry over wood frame construction. Prior to the arrival of Katrina, these structures were able to withstand other high-water events (surge and waves) generated by less powerful hurricanes and tropical storms with minimal damages. Their survival depended upon the elevation of the first floor and vulnerable residential-type stud-wall construction above the storm surge and waves.

Generally, when structures are elevated to a level where the storm surge and pounding wave action cannot impact the building's first-floor substructure or the first floor walls, their survivability increases dramatically. In an elevated condition, only wind forces become a threat to the structure. Application of hurricane-tested building code construction methods and materials use can reduce wind damages to raised structures.

4.5.7.3 Katrina Damages to Existing Floodproofed Structures

The massive surge and waves associated with hurricane Katrina either swept (lateral forces) or lifted (buoyancy forces) many elevated structures off their foundations or the pier foundation itself failed resulting in loss of the structure during the storm. Although hundreds of residential and commercial structures had been elevated according to acceptable FEMA standards proscribed in the NFIP guidelines, the combination of surge levels far exceeding the BFE and waves transported on the surge into the first floor walls and substructure of those elevated structures resulted in their destruction. Several elevated structures that survived Katrina showed signs of wind damage and inundation damages, but they were largely intact. Figures 10 through 13 show the damages to elevated structures resulting from Katrina.

The residential structure shown in the Figures on the top left was not located within the V-zone. The structure had inundation damages within the first and second floors but withstood the surge. The other three residential structures shown in the figures were located in areas classified by FEMA after Katrina as the "catastrophic damages zone" and have now been included in the enlarged V-zone within the new DFIRM's. Their level of damage is far greater than the structure located outside of the V-zone.




Figures 10, 11, 12 and 13. Damages to Elevated Structures

Observations of the structural damages due to Katrina indicated that many of the unit masonry construction columns and piers failed resulting in total loss of the elevated structures. Improper design and construction methods may have contributed to some of the failures, but in many cases even what appeared to be well-designed and constructed foundations failed due to the extreme forces brought about by Katrina. In these cases, the proscribed level of protection (BFE) was insufficient to prevent the battering forces of waves and debris from crushing the sidewalls of standard residential construction. In several cases concrete block columns and poured concrete, steel-reinforced cylindrical columns both failed resulting in total building loss. Based upon field observations, driven wood piling and deeply set wood poles seemed to survive the combined forces of surge and waves. In most cases the elevated structures themselves had been destroyed, but the wood post foundation, main supporting beams and cross-bracing survived the storm event. Figures 14 through 17 show these remnant foundations and the extent of damages inflicted by surge and waves.

Figures 14, 15, 16, and 17. Remnant Foundations

4.5.7.4 Floodproofing by Elevation (Raising-in-Place)

4.5.7.4.1 General

Elevating the first habitable or sales floor of a structure above specified flood levels is an effective way to reduce damages to a structure and its contents. This method of floodproofing can be applied to both new construction and existing structures (retrofitting) using several techniques including an extended foundation system or an engineered fill. Extended foundations can be accomplished by the use of pilings, piers, columns, or solid walls. The particular type of foundation used is dependent upon the building construction type (wood frame, masonry), building weight, and height of raise, the location of the building with respect to wave action and surge, and cost effectiveness.

In accordance with NFIP guidelines, solid wall foundations are not permitted in V-zones due to the destructive wave forces that can be brought to bear on wall surfaces resulting in foundation failure. However, solid wall foundations could be used in areas where flood damages would only be caused by inundation of the structure (no waves).

In addition to extending the foundation to elevate the structure, floodproofing requires extension of utilities serving the structure (electric power, water, sewerage, gas, telephone, and telecommunications) and modification of access from the ground surface up to the elevated first floor. In special cases (handicapped or elderly) some options for assisted access (chairlifts) can be included in the elevation design. Although these associated construction components constitute a smaller proportion of the total floodproofing construction process and cost, they are sensitive to the height of raise and determine the livability of the structure. NFIP regulations for coastal areas allow a maximum 300 square feet on enclosed space beneath an elevated structure for securing access to movable storage and as a utility chase.

Closely allied with retrofitting existing structures by elevation is the concept of “rebuilds” on site. In many cases, existing structures that have been found to be eligible for elevation with regard to the allowable water depths at the site cannot be raised because of structural integrity issues due to storm damages or building deterioration. In these cases, rebuilding a new elevated structure on site may be cheaper than either acquisition or rehabilitation of the existing structure. Successful “rebuilds” accomplish the basic objective of reducing flood damages to structures as well as increasing the value and conditions of the housing stock in the project area. All “rebuilds” are designed and constructed to building code specifications and elevated according to local floodplain management ordinances.

This additional option for landowners makes the floodproofing measure very attractive. Opportunities for “rebuilds” are probably numerous throughout the project area, but without detailed data on the conditions of individual structures, an estimate of their number is problematic at this level of detail. More detailed documentation of eligible structures within the project area would be able to capture the number of these potential rebuilds. Costs for rebuilds have been included in the floodproofing section of this appendix since they are identical to elevating new structures on eligible vacated lots.

4.5.7.4.2 Level of Protection

Floodproofing through elevation of the structure is very sensitive to the selected level of protection and storm hazards of the building site. In coastal V-zones and riverine floodways, floodproofing by elevation is generally to be avoided due to the immense physical forces that moving water can exert on building foundations and both building floor and wall systems. In addition to these dynamic water forces, the presence of water-driven debris adds to the extreme battering that standard residential wood-frame construction can be exposed to during a hurricane. Normal wood frame and masonry on frame building construction cannot withstand the dynamic forces imposed by wave and run-out impacts and surge. Even solid masonry construction built to accepted building codes can sustain significant damages and even experience failure under these extreme conditions.

The determination of the appropriate level of protection is a significant parameter for floodproofing by elevation. The NFIP standard requirement for floodproofing is elevation of the first habitable or sales floor (commercial) to or above the Base Flood Elevation (BFE). Additional elevation of the structure above the BFE, where practical, reduces the probability of damages thus reducing premiums on an owner’s flood insurance. Although additional elevation of the structure’s first floor above the BFE can substantially reduce insurance premiums and improve community ratings under the Community Rating System (CRS), this additional increment of protection is rarely undertaken by landowners. All of the local floodplain or coastal zone management ordinances in the project area indicate the BFE as the minimum level of protection for structures within the flood zone.

Immediately following Katrina, FEMA published the Advisory Base Flood Elevation (ABFE) mapping for the project area. This mapping displayed a revised BFE for the project area that incorporated the affects of Katrina in the new water surface elevations for the purposes of setting the first floors of new construction along the coast. A number of communities and counties in the project area adopted the ABFE into their existing floodplain management ordinances as interim measures. It was anticipated that revised flood mapping (DFIRM) would be issued by FEMA in the near term.

4.5.7.4.3 Building/Structure Elevation within the Identified High Hazard Zones

Due to the immense forces of high velocity water associated with waves, wave run-out and surge inundation, the nonstructural PDT decided that no floodproofing by elevation would be recommended in the project area for the V-zones delineated by FEMA. Observations of Katrina damages within the mapped V-zones supports the contention that forces in that zone are too extreme to risk residential building construction – few structures survived intact. More importantly, elevated structures in this area could result in their owners attempting to “ride-out” future storms and risk their lives in the process. At the point where the elevated structure may fail, the conditions of surge, waves and wind velocities would significantly reduce the chances for survival by the occupants. In addition, the lives of emergency personnel attempting to rescue those remaining in elevated structures under hurricane conditions would be placed in extreme jeopardy as well.

In addition to the mapped V-zone, the PDT identified an additional zone along the coast referred to in post-Katrina FEMA reports as the “catastrophic damage zone” wherein the majority of insured structures suffered damages greater than 50 percent of the structure value. This linear zone included the V-zone but extended further inland from the beachfront. Observations of damages within this zone by the nonstructural PDT confirmed that the majority of the structures within this zone were either totally destroyed (only the slab foundation remained) or the remaining structure had been severely, structurally damaged and would probably be demolished rather than repaired. Due to the extent of the damages caused by surge inundation and wave action in this zone the nonstructural PDT decided that floodproofing by elevation should not be recommended in this area.

Since the FEMA designated “catastrophic damage zone” was directly related to the actual Katrina event itself, the nonstructural PDT decided to duplicate that zone (most prominent in Waveland, Bay St, Louis, Pass Christian, Long Beach, Gulfport and Biloxi) along the entire coast within the project area. Based upon measured distances back from the beachfront in those areas, an 800 foot zone extending inland from the normal tide waterline was applied to the coast in Jackson County as well. The nonstructural PDT decided that floodproofing within this 800 feet wide buffer zone would not be safe due to the extreme forces that could attack elevated structures in this zone. These high hazard zones (combined and designated with the acronym HHZ) are shown in Figures 58 through 62 .

Elevation of structures (residential, commercial and institutional) within the FEMA-designated A and B zones (100 yr and 500 yr respectively) could be supported under the current guidelines for coastal construction. Floodproofing through elevation for structures in the FEMA-designated A and B zones is a nonstructural measure that should be carried into the final planning formulation.

4.5.7.4.4 Building Elevation Limitations and Parameters

Limitations on the height that structures can be elevated are based in part upon several factors including cost to elevate the structure (compared with its acquisition cost), high-velocity wind loading on raised structures, structural stability of elevated buildings, occupant accessibility, visual impacts and architectural suitability. Since the costs of protection measures and alternatives being considered in plan formulation would be compared to identify the most cost-effective solutions, the cost of floodproofing a structure would be compared with the cost to either acquire the structure or rebuild a new elevated structure on the same site. Once the cost to elevate the structure exceeds the cost to either acquire or rebuild a new structure on site, the elevation of the existing structure comes into question just based upon economics.

Powerful natural forces during storms and hurricanes place tremendous stresses on all structural components of the building and its supporting foundation. The elevated structure is positioned between the devastating forces of saltwater from the ocean and the equally damaging forces of high-velocity winds and wind-driven debris. Numerous structures that survived inundation by surge and waves from Katrina were ripped to pieces by hurricane-force winds and wind-driven debris.

Elevation of a structure above the ground places the building in the pathway of hurricane force winds that are undisturbed by ground-clutter. Trees and other surrounding structures (all ground-clutter) can affectively reduce wind velocities at ground level. Constant winds in excess of 120 mph can destroy most unprotected residential construction. Other than structures that have been built to more recent building codes (post-hurricane Andrew) that account for hurricane force winds, most residential structures are not built to handle high-velocity winds. Older structures that can be elevated probably would require some retrofitting of the structure roof and wall systems and windows to survive in the high-velocity wind environment.

The constant battering of wave run-out and surge-transported waves on the supporting columns/pilings and floor substructure of the building during storm/hurricane events raise concerns of sustainability and safety. Among the many forces at work are scouring around the bases of columns/pilings at the ground surface and impact forces of waves on the columns/pilings themselves. Wave run-out that occurs as storm surge brings breaking waves around the base of the structure can easily undermine columns and pilings as well as slabs exposed to this high-velocity water. Waves borne upon the surge can impact extended columns and pilings resulting in material failures or racking of the supporting structure. Assuring that the buried depths of the columns/pilings is sufficient to reduce failure and installing protected-edge concrete slabs surrounding the columns or pilings can reduce the affects of scour. Impact forces on the supporting substructure must be considered in the cross-section design and reinforcing components of the system. Racking can be addressed with cross-bracing between columns/pilings and perimeter stabilization components.

Tradeoffs between the issues of safety and costs of raising buildings to extreme heights and the ability to maintain vestiges of coastal communities in their current location must also be considered. Accounting for the removal of many existing structures and prohibition of rebuilding many structures in high-hazard wave zones (V-zone, etc.) discussed below, overly restricting the height of elevation can result in extensive evacuation of buildings and facilities from communities.

In addition, occupant accessibility (especially for physically challenged occupants) to the elevated home is a critical component of the elevation process. Exterior stairways in excess of 12 steps require intermediate landings per the building code and too many steps make the elevation option too laborious for older occupants. For those structures sited on narrow urban lots, situating access stairways with landings may not be feasible. Structures can be relocated on-site to enable easier access options, but these additional operations also increase the cost to elevate.

For those landowners with physical handicaps, an elevated structure poses significant access problems. Although there are several options for addressing handicapped access to an elevated structure, the costs of installing some of these options can be very expensive and require frequent OMRR&R by the landowner. Basic ADA specifications for access ramps for wheelchair users require a maximum slope of 1:12 or 8.33% for the ramp and intermediate landings every 30 inches of rise. Ramps must be at least 36 inches wide and landings must be at least 60 inches long. Using these component requirements, a wheelchair access ramp would have to be approximately 210 feet long to reach a first floor elevated 15 feet. On narrow urban lots, the use of access ramps for handicapped occupants would have limited application.

Although coastal communities around the nation have a somewhat “different” look visually because of the need for elevation of first floors, there are some limits to the visual quality boundaries of an elevated home or business. The overall dimensions of the structure (height versus width and length) can become unbalanced leading to a visually unpleasant building whose value could quickly plummet on the market. In some cases, community association guidelines or local building codes could prohibit extreme elevation of structures. Elevated residential buildings raised in full increments of one-story (8-10 feet) keep the visual balance of the structure (depending upon the architectural style) up to three-stories. The relationship of the lot size to the building size and the size/bulk of adjacent structures can also influence the visual quality of the raised structure. Visual quality is a significant criteria in determining the market value of structures, and landowners will take the resulting market value of their home or business into account when deciding to participate or not.

There are a variety of architectural styles present in the project area. Those styles include Acadian-Creole, Victorian, Classical and Arts and Crafts. The Acadian-Creole style is indigenous to the local area, but a few of the styles have been imported from other regions, countries and time periods. The more indigenous architectural styles, styles that were developed in recognition of the potential for flooding may be more conducive to elevation while the more classical styles developed in less flood-prone areas would not be as favorable from an architectural viewpoint to elevation. Structural styles that are traditionally multi-story could probably be raised successfully in one-story increments while architectural styles (ranch style) that are traditionally thought of as one floor would not be as favorable to elevation. Consideration for building massing in zoned areas and building proportions of height to footprint in some styles may dictate special requirements in elevation design. In a voluntary program of elevating structures in place, the architectural style of the home or building may be a determining factor in the landowner's choice of program participation.

Many agencies and local governments have proposed raising structures no more than one story (8-10 feet) while others have advocated 12 feet as a maximum height standard. Normally, the one story rule of thumb was applied so that vehicles could be stored beneath a raised structure, one-story increments look appealing visually and to avoid building materials waste. Issues of cost, accessibility, structural stability and visual impacts have been the focus of debates on maximum heights for elevation.

Guidelines established by FEMA in the recent "*FEMA 550 Recommended Residential Construction for the Gulf Coast*" recommend a maximum height of 15 feet for elevating residential structures along the Gulf Coast. This height recognizes the relationship between forces of moving water and hurricane velocity winds that can affect a raised structure. Proven engineering methods for the design and construction of stable, supporting foundations for structures elevated to 15 feet are included in the FEMA 550 guidelines. Since the guidelines are supported by sound engineering principles and field testing results in extreme conditions, the nonstructural PDT decided to accept the 15 feet maximum height limitation for floodproofing in the project area. The FEMA 550 guidelines can be accessed online at: [http://www.fema.gov/library/viewRecord.do?id=1853]

4.5.7.4.5 Mobile Homes

Mobile homes (a.k.a. trailers) present a unique problem in floodproofing by elevation. Generally speaking, mobile home construction is insufficient to withstand the hurricane force wind speeds that would be encountered by an elevated unit. Although the unit may be raised above the surge inundation limit and largely safe from flooding or waves, the raised unit would be subjected to extreme wind loading such that severe structural damage could occur. Comparatively speaking, standard stick-built and manufactured homes built to the International Building Code (IBC) with provisions for hurricane force wind loading would sustain minor damage in an elevated condition. Expending Federal funds to elevate mobile homes that may be totally destroyed by high winds during a future storm event is an unwise course of action and other options are available.

For this reason, the nonstructural PDT recommends that mobile homes not be elevated in the floodproofing program, but that owners of existing mobile homes that were inundated by Katrina and that could be elevated on site (water depths equal to or less than 13 feet) be given the option of an elevated rebuild using a manufactured home constructed to IBC standards. The manufactured home would be of a similar size to the existing mobile home featuring similar amenities and would be elevated on a driven wood piling foundation (the cheaper form of floodproofing). Since the floodproofing program is voluntary, owners could choose not to participate in the rebuild option or be purchased in which case they would be offered relocation benefits similar to other structure owners. The preferred option would be to maintain a tax-producing land use within the community that keeps the family connected to employment and schools while upgrading the overall housing stock and reducing future hurricane damages.

4.5.7.4.6 Foundation types

There are a wide variety of foundation types and materials used to elevate structures in the project area. The choice of foundation type is based in part on regulatory requirements, construction and OMRR&R costs, visual quality, building size and weight, architectural suitability, and availability of materials. In many cases, the foundations appear to have been constructed as retrofits of existing homes requiring lifting of the structure to construct the supporting foundation. More recent residential construction observed in the area indicates elevated foundations constructed during the building process and those appear to be more integrated in the design of the building. Figures 18 through 21 show some of the foundation types observed in the project area.

Poured Concrete Piers

Stacked Concrete Block

Concrete Block Enclosure

Wood Post and Piling

Figures,18, 19, 20 and 21. Predominant Raised Foundation Types

There are two main foundation types for elevating structures: open and closed. Open types depend upon numerous upright columns or pilings that support critical bearing points beneath the structure. Typically an array of wood or metal beams and joists attached to the vertical members provide support to the first floor. The open foundation allows water to pass through largely unimpeded resulting in less stresses on the foundation members but everything below the first floor is subject to inundation forces. Where moving water may be present, the open foundation is more favorable. Open foundations also maintain good air circulation beneath the structure allowing for more affective drying following a flood event and less potential for mold and mildew growth where sunlight does not penetrate. As stated earlier, NFIP regulations provide for a maximum of 300 square feet of enclosed space beneath the elevated structure for movable storage, access to the first floor and utility chase. Generally in northern climates where cold air circulation beneath the structure can increase heating demands and require insulation beneath the raised first floor, open foundations are not favored. In milder southern climates, the open foundation does not significantly increase heating requirements, so it is more acceptable.

Many examples of open foundations are present in the project area (see Figures 22 through 25). Closed foundation types depend upon solid masonry walls (poured concrete, concrete panels, unit masonry) or some other enclosing, perimeter wall system that supports the exterior walls of the elevated structure. Structure walls are fastened onto wood sill plates anchored into the masonry wall structure. Perimeter bond-beams can be used to tie the top of a unit masonry wall system together

Figures 22, 23, 24, and 25. Open Foundation Types

to avoid racking of the walls during water or wind stress. Interior posts/columns with a system of beams and joints provide support of the first floor. Enclosed foundations do provide a measure of perceived security beneath the elevated structure and movable storage items are not in plain view of passer-bys. Also, closed foundations reduce airflow beneath the structure which can be a good feature in colder climates, but the enclosed foundation does present several problems. First, the closed foundation does represent a large obstacle to flowing water – an obstacle that can create significant impact forces on the wall surfaces from flowing water or wind. These forces can be offset to a certain extent by allowing the enclosed area to be flooded thus equalizing the pressures on the masonry walls. However, in a coastal zone where wave run-out and waves can begin impacting the foundation walls long before surge inundation fills the enclosed area, these extreme forces can result in wall failure and structure loss. The NFIP does not allow the use of solid perimeter wall foundations for elevating structures in wave impact coastal zones (V-zone). Figure 26 shows a structure raised on a solid wall foundation. This type of foundation can be used in areas where inundation only would occur and then only when sufficient, automatic equalization of water pressures can occur. In addition to the problems of unequal wall pressures, enclosed, damp foundations (common during wet weather or following a flood event) can lead to the growth of molds and mildews that can be life-threatening and hard to control without good air circulation and sunlight penetration.

Figure 26. Structure Raised on Solid Wall Foundation

4.5.7.4.7 Foundation materials

A variety of materials can be used in open foundation systems. The selection of appropriate materials is based upon criteria such as cost, availability, durability, corrosion resistance, strength, reliability and maintenance. An assortment of foundation materials ranging from wood and steel to unit masonry (concrete block) and poured concrete are present in the project area. Some of the materials weathered Katrina's wrath quite well, others did not perform as expected by the owners. A selection of the foundation types is shown in Figures 27 through 30. By field observation, treated wood pilings (square and round) that had been driven or drilled to a sufficient depth appeared to survive the fury of inundation and waves and wind forces. In many cases the supported structure had been totally lost but the wooden substructure remained intact.

Some of the success of the wood pilings may have been due to inadequate strap connections to the supported structure. Had the strapping been accomplished according to the building codes for hurricane force winds, many more of the piling systems may have failed when the structure was destroyed, but that cannot be confirmed by observations in the project area. Based upon post-Katrina observations and data provided in FEMA technical documents, wood piling driven or drilled to sufficient depth to avoid failure due to scour and adequately braced can be used to elevate structures to the maximum 15 feet height. The nonstructural PDT decided to use driven wood pilings as the basic floodproofing foundation for developing costs for floodproofing. This decision was based upon materials availability, relatively low costs for materials and labor to install and their apparent durability under stress.




Figures 27, 28, 29, and 30. Foundation Materials

In some cases elevated foundations were constructed of steel posts with fabricated steel beams and joists. Several of this type survived the storm event, but in most cases the supported structure was destroyed. Again inadequate strapping between the supporting foundation and structure may have spared the foundation when the structure was destroyed. Other than the high cost of steel posts and fabricated components and their availability in large quantities to support the structures' first floor, steel-based foundations systems would be a feasible alternative.

In a number of cases, reinforced unit masonry (concrete block) columns failed along the coast. Some masonry columns were not reinforced adequately and those failed quickly due to wave impacts. In some instances, reinforced masonry columns failed with the reinforcing steel bars snapped off or bent at ground level where the column met a concrete footing. Figures 31 through 34 show these failed systems. The nonstructural PDT decided not to use standard unit masonry columns (reinforced or not) as supporting foundations for elevated structures due to the number of failures observed in the field. A modified version of the unit masonry column type is described below and will be used to support existing structures that can be raised.

Figures 31, 32, 33, and 34. Failed Supporting Foundations

During investigations of various elevation techniques and materials for the project, the nonstructural PDT became aware of a unique structure lifting system ("segmented piles") that also provided a reliable open-foundation system for raised structures. The system is based upon concrete unit masonry that is stacked around steel rods and driven by a pneumatic jacking system. The segmented piles are positioned at critical load points under the structure (mostly slab foundations) to assure stability of the structure and to avoid differential settlement of the walls and roof systems in the building. Initially the rods and blocks are driven into the soil using the weight of the structure above and the pneumatic jacking system until refusal. Once that solid footing is achieved, the jacking system then begins to elevate the structure as additional blocks and steel rods are added beneath the structure. Figures 35 through 37 show the installation of the segmented piling system and the final result.

According to the contractors working with the system, this system can provide a safe and durable foundation just using the segmented piles up to four feet of first floor elevation. After four feet of elevation, the contractor reverts the structure elevation to a more standard lifting process using cribbing and steel beam supports. The segmented pilings are then removed to the ground surface and a concrete, grid-shaped footing with steel reinforcing is poured connecting all of the segmented piling footers and reinforced concrete columns are erected beneath the structure with steel beam supports that assure stability and durability of the structure. Elevation up to the limit of 15 feet can be obtained with this system, but due to the increased cost of erecting the reinforced concrete columns after four feet of elevation, this system would only be used in the program up to the four feet of elevation, after which structures would be placed on driven wood piling.



Figures 35, 36, and 37. Segmented Piles Construction Method

Also prevalent were poured concrete columns (square and cylindrical) with either wood or steel beams supporting joists and tied into the structure floor system. In most cases these materials survived the stresses of water and wind, but at least in one instance this foundation material failed. Figures 38 and 39 show a building location where poured, reinforced concrete columns failed at the base where they were connected to concrete footings. Although the concrete itself performed well, the reinforcing design and connection to the footing may have contributed to the failure. In addition, the supported structure had been destroyed leading perhaps to failure of well-connected foundation members. As all of the columns that failed were oriented in a similar direction, the loss of the structure and columns may have been a combination of wind and wave action on the supported structure. Several new rebuilds along the coast are being supported by poured concrete columns (see Figures 40 and 41).

In addition to the use of wood, poured concrete and steel as vertical support components, these materials can be used as supporting substructure beneath the building. Treated wood beams, fabricated steel beams and cast concrete beams can all be used to support the structure first floor.

Selection of the appropriate material for these supporting elements is based upon cost and design requirements. Using building materials that can withstand the rigors of the saltwater environment, wind-driven rain and stresses is mandatory for elevating structures. All metallic connections and fasteners between extended columns/pilings, supporting beams, lateral bracing and stairways must be able to resist the corrosive forces of saltwater and maintain structural integrity during extreme conditions.

Figures 38 and 39. Reinforced Concrete Columns Failure

Figures 40 and 41. New Concrete Column Construction

4.5.7.4.8 Safety Issues

As in all vertical construction, safety is a paramount concern. Besides the normal safety apparatus and equipment that construction crews may use or wear during the elevation of a structure, there is a constant threat of a catastrophic failure of the temporary supporting members leading to loss of the building and serious injuries or death of crew members. Only qualified, experienced and bonded contractors/builders should be elevating structures. In addition to construction of the supporting foundation, new building construction on elevated foundations places the construction crew as much as 15 feet above the ground surface while working on the new structure. The risks for injury or death due to falls or impacts from falling materials or tools are multiplied during this type of construction. All appropriate OSHA safety standards should be followed during this construction process including the wearing of personal safety gear (helmets and safety shoes) and construction procedures that limit the risks of injuries or death during the elevation of the structure and ensuing construction beneath the raised structure.

4.5.7.5 Floodproofing Design – Residential Construction

4.5.7.5.1 Design Assumptions

In view of the comprehensive nature of this protection plan for the project area and the general lack of information on the characteristics of individual structures, a number of assumptions were made in determining what an appropriate elevation design would be and the approximate costs of elevating residential construction structures based upon that standard elevation design. Those assumptions included:

1. Average footprint size of the first floor of the representative residential structure was 1,600 square feet,
2. Floodproofing of commercial uses within residential-type structures would be elevation in like fashion,
3. Floodproofing of public buildings would be estimated as ringwall construction (see Public Buildings Replacements – Section 4.6) rather than elevation,
4. The maximum elevation of the first floor of any structure is 15 feet above ground level,
5. All structures within the floodproofing area were built upon slab foundations that would have to be adequately braced when lifted onto a new foundation,
6. Foundation type for all existing structures elevated between 0 and 4 feet would be segmented piles,
7. Foundation type for all existing structures elevated between 4 feet and 15 feet would be formed concrete columns.
8. All foundations for elevation where no structure now exists on the property will be driven or drilled wood piling,
9. For the purposes of estimating costs, two categories of raise were considered: 0 to 6 feet of raise and 6 to 15 feet of raise. All eligible structures were categorized into these two groups,
10. Each residential structure has two entrance doors that would require access stairways,
11. A 300 square foot enclosed space would be included under the elevated first floor for storage purposes and utility chase for structures raised at least 7 feet,
12. Repairs or rehabilitation of an existing structure in the elevated position would be minimal and financed by the structure owner or through insurance payments,
13. The structure is DSS in its current condition with adequate sewer, water, HVAC and is structurally sound to elevate,
14. Existing floor joists are of sufficient size and quality to adequately support the structure on the new raised foundation,
15. Floodproofing elevation would require new beams to support the existing sub-floor structural system,
16. All rehabilitation of the structure above the first floor to meet building code standards for hurricane construction will be financed by the landowner or the project sponsor.

17. A separate cost for ADA requirements (access ramp or chairlift) was not included in the basic design package, but costs for step access and the contingency amount should cover these additional requirements.

4.5.7.5.2 Floodproofing/Elevation Design – Residential Construction

For the purposes of this nonstructural plan, floodproofing by elevation is only being implemented in areas devoid of significant wave action. Those areas affected by significant wave action are referred to in this Appendix as “high-hazard zones” and are destined for permanent land acquisition or limitation of development rights under the nonstructural plans. Although the FEMA 550 guidelines do provide information on floodproofing by elevation in the V-zone, the minimum level of protection being presented in the nonstructural plan (an approximation of the anticipated DFIRM BFE elevation plus 2 feet) would not adequately protect an elevated structure in the event of a recurring Katrina-type storm. The impacts of waves on normal residential wood-frame wall construction could result in total failure and loss of the structure and its contents. In addition to the tremendous forces exerted by surge and waves, floating and semi-floating debris from other destroyed structures creates a “battering-ram” effect on standing structures that also quickly leads to structure failure. The visual evidence of damages to standing structures and vegetation (especially trees) from this undulating debris pile was noted throughout the project area. The combination of surge, waves and floating debris resulted in total loss of many elevated structures in Katrina. The following preliminary elevation design and cost estimating information is predicated on raising structures only in areas of surge inundation without significant waves or anticipated debris.

Given the large number of structures in the project area, their diversity of size, type, foundation, use and age, and the limited information available on each structure, the preliminary elevation design and estimated costs were based upon a simplified prototype structure (residential in construction type) and two levels of elevation. A 1,600 square foot structure was selected as the most typical residential structure in the project area. Based upon review of aerial photographs, ground observations and data research, this prototype structure footprint-size was selected as being the most representative of the population of all residential structures.

In view of the preliminary nature of the comprehensive plan and the necessity of further, more detailed technical documentation of floodproofing designs and costs prior to implementation, the heights of elevation were divided into two categories 0-6 feet and 5-15 feet. For existing structures the segmented piling technique was used for cost estimating purposes between zero and four feet of elevation. All foundations for existing structures being elevated greater than four feet were considered to be formed concrete columns. Structures with attached slabs would be elevated with hydraulic jacks and supported by steel beams and timber cribbing. The new foundation would be constructed beneath the raised structure.

Following completion of the new foundation, the structure would be lowered onto the supporting beams and all utilities would be re-connected. In the case where a structure was being raised equal to or greater than 8 feet above the ground surface, a 300 square foot storage space/pipe chase on a concrete slab would be provided in accordance with the FEMA 550 guidelines and local ordinances. New decks and steps for access to the elevated first floor would be installed with pressure-treated wood. Grading around the foundation and lot would smooth any remaining construction scars.

In the case of a property that was considered eligible for elevation (inundation depth less than 13 feet and out of a high-hazard zone), but had no current structure, all elevated foundations would be driven or drilled wood piling. Piling would be 12” in diameter and tapered for driving. Driving depth is estimated to be 40 feet in accordance with the FEMA 550 guidelines. Cross-bracing would be standard practice for all timber piling foundations. In accordance with FEMA 550 guidelines, a 300 square foot storage area/pipe chase was included in the designs and cost estimate for all structures elevated 8 feet or greater.

Although any rehabilitation of the structure above the first floor to meet building code requirements for hurricane protection is to be financed by the landowner or project sponsor, hurricane resistant connections (metal strapping and hardware) between the new raised foundation and the first floor substructure (joists or slab) are part of this preliminary design and are included in the preliminary cost.

Using the stated design assumptions, basic elevation designs for the three primary foundation types (segmented piles, poured concrete columns and wood piling) were prepared. These preliminary elevation designs are shown in Figures 42 and 43, 44 and 45 and 46 and 47. Construction materials will be specified according to accepted engineering and architectural practices for coastal construction and in accordance with the provisions included within the FEMA 550 guidelines for floodproofing structures on the Gulf Coast.

All materials used in the floodproofing work would meet ASTM specifications for construction in coastal areas accounting for the corrosive salt-water environment. Non-corrosive, ferrous connectors, fasteners, steel beams and hardware were used throughout the design and all wooden members used would be pressure-treated materials. All concrete and mortar mixes used in the design would meet ASTM requirements and all utility work (electrical, gas plumbing, HVAC, telephone, and cable) will be installed according to local building codes (minimum IBC 2003).

Prior to implementation of any segment of the identified floodproofing work, more detailed guide plans and specifications would be prepared for each eligible, participating structure with a detailed cost estimate suitable for contract negotiation purposes.

4.5.7.5.3 Floodproofing Cost Estimating – Residential Construction

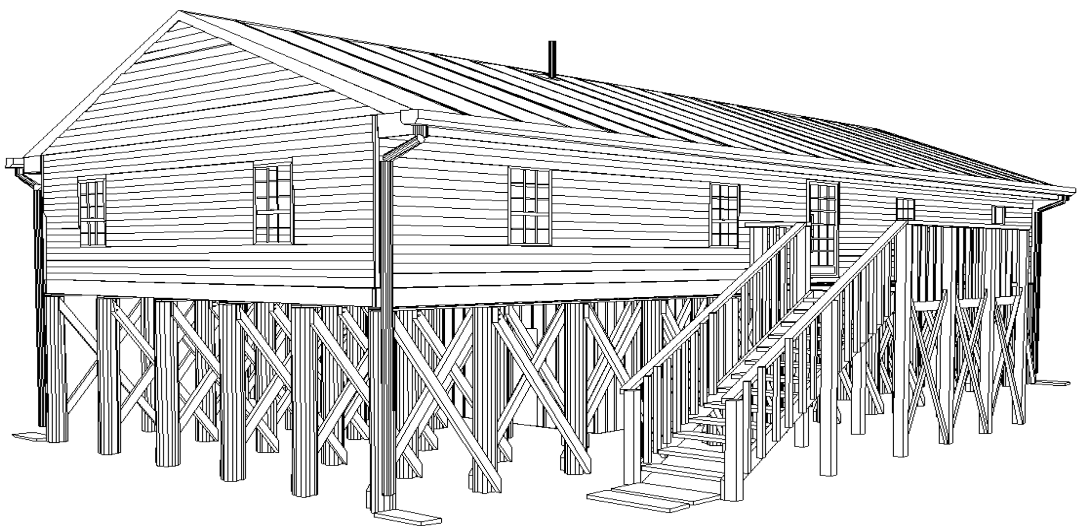
Costs for each of the three primary foundations were based upon the preliminary designs and the assumptions listed above. Since floodproofing contracts are normally negotiated and executed between the structure owner and the contractor (as opposed to a contract between the Government and the contractor), Davis-Bacon wage rates are not required and therefore labor rates in the cost estimate reflect those rates that would be common to the region. Material costs were based upon regional averages for building materials and specialty items. Generally, a 25% contingency was added to all costs unless determined otherwise by the cost engineer. Costs for floodproofing individual prototype structures (structure retrofit and new construction) are shown in the Cost Estimate Appendix.

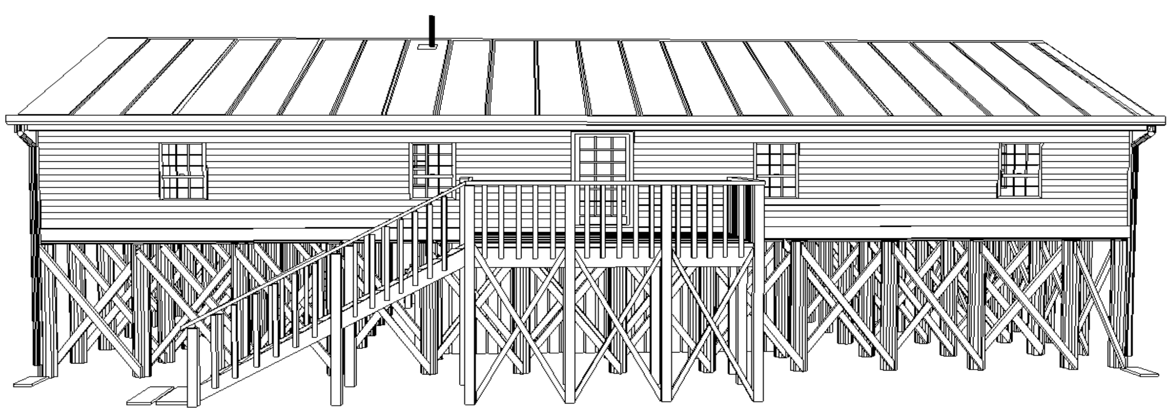
4.5.7.6 Floodproofing Design – Commercial and Public Buildings

4.5.7.6.1 General

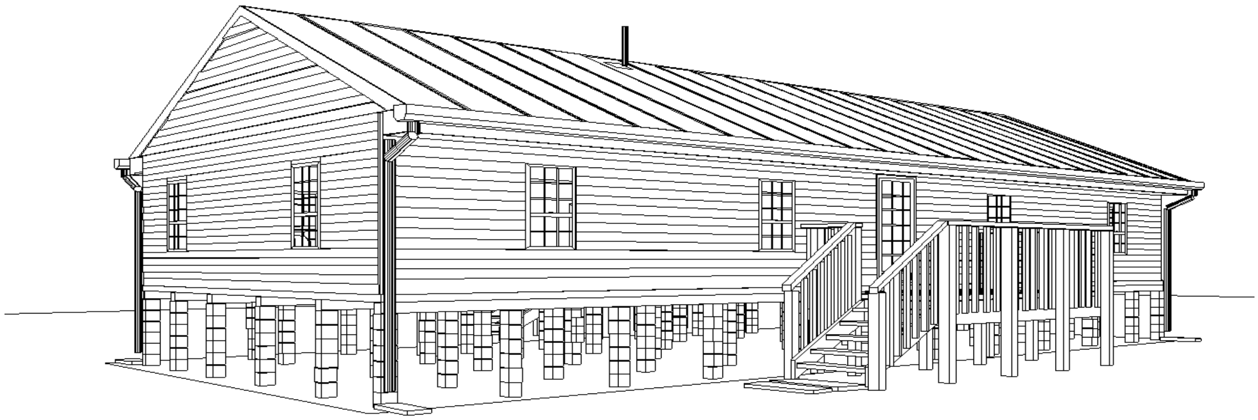
In comparison to floodproofing residential construction through elevation, floodproofing commercial and public buildings is much more complicated due to the need for ground floor access, a much larger footprint size and heavier construction materials (i.e. masonry) in the walls and floors. Commercial and public uses that occupy structures featuring residential-type construction can be elevated according to the techniques, design and costs discussed above. However, commercial sales floors elevated above ground level are not popular with shoppers unless the 2nd floor access is part of a larger raised platform (i.e. elevated mall). For similar reasons, access to most public buildings (significant ADA issues) is preferred at ground level. For this reason floodproofing by elevation for these types/uses of buildings is generally unacceptable to the structure owners and few participate in a voluntary program.

Another major difference is the positioning of the commercial or public building on the lot. Normally residential structures are positioned on the lot with adequate front, side and backyard setbacks (except for the urban residences such as townhouses, etc.) within which construction of various forms of floodproofing can take place. In many cases, commercial retail structures and public buildings are located in more urban settings with minimal setbacks (or no setbacks) from streets, alleys or adjacent buildings. Adequate space for access steps or ramps to an elevated second story is not available on these limited lot sizes.





Figures 42 and 43 – Floodproofing Design – New Structure Wood Piling



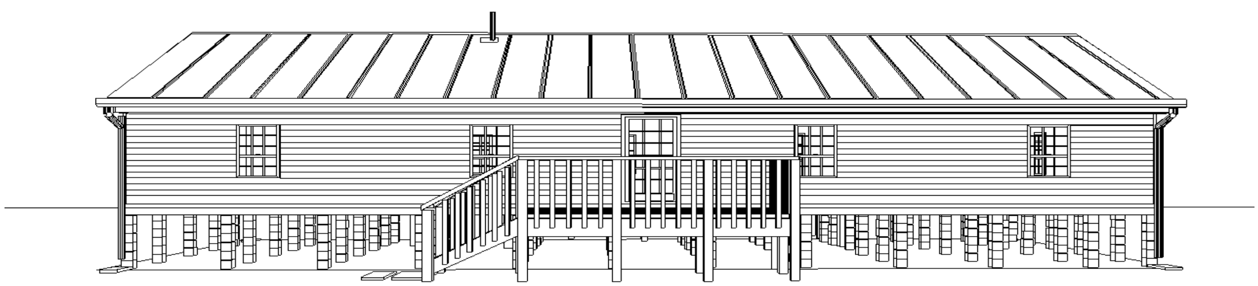
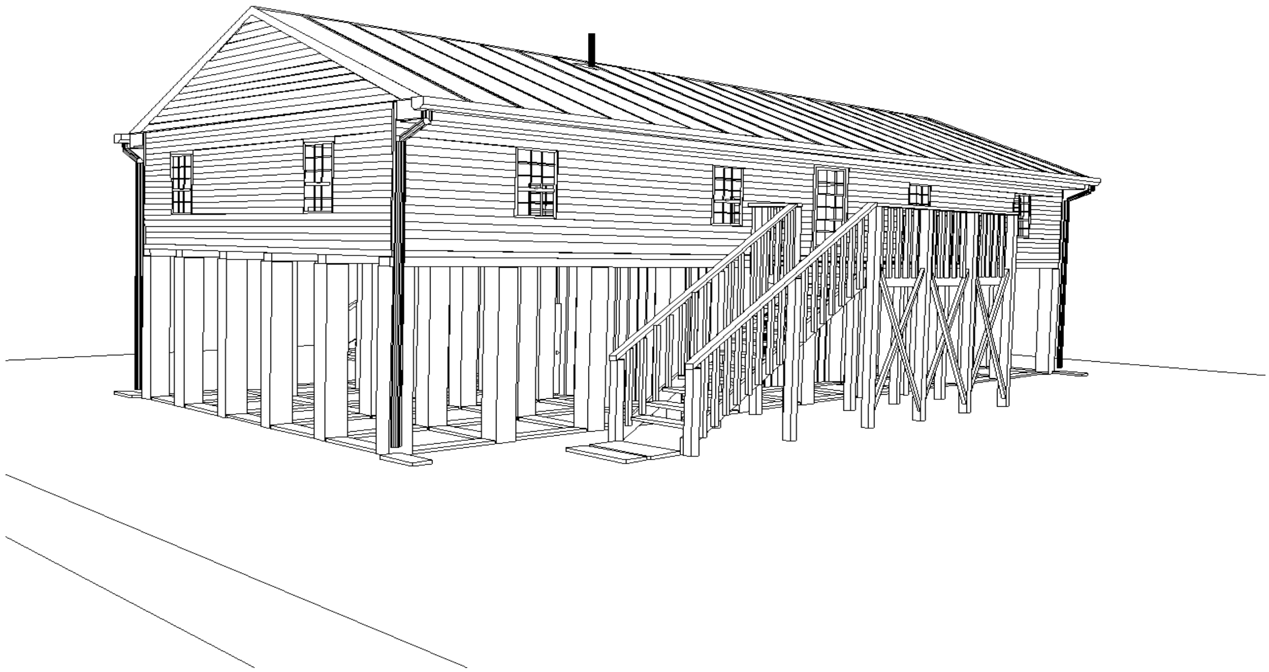
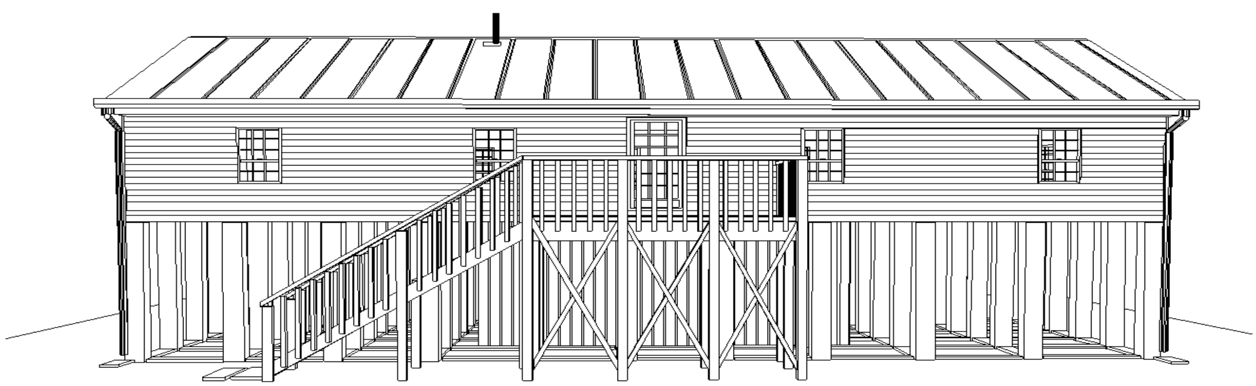


Figure 44 and 45 – Floodproofing Design Segmented Block – Structure Retrofit





Figures 46 and 47 – Floodproofing Design Concrete Column – Structure Retrofit

With these restrictions in mind, other forms of floodproofing such as dry floodproofing must be considered for the commercial and public buildings. Dry floodproofing can take many forms as discussed in Section 4.5.7.2 above. Two of the most popular forms are veneer walls and ringwalls or ring-levees. Veneer walls are constructed as a waterproof layer of dense materials attached directly to the existing structure wall to prevent water-penetration (see more detailed description below). Ringwalls and ring-levees are structural components within nonstructural measures whereby a single structure or complex of allied structures are enclosed with a ringwall or ring-levee structure (see a more detailed description below). In each case, this dry floodproofing technique prevents surge inundation from entering the structure or facility. The primary difference between elevation as a floodproofing technique and this form of protection is the need for closures in the veneer wall or ringwall at structure openings (doors) and the potential need for an interior drainage and pumping system in the ringwall or ring-levee system to remove rainwater due the storm event.

4.5.7.6.2 Design Assumptions

As was the case with residential units, very little specific information has been gathered on the uses, sizes and construction types of the commercial and public buildings within the project area. Generally speaking, they are composed of a mixture of masonry, wood frame and fabricate metal structures. Most of the older public buildings within the urban areas are of masonry construction and are multi-story. Numerous commercial retail and office buildings in Biloxi, Pascagoula and Gulfport are multi-story masonry buildings as well. Newer commercial retail structures located in the sprawl areas and along the major highways (Routes 90 and 29) are generally wood frame construction with masonry surfaces or fabricated metal buildings with various surface finishes. All of the commercial and public buildings appear to be founded on concrete slabs. In view of these observations, the flowing design assumptions were formulated to guide the floodproofing design and cost estimating for these types of structures.

1. The average commercial structure within the project area has a footprint of approximately 8,000 square feet and sits on a concrete slab.
2. Commercial structures can be protected up to 4 feet of water depth by a veneer wall. Costs for that form of protection would be based upon similar installations of veneer walls at commercial structures in LRH.
3. Any flood depths greater than 4 feet at commercial structures would require the use of a ringwall or ring-levee. The costs of that protection method would be capped at the average cost of commercial acquisitions (approximately $2.5 million).
4. Floodproofing of public buildings (schools, fire stations, police stations, city halls, etc.) would be by ringwalls only. Building sizes would be estimated based upon aerial photographs, number of students (square footage) and ground observations. Costs for this form of protection would be estimated based upon indexed values for similar installations at public buildings in LRH. Costs for closures and interior drainage are included in the per linear foot cost.
5. Floodproofing for both commercial structures and public buildings that are of a residential construction type (wood frame on a slab) would be by elevation or ringwall only (wood frame construction cannot support veneer walls).

4.5.7.7 Veneer Walls

One of several methods of dry floodproofing consists of applying a waterproof veneer material immediately against the existing structure wall. In order for landowners to realize the benefits of premium reductions on flood insurance policies, any veneer wall installation must provide at least I foot of protection above the established BFE. The applicability of this method of dry floodproofing depends largely on the structural stability and lateral strength of the receiving wall of the building.

Most residential construction, even masonry brick on concrete block does not have sufficient strength to withstand water pressures above 2 or 3 feet deep. In some cases, heavy industrial or commercial wall construction can withstand greater lateral pressures, but protection above 4 foot depths of water becomes problematic. Un-equalized pressures on un-reinforced masonry walls will soon lead to leaks and possibly catastrophic failures. The waterproof material can range from various sheet polymers, rubber and plastics to concrete. In some cases, constructed veneer walls of high-density, waterproof concrete can be applied directly to the structural walls to provide protection to interior contents. Appropriately sized footers and wall ties provide stability and reliability to the veneer wall structure. Visually pleasing surface treatments can be applied in-situ to poured veneer walls or other surfaces such as brick or stone can be applied to the waterproof concrete structure. Figure 48 shows an example of a veneer wall installation (brick facing) around a restaurant.

In addition to the stability of the structure's walls and waterproofing capability of the material, treatment of closures at existing entrances (doorways, garage doors, windows) into the structure is critical to a successful watertight solution. In veneer wall applications, watertight entrances are affected through casketed, sliding or rolling doors or metal plate inserts in the veneer wall. Although proven designs for these closures are available, none of them are automatic requiring placement by personnel who are on-site immediately prior to or during the flooding event. Annual maintenance of the closure systems is critical to maintaining protection for the structure.

Figure 48. Veneer Wall Installation

Costs for constructing veneer walls on structures varies based upon the perimeter length of the structure, foundation conditions, wall height and number of closures. The NS PDT members have been involved in the design and construction of several veneer walls in nonstructural projects and preliminary costs for this measure can be estimated from those applications. Annual O&M costs for veneer walls relates to inspections of the wall and closures and replacement of gaskets at closures.

Veneer wall costs were based upon information from previous construction of these facilities on LRH nonstructural projects as shown in the above photograph. An average commercial footprint size was determined from aerial photographs and used to estimate approximate costs for commercial floodproofing by this method of protection.

4.5.7.8 Ringwalls/Ring Levees

Another method of dry floodproofing involves the construction of either ringwalls or ring-levees around an individual structure or group of associated structures. Planning and design considerations for ringwalls and ring-levees are similar to any floodwall/levee structure surrounding a community or urban area including risk-based determination of level of protection (wall or levee height), closures at entrances, interior drainage and pumping, geotechnical concerns, foundation design, penetrating utilities, sources of embankment materials and operation and maintenance requirements. Ringwalls can be either of an I-wall design or T-wall design depending upon the soil conditions, footprint restrictions and the height of protection. Normally these ring structures are only applicable to larger commercial, institutional or industrial facilities due to the cost of construction and annual OMRR&R.

Ringwalls can be used to protect schools, medical facilities, and essential emergency facilities. Use of this method of floodproofing is limited on a large scale for residential structures due to restrictions of lot size upon which to align the structure footprint and its cost relative to other options for protection. Generally speaking, these forms of protection are problematic in urban areas where lot sizes are smaller and building setbacks are narrow. Requirements for ongoing OMRR&R and the costs associated with those requirements for these more complex structures also require substantial revenues from the site owner(s).

There would be situations where a ringwall or ring-levee may provide an appropriate level of protection in-place for a critical facility or major employer in the community. On a somewhat larger scale (short of a structural measure), ringwalls and ring-levees may be appropriate for protecting entire neighborhoods of a community or a business or educational complex. In these cases, multiple gate openings in the wall or levee structure require onsite operation just prior to and during a flood emergency and interior drainage and pumping capability can become significant design considerations. Multiple closures and pumping systems require an on-site presence in situations where many surrounding residents may have already evacuated due to the flooding threat. This situation puts operations personnel in great peril should the protection be overtopped.

There are a large number of structures, groups of structures and facilities within the project area that provide critical services to the surrounding neighborhood or community at large. Floodproofing those facilities in-place reduces flood damages and maintains the essential services intact in lieu of acquisition and relocation. Opportunities may arise whereby ringwalls or ring-levees protecting neighborhoods could offer protection for valuable infill redevelopment sites allowing at-risk structures located outside the new line of protection to relocate into protected vacant sites. This floodproofing/infill scenario accomplishes the flood damage reduction objectives while minimizing impacts to the socio-economic and environmental justice components of the project area. For these reasons, dry floodproofing through the use of ringwalls and ring-levees will be carried forward into more detailed formulation of nonstructural plans. Figure 49 shows an example of a ringwall protecting a high school and Figure 50 shows an example of a ringwall protecting a commercial structure.

Figure 49. Ringwall Protection for a High School

Figure 50. Ringwall Protection for a Commercial Structure

Capital construction costs for ringwalls and ring-levees can be high depending upon the structure's or complex's perimeter length, soil conditions, height of the wall/levee, material sources, hauling distances, number of closures, interior drainage and pumping requirements, alignment limitations, and wall type (I-wall or T-wall). Among all of the nonstructural measures, ringwalls and ring-levees have the highest potential O&M costs due to the complexity of the structural features and the risks involved in failure of individual components of the protection system. In addition, these protection features require on-site personnel to affect access closures and assure that interior drainage systems (pumping systems) are working prior to the event.

The NS PDT members have been involved in ringwall design and construction for schools and businesses from which preliminary costs have been developed for the plan. Based upon indexed costs for a ringwall (heights ranging between 4 and 8 feet) with closures and interior drainage, linear costs of $3,100.00 per linear foot (included E&D and S&A) of ringwall were used to estimate providing this protection for public buildings.

4.5.7.9. Waveland, MS Floodproofing Project

In an effort to demonstrate the feasibility and effectiveness of wet floodproofing as a means of reducing flood damages in the project area, a project in Waveland, MS has been formulated as a part of the overall nonstructural program. This project would provide an opportunity to evaluate the technical aspects of the FEMA 550 guidelines as a basis for elevating structures in the program, allow for the public and local officials to see first-hand the application of floodproofing measures by elevating residential structures and affirm Corps cost data and contracting procedures that would support expanded applications of this flood damage reduction method in the MsCIP project area. Given the large number of parcels which would be eligible for floodproofing by elevation and other methods, innovative contracting methods would need to be tested to assure that good quality construction that was both acceptable to the structure owner and that limited the liability of the Corps could be applied in an efficient manner across the project area.

Using available GIS data that displays the ABFE flood levels in the Waveland area and the extent of the high-hazard zones described in this appendix, the NS PDT identified, in cooperation with the Mobile team, a geographic area within Waveland where wet floodproofing would be an effective method of reducing flood damages. This selected area is outside of the identified high-hazard zones where wave action and surge would endanger an elevated residential structure and its occupants. In this initial study phase the ABFE-2 feet was used as the design flood elevation for elevating approximately 25 residential structures. Prior to implementation (if the project is approved), the newest approved local ordinance (City of Waveland local floodplain management ordinance) base flood elevation (or higher) would be used to set the raised elevation of the first habitable floors of the structures. The location of the proposed project is shown in Figure 51.

The 25 residential structures are mainly single-family, wood frame structures on structural slab foundations (two observed crawl-spaces). Many of the residences have a brick veneer exterior. Heights of elevation range between 4 and 6 feet at the ABFE-2 feet inundation level. Using the elevation methods described above, it is anticipated that a combination of the segmented block foundation (0-4 feet high) and the concrete column foundation (> 4 feet elevation) would be used in the project. Project construction would take place over a four year period depending upon the flow of funds. Costs for this method of elevation are dependent upon the footprint size of the structure and the height of elevation. It is estimated that the total, fully-funded cost of the project would be approximately $4.6 M. Upon approval of the project concept a more detailed implementation report would be completed showing detailed cost data, floodproofing procedures, contracting procedures and schedules for completion of the project.

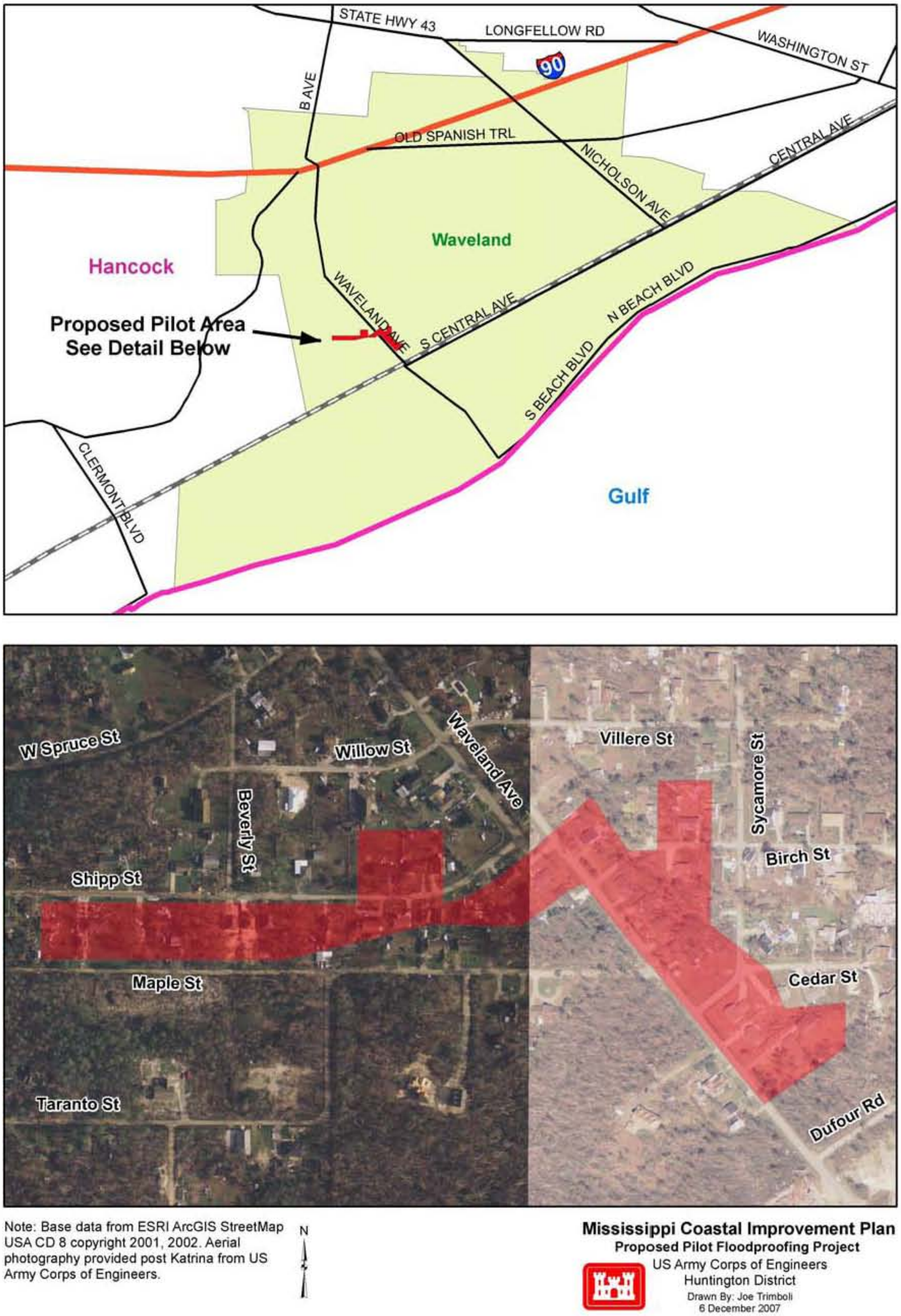


Figure 51. Location of Proposed Waveland, MS Floodproofing Project

4.5.8. Non-Corps Federal Floodproofing Programs

4.5.8.1. General Program Descriptions.

Following the rescue and recovery operations in the project area, both FEMA and HUD entered the damaged Gulf areas and began to implement assistance (grant and loan) programs for elevating structures. Each of the two agencies has been offering floodproofing assistance to eligible landowners so that homes, businesses and public structures could be elevated to reduce future damages.

FEMA, through their Hazard Mitigation Grant Program (HMGP), has been providing elevation grants (through MEMA) to eligible landowners so that either new construction or retrofitted homes could be elevated in accordance with the local floodplain management ordinances. The grant would be in addition to any flood insurance payments that an insured property owner may have received. The grant amount would generally cover the total cost of the structure elevation. The HMGP elevation requirements specify that a new or retrofitted structure be elevated to or above the base flood elevation (BFE) that has been delineated in the new DFIRM whether or not the new DFIRM has been locally adopted or not. FEMA has prohibited elevation of structures within the new V-zone in the HMGP except for structures that must be located within the V-zone due to their water-related usage.

HUD also has an elevation grant program that provides up to $30K to eligible landowners to assist in raising the first floor of either a new home or a retrofitted home to reduce future flood damages. The maximum $30K grant helps to defray the cost of elevating the home and is payable in two installments - $15K when the elevation permit is obtained and $15K when an occupancy permit is obtained. Neither HUD nor MDA are providing agency oversight for the elevation design or construction processes, but are relying on local NFIP and building code inspectors to assure compliance with the local ordinances. Since the program relies solely upon adherence to the local floodplain management ordinances, the HUD program has no restrictions on elevating homes within the V-zone shown on the new DFIRM, but has requirements for meeting building elevation construction standards within the V-zone.

Both of these programs provide monetary assistance to landowners that elevate their homes, but in the case of the HUD grant, the $30K limit may not provide the total amount necessary to cover the entire costs of elevating the structure according to the full requirements of the NFIP or the local building codes (IRC/IBC). When the distance between the ground surface and the BFE is minimal (1-3 feet) and the structure is being newly constructed, the grant may cover the increased costs of the extended foundation, utility lines and additional steps that support, service and access the raised first floor. Normally, the incremental cost of elevating new construction to meet NFIP requirements is less than retrofitting an existing structure.

Where an existing structure must be retrofitted with a new foundation or where a new structure must be raised to a higher level (8-15 feet) above the ground surface, the HUD assistance grant may not cover the homeowner’s full cost. Retrofitting normally requires much preparatory work beneath the structure (dependent upon the foundation type; slab, crawl space, basement) followed by raising the first floor of the structure to the new design flood height (BFE) and installing new piling or masonry columns beneath the structure. Retrofitting an existing structure using current design guidelines and increased BFE heights can result in higher construction costs. These high costs may exceed the elevation grant by a significant amount. Significantly elevating a new structure (10-15 feet) can be quite expensive considering the costs of installing deep pilings, bracing the pilings, construction of extended utilities and providing access to the higher first floor. Any special needs of the household members under the American Disabilities Act (ADA) that require wheelchair ramps or chair lifts can add significantly to these costs.

In addition to the differences between elevation construction costs (based upon Corps project cost data) and the grant amount specified in the HUD elevation program – a difference that the landowner will bear, the lack of restrictions on elevating residential construction within the V-zone in the HUD grant program area is a concern. Funding redevelopment and elevation within the V-zone based solely upon local floodplain ordinance requirements would be in conflict with the MsCIP report recommendations. Generally, the BFE to which all new construction or retrofitted construction under the HUD assistance programs must raise the first habitable floor, may be lower than the hurricane surge that would be anticipated (and was experienced during Katrina) from a Category 5 hurricane. Hurricane surge depths in Katrina exceeded 25 feet in portions of the V-zone of the project area.

For instance, at one property parcel in Waveland, MS, a parcel located within the designated V-zone and included in the MsCIP study database, the Katrina surge was approximately 16 feet deep above the ground surface (ground elevation at that parcel approx. 8.9 feet msl). In the MsCIP nonstructural plan, this structure would only be eligible for permanent acquisition since the structure was located in the V-zone. The pre-Katrina BFE elevation at that parcel was 15 feet msl and the BFE from the new DFIRM is 23 feet msl - an 8 foot increase. A new structure elevated to the new BFE elevation (approximately 23 feet msl or a raise of 14.1 feet above the ground surface) could still be subjected to 2 feet of surge inundation from a Katrina-like storm with storm-driven waves possibly impacting the first floor stud-wall construction. The residual damages to that structure could be significant and any occupants taking refuge in the structure who may have decided to “ride-out” the storm would be in extreme peril. Many parcels similar to this example exist within the project area in the V- zone.

The result of this lack of development restriction in the V-zone in the HUD program would be to allow residential structures to be elevated such that the first habitable floor may be subject to the same surge and wave combination that resulted in the loss of thousands of homes and many lives during Katrina. The number of totally destroyed homes in the V-zone that had been elevated in compliance with the pre-Katrina BFE is a testament to the potential for significant residual damages and loss of life that could occur as a result of implementing an elevation grant program in the V-zone.

In addition to the two elevation programs, HUD’s compensation program (two phases) provides grants of up to $150K to landowners whose structure was damaged by surge inundation in the Phase 1 program and up to $100K to landowners in the Phase 2 program. The Phase 1 program addressed all those eligible owners whose home was located outside of the 100-year flood zone but still suffered inundation damages from surge flooding. The Phase 2 program addresses all of those whose home was damaged by surge inundation and are located within the 100-year flood zone as shown on the FIRM. The compensation is in a lump sum based upon the estimated percentage of damage of the structure up to the $150K – or $100K limitation and requires no certification of work completed to address the structure damages. Any structure that was damaged more than 50% of the structure’s value is required to meet the NFIP requirements for elevating the first floor above the most current BFE and the additional HUD grant in the elevation program (up to $30K) may be used to supplement the compensation grant to raise the structure.

Again as in the case of the HUD grant to elevate structures, the only restrictions placed upon the use of the compensation grant is conformance to the local building codes and NFIP regulations and local floodplain management ordinances. Homeowners choosing to rebuild their homes or repairing a damaged home within the V-zone under the HUD program can do so long as they meet the NFIP requirements and the local floodplain management ordinances. As shown above for the elevation programs, it would be possible for a homeowner to accept the compensation grant in the phase 2 HUD program and reconstruct a new structure in the VE zone that would be highly susceptible to residual damages in a recurring Katrina-like storm.

The MsCIP plan in comparison, although using the storm events of 2005 and especially Katrina as its benchmark for protection and reducing flood damages and loss of life, would substantially reduce residual damages and threats to public safety. Avoiding any new construction or elevation of existing structures in the high-hazard zone virtually eliminates the potential for such surge/wave-related losses in future similar storm events.

In terms of financial assistance, the MsCIP is founded on the premise of government-directed construction activities with associated design, regulatory and contracting controls to assure good quality, legality and accountability. Both the FEMA and HUD programs are essentially grants to landowners with minimal controls for design quality or accountability outside of local government oversight. The MsCIP program costs are founded on the requirements of the Uniform Relocations Act and actual floodproofing/relocations costs while the HUD program has set grant limits regardless of the actual costs of the work required.

4.5.8.2 Coordination with Proposed MsCIP Nonstructural Measures

In their implementation, components of the MsCIP and the FEMA HMGP program may be able to be integrated into a coordinated flood risk reduction program using permanent acquisition, structure elevation and both floodproofing and replacement of public structures. The restrictions in the HMGP limiting reconstruction or elevation in the V-zone are lock-step with the MsCIP recommendations for that high-hazard zone. However, the current HUD assistance and elevation grant programs have no restrictions on elevating structures (new or retrofitted) or new residential construction in the V-zone to match the recommendations in the MsCIP that restrict redevelopment in that high-hazard zone. Sole reliance on the current local ordinance requirements and use of upgraded building standards in the high-hazard zone through the HUD programs may not be sufficient to avoid the potential loss of property and lives during a Category 5 hurricane.

The differences (no matter how slight) between the MsCIP plan recommendations and the HUD grant programs, reinforces the need for a collaboratively developed plan for long-term flood risk reduction that can integrate these programs into one consistent long-range comprehensive strategy for creating disaster-resilient communities. As previously mentioned, the ongoing FEMA HMGP and the MsCIP plan recommendations appear to be very compatible. The best capabilities of the three Federal agencies can be brought to bear on the flooding problems of the project area through collaborative planning.

4.5.9 Permanent Acquisitions (Evacuation)

4.5.9.1 General

Permanent acquisition, (a.k.a. evacuation or buyout), of coastal properties is an effective way to reduce flood damages and loss of life due to drowning as a result of hurricane surge. Parcels within the designated project area (with or without structures) can be purchased at fair market value under the provisions of the Uniform Relocations Assistance and Real Property Acquisition Polices Act of 1970 (P. L. 91-646).

Last resort housing benefits may be available to those displaced persons who relocate to a DSS structure located above the Katrina inundation elevation (or the 500 yr. flood event as defined on FEMA NFIP mapping) to further the objectives of migrating the population northward and away from the coast. Specific recommendations for implementation of provisions of the Uniform Relocations Act as they may apply to acquisitions of property in the project area are contained within the Real Estate Appendix.

Under the Uniform Relocations Act, residential occupants are provided the fair market value of their real property and can be assisted in locating suitable DSS (descent, safe and sanitary) replacement housing. Commercial landowners are provided the fair market value of their real property and may be eligible for certain moving and related expenses. Public structures (schools, medical facilities, city halls, county offices, police and fire stations, emergency services, etc.) owned and operated by state or local units of government (municipal and county) can be addressed through the substitute facility doctrine in lieu of permanent acquisition as described in Section 4.6 below. Once the existing structures are demolished (or the structure owner may be permitted to claim salvage rights to the structure and move it at their own cost if they so wish), the vacated land can be turned over to a local project sponsor for future OMRR&R under existing ordinances as may be modified by project agreements. Certain identified lands once purchased can be restored to wetlands from which additional ecosystem benefits can be generated. Post-acquisition use of the land can be dictated through the project partnership agreement (PPA) and could include wetland habitat restoration, recreation or open space uses that would not result in re-establishment of damageable property. Other options can be explored by local communities through local land use zoning for acquired properties.

This nonstructural measure would be applied to a zoning-influenced, land use pattern of residential, commercial, and institutional uses as well as both occupied and interspersed vacant parcels located within identified hazard zones in the project area. Some of the current vacated parcels were occupied prior to the arrival of Katrina and others were vacant prior to that event. In the robust coastal development market that existed prior to Katrina, interspersed vacant parcels were inhibited from development by ownership/title issues, legal liabilities, high prices, or other site constraints that limited their consumption in the marketplace. The PDT determined that these interspersed vacant parcels may not be developed immediately after new regulatory ordinances were adopted and any reinvestment funds were made available to the landowners.

However, parcels now vacated as a result of structure damages from Katrina may be redeveloped within a short period of time when both regulatory and funding issues were resolved. This process is occurring now at an accelerating rate. It was assumed for this report that landowners of parcels currently vacated have found other housing options elsewhere and would not require relocations assistance. Landowners who are now residing in FEMA trailers onsite would be eligible for relocations assistance when the property was acquired. For these reasons, parcels with current structures in place and those parcels previously occupied prior to Katrina (both located in the high-hazard areas described below) could be targeted for early acquisition to forestall redevelopment (i.e.

the Phase I HARP). Other local mechanisms for limiting redevelopment of interspersed vacant properties are discussed in the section discussing TDR and PDR programs.

4.5.9.2 High-Hazard Zone

The nonstructural PDT identified several zones within the project area, where due to extreme forces generated by storms and hurricanes, other measures such as elevation of an existing or rebuilt structure would not be prudent and may endanger the future occupants. Within these zones, successful emergency evacuation during the height of a storm event would be highly improbable and dangerous for the responders, elevated structures may be prone to foundation failures due to waves and surge, elevation by placed fill material is prohibited or infeasible, and non-elevated structures may suffer total or significant losses. Each of these zones was graphically identified using GIS mapping and FEMA database information (see Figures 56 - 60). There are three identified zones where permanent acquisition and evacuation of the property is the preferred nonstructural treatment. Those three zones referred to in this report in a collective sense as the "high-hazard zone" contain approximately 15,000 parcels and are described below:

1) The FEMA-identified V-zone displayed on the National Flood Insurance Rate Maps (FIRM) within the project area. This "Velocity" water zone features extreme energy wave action that was responsible for much of the building damages during the Katrina event and makes elevating structures or otherwise floodproofing structures in-place very dangerous.

2) The FEMA-identified "catastrophic damages zone" which was identified in a "post-Katrina" damage assessment of FEMA insured structures within the project area. This zone included a preponderance of structures that had received damages in excess of 50% of the structure's value. Field observations by the nonstructural PDT confirmed that most of those structures in the zone had been totally destroyed or severely damaged (major structural damages). This area includes the V-zone within its boundaries.

3) A flood damage zone was delineated extending 800 feet back from the beachfront within portions of Jackson County. The aforementioned "catastrophic damage zone" established by FEMA was based upon the Katrina event only and therefore did not account for the area of damages that could be expected along Jackson County were a Katrina-like storm to strike at that location. The 800 feet zone approximated the spatial extent of observed total structure loss and severe structural damages observed within Hancock and Harrison counties located closer to the Katrina landfall. Modifications of this zone's extent from the waterline may be made during more detailed planning to account for intervening topography that would limit the impacts of surge and waves.

4.5.9.3 Non-Floodproofing Zone

The nonstructural PDT also identified one additional zone within the project area where the preferred method of flood damage reduction would be permanent acquisition and evacuation of the property. This zone is located where water depths at the individual structure location occurring during the specified inundation event would exceed the maximum height of elevation prescribed by FEMA's 550 Guidelines for structure elevation. Those guidelines indicate that elevating structures more than 15 feet from the ground surface in hurricane areas would place the elevated structure in high-velocity hurricane force winds resulting in significant damages to the building. Any structure that would be required to be elevated more that 15 feet to place the first habitable or sales floor above the specified inundation level would be acquired. Using GIS software, a zone of inundation deeper than 13 feet (2 feet of freeboard) was identified within the project area where acquisition would be the preferred method of protection. Based upon the tax parcel GIS database information, there are approximately 15,000 parcels in the project area that fall within this non-floodproofing zone.

Additional structure by structure determinations accounting for structurally unsound, dilapidated, non-DSS, or unsafe structures would also result in acquisition of the property and structure. In some cases where the cost to elevate a structure would be greater than the cost to acquire, the owner would be given the option to "buy-up" to the elevation cost or be acquired voluntarily. Another option of rebuilding a new elevated structure on site at a cost less than elevating the old structure would be considered as an alternative to acquisition. As these "transfers" from elevation to acquisition are unknown at this time (determined either during more detailed planning or during implementation), they have not been identified on the GIS mapping as were other zones.

4.5.9.4 Real Estate Acquisitions

Any structure identified for acquisition would be processed according to the provisions and requirements of the Uniform Relocations Assistance and Real Property Acquisition Polices Act of 1970 (P. L. 91-646). In accordance with this Act, the Government will pay the landowner fair market value for the property and structure – a fair market value determined at the time of purchase. In view of the enormous number of potential acquisitions in the nonstructural program and the anemic housing market (post Katrina), application of the full range of relocation benefits under the Uniform Relocations Act may be warranted. Residential structures, because of the potential for social and economic impacts that could occur to families during relocation, are afforded a wider range of opportunities and financial assistance under P. L. 91-646 than are commercial businesses. In addition to the fair market value of the existing property and structure, business owners may be eligible for certain moving and related expenses. Residences are provided much greater benefits to assist with offsetting the hardships of acquiring a new home, relocating contents, and other moving expenses incurred by households. Additional details of the Uniform Relocations Act and its application to acquisitions in the project area can be found in the Real Estate Appendix.

In acquisition situations where the existing structure or facility is determined by Corps Real Estate staff to be a publically-owned and operated building or facility, the Corps of Engineers Real Estate regulations (ER 405-1-12) concerning the disposition of public facilities and structures would establish the methodology for determining value. Under this regulation, acquisition of publically-owned facilities and structures required to be purchased to meet the project design objectives should be based upon the "Substitute Facility Doctrine". Since just compensation for an acquisition is based upon fair market value at the time of purchase and since publically-owned and operated structures and property may not have a "market value" such as do residential and commercial structures, the cost of constructing a substitute facility may be used as a measure of just compensation.

Generally the substitute facility will serve the owner in the same manner as the existing facility with regard to size, usage and functionality. Typically the substitute facility doctrine is used to address the acquisition of schools, city halls, police and fire stations, and other state, municipal and county owned and operated facilities and structures and they are all collectively referred to as "relocations" in Corps water resources projects. Within the zones identified by the Corps to be too hazardous to elevate structures (high-hazard zone and non-floodproofing zone), there are likely to be publically-owned and operated facilities and structures that will fall under the category of "relocations". The Moss Point municipal facilities discussed in Section 4.6.6 are an example of the application of the substitute facility doctrine referred to as "relocations" in this report.

4.5.9.5 Reuse of Evacuated Floodplain Lands

Since many of the parcels destined for acquisition have existing structures on them, the demolition costs to remove the structures and other site improvements (structural slab, driveways, utilities, building pads, etc.) would be allocated to the nonstructural measures. These demolition costs would only apply to those properties, structures and facilities which the Government acquires as a part of the project. Public streets, utilities and other facilities not within the footprint of the permanent acquisition measure would not be removed with project funds.

A significant amount of the project land area is either occupied by wetlands or had been wetlands before development encroached upon these sensitive habitat areas. It is widely recognized that wetlands and especially those tied hydraulically to the Gulf and its bays are a significant component of the aquatic and terrestrial health of the Gulf aquatic ecosystems. In addition to reuse for ecosystem restoration, evacuated floodplain areas could be used for recreation uses that would be compatible with the inherent flood risk. The locations of these recreation areas and appropriate facility development would be coordinated with the counties and the municipalities in which the evacuated parcels are located. Costs for these recreation developments would be cost-shared with local sponsors at the appropriate rate. Operations and maintenance costs for all post-evacuation recreation development would be the sole responsibility of the local sponsors.

In view of the national and regional benefits associated with expanding wetland habitat along the Gulf and within the project area, those parcels subject to evacuation under the nonstructural program, either located within the high-hazard zone (HARP) or in those areas where floodproofing is not a viable option (inundation depths greater than 13 feet), and that are suitable for wetlands restoration could be set aside for those ecosystem purposes. Using information from ERDC, USFWS and other natural resources agencies, areas suitable for wetlands restoration were mapped in GIS format and prioritized by a joint-agency team. The wetland layers were integrated with tax parcel, structure databases and acquisition layers to determine where permanent acquisitions and wetlands restoration would coincide.

Figure 52 shows the array of potential ecosystem restoration sites across the project area that could be located upon lands acquired in the high-hazard zone (HARP) and the non-floodproofing zone. The potential wetland ecosystem restoration sites (approx. 24 sites) located on evacuated lands are delineated on the map as “Nonstructural risk reduction sites” (orange triangle with #5 inside) to denote that the primary benefit from the action is risk reduction with the wetland ecosystem restoration as a secondary benefit.

4.5.9.6 High Hazard Area Risk Reduction Plan (HARP)

As discussed previously, reconstruction within the project area has been delayed due to uncertainty about the new NFIP regulations for constructing structures and the absence of rebuilding funds due to ongoing insurance claim judicial proceedings. As reconstruction funds become available and the revised NFIP floodplain mapping is adopted, residential and commercial reconstruction may begin at a feverish pace. In view of this anticipated reconstruction boom and the additional costs that would be incurred by the government in purchasing high-hazard zone (HHZ) properties with new, larger, more expensive homes (with greater demolition costs), a proposal for a High Hazard Area Risk Reduction Plan (HARP) has been formulated.

The HARP would target parcels within the high-hazard zone that are currently occupied or could be re-occupied by new structures or those interspersed vacant parcels that could be occupied in the future. Of the total approximated 15,000 parcels located in the high-hazard zone, 2,000 parcels would be included in the initial HARP. That number of parcels could be addressed by Corps real estate resources over approximately a 5 year period, provided that Federal funds would be appropriated. The total estimated cost for the initial HARP is $408.4 million. More detailed information about the HARP can be found in Exhibit C of the Real Estate Appendix.

Also within the HARP footprint are 4 municipal structures in Moss Point, MS that have been identified as being public facilities that may be eligible for replacement through the Real Estate “substitute facility doctrine” in lieu of acquisition. The costs for the Moss Point replacement of public facilities are included in the total HARP cost. The Moss Point municipal complex is discussed in more detail in Section 4.6.6 below.

The initial 2,000 parcels in the HARP would be extricated from the designated high-hazard zone (HHZ) that extends the entire east-west length of the project area. Within that linear zone are several high-quality wetland ecosystem areas (including emergent tidal marsh) that were (prior to Katrina) occupied by various land uses such as residential and commercial structures and facilities. Figure 52 shows those potential ecosystem restoration areas within the high-hazard zone where acquisition of property through the initial phase of the HARP (2,000 parcels) could provide opportunities for wetland ecosystem restoration following land acquisition and demolition of any remnant facilities (pavements, utilities, foundations, etc.). The orange triangles marked with the number 5 (Nonstructural Risk Reduction Sites) denote potential ecosystem restoration sites that would occur on lands acquired for risk reduction.

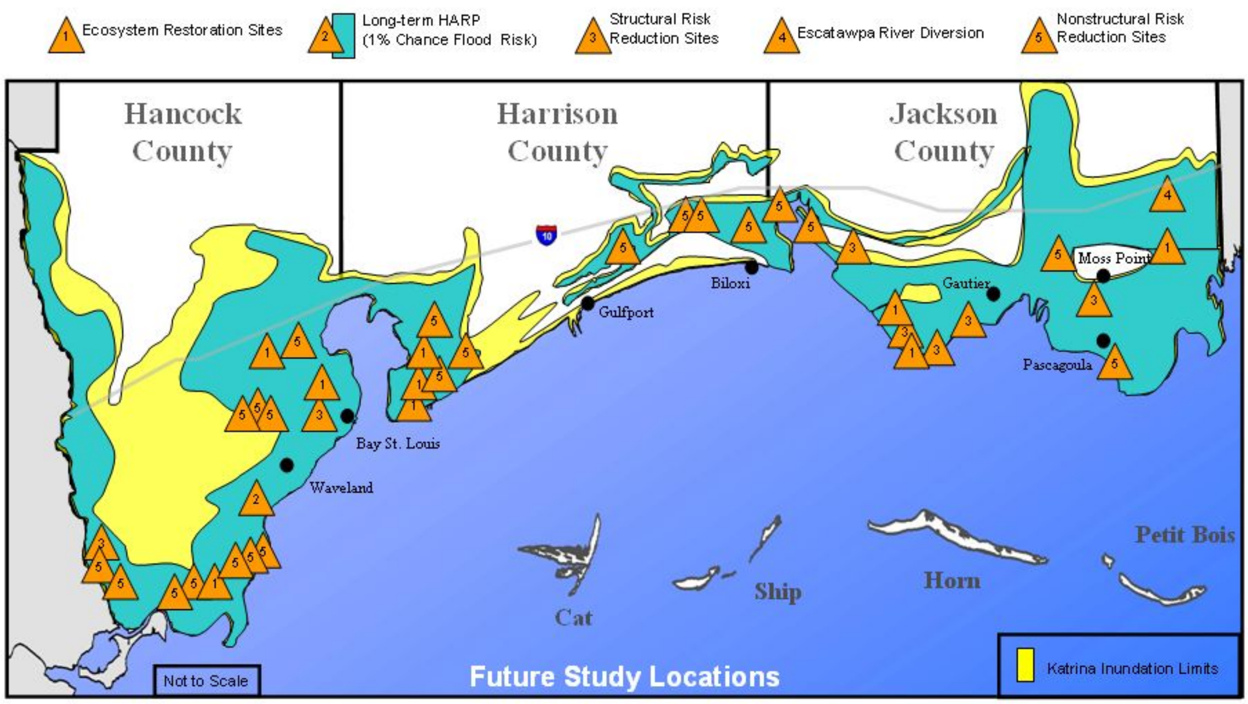


Figure 52 – Post-Evacuation Ecosystem Restoration Areas

4.5.9.7 Permanent Acquisition of At-Risk Properties through Other Federal Programs

Another option for implementing permanent acquisitions within the identified zones would be through the FEMA post or pre-disaster Hazard Mitigation Grant Program (HMGP). Within the overall hazard mitigation program, FEMA has two notable mitigation components that concentrate on acquiring flood-prone properties: the Repetitive Flood Claims Program (RFC) and the Severe Repetitive Loss Program (SRL) that could be used to acquire structures and properties located in these designated high-hazard areas. Generally, all of the FEMA programs target only structures with flood insurance through the NFIP. Annual funds are distributed to participating states through these programs that in turn can provide funds to individual municipal or county jurisdictions to implement their local mitigation plans. Coordination of the proposed acquisitions with the counties' and/or municipalities' All-Hazards Mitigation Plans submitted to FEMA could secure needed real estate acquisition funding and acquisition of the flood-prone properties. Actual implementation of the program would be handled by the state or a local jurisdiction (county or municipal government). Under the provisions of the HMGP program, properties acquired could not be rebuilt upon in the future. Opportunities for merging the FEMA Hazard Mitigation Grant Program and any Corps of Engineers permanent acquisition program within the project area may be possible.

The HUD Homeowners Assistance Program does not acquire property, but merely provides grant funds up to $100K in its Phase 2 program for homeowners living within the 100-year floodplain to compensate for damages from Katrina surge. The targeting of low and moderate income families by the HUD compensation program does raise the potential of the Corps program with greater financial benefits being applied to a wealthier segment of the population. This may be viewed as a somewhat inequitable scenario when viewed from the public's perspective. Other than financially supporting reconstruction or continued habitation in the high hazard zone, the HUD HAP does not conflict in its implementation with the MsCIP plan.

4.5.9.8 Relocation of Acquired Households and Commercial Businesses

4.5.9.8.1 General

The sanctity of the American home and all that it represents to the owner and family are at stake when nonstructural or structural measures are being considered for reducing flood damages. The home represents a unique place full of social interaction, psychological development, self expression and security from the outside world. Our homes may be the largest single investment in our adult lives and the place where families are started and nourished. For those retired, the home may be a place of relaxation and the center for extended family vacations (especially those located on the Gulf). Leaving one's home either by choice, by necessity or by force can be a very traumatic and stressful event. In close association with losing one's home is the loss of one's neighborhood or community due to a relocation project. Numerous studies have shown that although there can be both positive and negative impacts from housing displacement/relocation, the negative impacts can be more long-lasting and mentally stressful. With these considerations in mind, relocation of substantial numbers of households in either structural or nonstructural projects must be accomplished with appreciation for these impacts and stresses on the household members.

Based upon available inundation data for the parcels within the study area and the design limitations on elevating structures (maximum 15 feet in height) there may be a great number of acquisitions and relocated businesses and households in any nonstructural plan featuring floodplain acquisitions for the project area. Needless to say that any major nonstructural program that would feature significant numbers of relocations from the coast would dramatically change the economic and social characteristics of the coastal communities. In addition, the number of public buildings (many regarded as critical facilities) that could be eligible for relocations indicates that some relocation/redevelopment models could produce dire economic and social consequences for the coastal communities. In view of this potential, there are three possible avenues for addressing the relocations of these commercial and residential uses.

In addition to the potentially large numbers of landowners who may be only eligible for the permanent acquisition option due to the hazardous location or ground surface elevation of their property, the personal nature of the nonstructural program further exacerbates the problems of relocating thousands of individual households and commercial establishments within the project area. Left to each landowner's own understanding of the program and expectations of the future, individual decisions to participate in the acquisition program and where to relocate to will be outside the control of the municipality or county governments. An unplanned or uncoordinated dispersion of the coastal population would create many "wicked" problems for municipal managers and public service providers – "wicked" problems being those for which there are no discernable good answers. In view of this potential "scattering" problem, some in-place market systems and options should be explored and considered in planning for such a large movement of the population.

4.5.9.8.2 Market Housing Resources

Although hurricane Katrina demolished or severely damaged an estimated 65,000 residential structures, there are a number of remaining DSS structures that may become available on the market should a Corps buyout program be implemented. These "latent" market resources could be used to address relocations provided that the annual number of relocations from a Corps-sponsored program would not exceed the capability of the existing housing market to allow existing owners of DSS homes to "buy-up" in the market. Some rebuilding of owner-occupied and rental units is already underway in the project area following Katrina (over 1,600 building permits for single-family units in 2006), but the local housing market may not be capable of producing sufficient numbers of DSS replacements to satisfy the entire program-driven need. Should the Corps-sponsored program provide sufficient financial resources through P. L. 91-646 to allow the acquisition or creation of DSS market housing, this option could result in both successful relocations through the acquisition program and a significant housing construction program that would address the expectations of the existing owners and developers.

Regrettably, relying on existing market housing resources to address all of the relocation needs of program participants has a "down-side". Since these available housing resources are now scattered all over the three counties (or to adjacent counties or in other states), these once "neighborhood or community-centered households" would be dispersed all over the region. Besides the obvious impacts of breaking many long-standing social ties within the older, well-established neighborhoods and communities, social problems arise with displaced children, the elderly, physically handicapped, fixed-income, and other interdependent households within the community from displacement. Car-pooling, babysitting, in-home care and other informal social contracts would be broken within the community. In addition to these "social" impacts, dispersal of acquired households could result in impacts to schools, utility districts, public services, and other organizations (churches) that depend upon a stable population for financial resources.

In turn, those communities where displaced landowners would relocate to would be confronted with accommodating the needs (schools, utilities, public services, etc.) of many new neighbors of varying backgrounds and expectations without sufficient financial resources to mitigate the socio-economic impacts. Similar impacts have been realized in "boom-bust" communities associated with energy development and military projects of the past. There are numerous small communities located just north of the I-10 corridor that could be the recipients of this out-migration of relocatees. Table 10 shows a listing of those communities including their land area (in square miles), population, population density and projected population in 2030. The population projections are based upon information from the Gulf Regional Planning Commission's analysis of future traffic generated by zones within Harrison County. It is possible that one or more of these communities would be impacted by an influx of relocatees and many do not have the infrastructure or resources to handle a large number of new residents.

With respect to the commercial relocations, convenient access to one or more of the major existing highways in the area is of paramount importance. Major arterials such as Route 90, Route 49, Route 63, Route 603/43 and Route 110 have captured the majority of the new commercial growth in strip malls and big-box retail complexes. Relocations of at-risk businesses along the coast could follow a similar path given the availability of adequate land along these access roadways. Some flood-safe infill opportunities may exist within established communities, but they are limited due to zoning

Table 10.
Communities Adjacent to the Project Area

Community Name	Population Estimates	Population Density	Community Area	Projected 2030 Population
Escatawpa	3,566	553/sm	6.45 sm	NA
Latimer	4,288	265/sm	16.2 sm	NA
Van Cleave	4,910	113/sm	43.4 sm	NA
Kiln	2,040	153/sm	13.3 sm	NA
Picayune	10,535	918/sm	11.8 sm	NA
Lyman	1,634	135/sm	8.10 sm	4077
Saucier	1,303	186/sm	7.0 sm	NA
Helena	778	385/sm	2.02 sm	NA
Dedeaux	598	NA	NA	3040
Wool Market	3,050	NA	NA	5161
Orange Grove	1,914	NA	NA	3500
New Hope	601	NA	NA	1396
Wortham	NA	NA	NA	NA
Lizana	1,624	NA	NA	2459

sm = square mile(s); NA = data not available
Data source: US Census 2000

restrictions and lot sizes. Other commercial redevelopment opportunities may exist within planned unit developments established with relocated housing initiatives. Certainly for businesses that depend upon a more local clientele, relocation into an existing community structure would better assure their financial success.

4.5.9.8.3 Existing and Planned Redevelopment Sites

In view of the potential impacts that scattered displacement of acquired households could generate in surrounding communities, at least three other redevelopment scenarios should be considered. The first redevelopment scenario is based in part upon a recommendation of the Mississippi Renewal Commission that consideration be given to managed-infill development within existing municipal areas where interspersed vacant property (or property with abandoned buildings that could be demolished) would be available for reconstruction of new housing units. These infill sites should be located at elevations greater than the 500 yr. frequency elevation shown on local FEMA FIRM or where the replacement house could be elevated to avoid first floor damages from a 500 yr. flood event as defined in FEMA mapping or within a line of protection that may be afforded by a Corps structural project (i.e. ring-levee project).

Since existing utilities, streets, public services and other amenities are available at these sites, costs associated with providing these site amenities are significantly reduced. Issues to be resolved in infill projects include land costs, infrastructure capacity, potential HTRW contamination and restrictive zoning regulations. Despite these site issues, infill development helps to increase concentrations of municipal population that can support transit services, recover lost tax revenues, and support social organizations and public services. Any new housing options at infill sites would be subject to local zoning and building codes thus assuring that replacement housing would be DSS and able to withstand hurricane winds.

As was shown in the Mississippi Renewal Design Charrettes, there are many housing and commercial design options available that could provide a visually pleasing urban environment while addressing the flooding risks. Opportunities for mixed use development (residential and commercial) in the more urban areas of the project would abound and strengthen the communities by reinvestment in those damaged economies. Application of New Urbanism concepts for recreating traditional neighborhood areas within existing urban spaces could significantly change the social and economic structure of the communities and reduce the need for vehicular use and parking. See Figure 53 for an example of infill development within the project area in areas where elevation of the new structures may be necessary to meet the program guidelines.

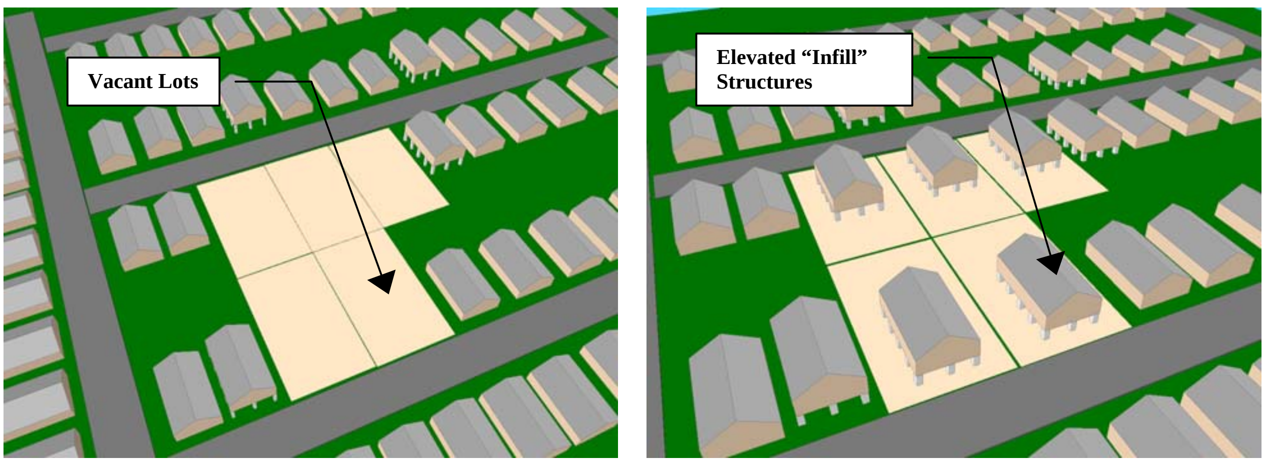


Figure 53. Infill Development

An additional option for redevelopment that could accommodate displaced landowners is the creation of new communities in flood-safe areas. This option can address issues of community cohesion and social impacts that would be raised in circumstances where an existing neighborhood or community has established social or ethnic ties that would resist displacement or where environmental justice issues may arise from acquisition. Sites located above the Probable Maximum Intensity (PMI) hurricane surge inundation elevation (or at a minimum 500 yr. frequency level) or sites that could be physically raised by fill material to be above those elevations, would be platted according to existing subdivision regulations featuring basic residential amenities (utilities, infrastructure, streets, lighting, sidewalks, etc.) and be ready for new housing construction to accommodate displaced landowners. A variety of lot sizes would be platted in the new communities so that a variety of home sizes could be accommodated to meet the replacement housing needs of the displaced owners under the Uniform Relocations Act provisions. These sites could be developed in such a way that many of the urban development concepts recommended by the New Urbanism Congress for Mississippi Renewal could be realized on the ground. These “Housing and Community Development” (a.k.a. H&CD) sites could be located with convenient access to Interstate 10 interchanges and the major arterial roads leading back towards the coastal area. A north-south transit system on those arterials could be initiated to reduce future traffic flows between the relocated communities and the remaining shoreline urban areas.

Should this H&CD option be exercised, relocations of schools and other critical facilities as part of the coastal protection project could be coordinated such that the new communities would be served by those relocated public facilities. Figure 54 shows an example of a new community development with opportunities for residential, commercial and institutional land uses. Development costs for H&CD sites could be as high as $45,000 per lot including land acquisition, site grading and drainage, utilities, streets, lighting and landscaping.

The third redevelopment scenario is based upon the new community concept but the physical location of the existing community does not change. The best example of this option is the community of Pearlington where the current density of development is relatively low and portions of the existing community exhibit higher elevations above the Gulf. The primary component of this redevelopment scenario would be raising areas of the community with locally excavated fill material.

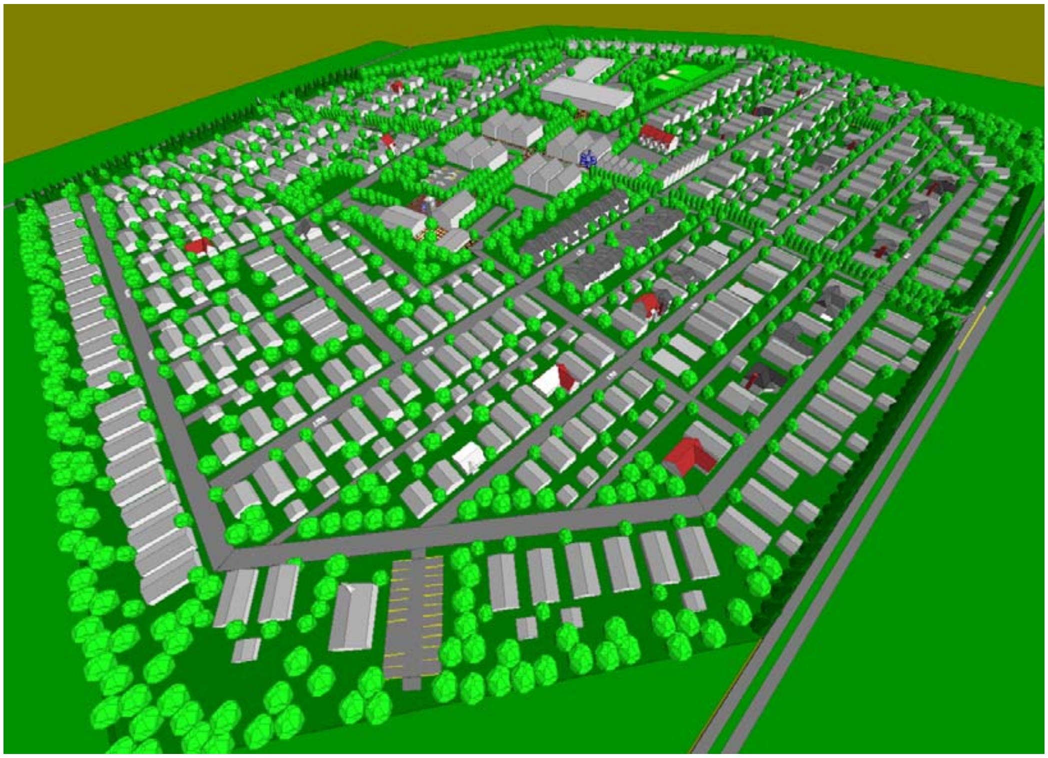


Figure 54. New Housing and Community Development Site

That new site elevation could be adjusted to meet any of the selected levels of protection associated with surge inundation from hurricanes. New residential, institutional and commercial development could be constructed upon the raised site in a more dense development pattern that would be more efficient and safer thus avoiding the social impacts associated with dispersal. New utilities and roadways would complete the community redevelopment.

In the case of Pearlington and the few small residential subdivisions surrounding that community, their current footprint is surrounded by a low-lying landscape that could be converted to wetland habitat as part of the excavation process for fill materials. With careful planning and design the development of a new raised Pearlington community could result in many acres of new wetland habitat adjacent to the Pearl River as a by-product of the borrow operation. Opportunities for a “safe harborage” along the Pearl River could also be explored as a part of the excavation of near-by borrow material to raise the community. Further investigation of this type of on-site redevelopment may indicate other coastal locations for its use and some cost savings above other options for whole community relocations. Certainly the prospect of creating additional high-quality wetland habitat as part of the redevelopment process is noteworthy.

In recognition of current community planning models that emphasize more concentrated development rather than the sprawl pattern of the last four decades, relocations of large numbers of households would need to be better planned and closely coordinated with the municipal and county planning and zoning commissions. New urban development initiatives being promoted by the New Urbanism Congress and “green” neighborhood programs being promoted by LEED (Leadership in Energy and Environmental Design) can be applied to new relocation sites. In an age of higher fuel prices, growing concerns of the effects of greenhouse gases, and conversion of green areas to urban uses, this anticipated redevelopment needs to emphasize walkable communities and reliance on public transit rather than the vehicle-oriented neighborhoods that have become popular along the coast. The more concentrated urban communities within the project area (Biloxi, Gulfport, and Pascagoula) exhibit these more pedestrian-oriented patterns of development. Any new redevelopment options must consider these emerging societal concerns.

4.5.9.8.4 Replacement Housing Options

As important as the location and quality of the relocations sites will be to local governments, the quality and affordability of relocation housing units will be more important to displaced families. The need for affordable DSS housing resources in the project area is well documented. Much of the new replacement housing that has appeared following Katrina has been larger and more expensive than the destroyed units. This trend in replacement housing does not bode well for those families that may be in need of replacement housing but either had limited financial resources or did not have insurance coverage. Housing unit options that can meet a wide range of financial situations will be more successful in such a massive relocation effort.

Housing options such as manufactured units (not mobile homes), panelized units and modular units can provide reasonably priced, well constructed homes for relocated families. Most amenities found in stick-built homes can be incorporated into manufactured homes at the factory. Built in a controlled environment with quality materials, close tolerances and meeting the latest building codes, these units can be produced in large numbers for reasonable prices. A wide variety of styles, sizes and built-in amenities are available from multiple suppliers. All International Building Code requirements can be met with these manufactured housing units. Transported into redevelopment sites and placed on either a concrete slab or crawl space foundation, installation of these units requires days rather than weeks or months and new communities can be established quickly. Coordination with local zoning and code enforcement offices prior to construction and installation of these housing units can reduce any development permitting problems.

4.5.9.8.5 Cemeteries

Among the many personal items that may be encountered during the purchase of private property and relocations of a household or business is a cemetery on the acquired property. The cemetery could be associated with a family or with a church or another commercial enterprise. Cemeteries will not be purchased or relocated as a part of the nonstructural permanent acquisition measure. Under the nonstructural program, cemeteries remaining on the acquired and evacuated land do not result in residual damages and do not further threaten lives. Cemeteries will be left in place unless the landowner chooses to relocate the cemetery with their own resources. The purchase price of the property will take into account the value of the land occupied by the cemetery. Reasonable access to the cemetery for the family or business (or church) will be provided during the structure demolition process. Any additional security, adornment and all maintenance of the cemetery or the plots in the cemetery will be at the discretion and expense of the cemetery owner(s).

The only cemeteries that may be purchased under the nonstructural program would be those located within property purchased for redevelopment sites and then only in cases where the location and size of the cemetery significantly limits the efficient use of the site. All efforts will be made in the site development process to avoid any new or relocated home construction on land previously occupied by known cemeteries. Cemeteries found within the footprint of the contractor's work limits of a structural project (Levee, floodwall, pump station, etc.) will be relocated in accordance with standard Federal relocation procedures.

4.6 Replacement/Relocation of Public Buildings and Facilities

4.6.1 General

Permanent acquisitions within the high-hazard zone (HARP) and the zone where inundation depths would be greater than 13 feet above the ground surface affect a zoning-influenced pattern of residential, commercial and publically-owned institutional land uses. Among those land uses are a scattering of publically-owned and operated buildings and facilities which house the administrative, emergency, security, and management personnel and operational systems that continuously support the project area. As described in Section 4.5.9.4 above, for those facilities and structures that have been identified as having a compensable public interest and cannot be otherwise protected by floodproofing or structural methods or that are located within the high-hazard zone (HARP) would be addressed through the substitute facility doctrine and treated as a relocation item in the project. In these instances, a relocations contract would be executed between the Corps and the public jurisdiction (state, county or municipality) for design and construction of the replacement building/facility. Identification of public facilities that may be eligible for replacement was based in part upon FEMA data and data provided by individual counties and municipalities.

4.6.2 Critical Facilities Database

The database within FEMA's HAZUS (**HAZ**ards **U**nited **S**tates) program identified approximately 75 structures categorized as "critical facilities" within the project area that were damaged by Katrina. Many of those public structures and facilities were confirmed by cross-checking municipal and county databases. Of that total number, approximately 66 could be identified (by name or by use such as schools, fire stations, police stations, city halls, emergency management, or medical facilities) as being publicly-owned or otherwise eligible for the facility replacement under Corps Real Estate regulations. A number of the critical facilities were identified as being privately-owned (faith-based schools, government offices in private office space) and would be purchased through the permanent acquisition program as commercial businesses. Of the 66 structures, 49 could be positively identified with an existing tax parcel in the project database and were determined to be eligible for replacement or floodproofing by some method.

4.6.3 Relocations Planning

Using the GIS hazard zone layers previously developed for commercial and residential structures and the locational data from the tax parcels and HAZUS program, preliminary options for each of the public buildings and facilities were determined. Due to some inaccuracies in the geo-coding of the structures used in the GIS databases, exact determinations of the disposition of each public building cannot be made until each building or facility is field verified in a more detailed study. As with residential and commercial structures, any public buildings/facilities that were located within the three high-hazard zones were determined to be eligible only for replacements to a flood-free site. Public buildings such as schools, city halls, police stations, fire stations, emergency services buildings, and medical facilities located within those hazard zones would be relocated (substitute or replacement structure) through a relocations contract to a suitable flood-free site. Initial analysis of the data indicates that 7 structures/facilities may be eligible for replacement at a new flood-free site. Another 42 public structures were determined to be protected by floodproofing by various methods (assumed to be ringwalls for this appendix).

Prior to any detailed planning for a substitute facility, the Corps would conduct an analysis of each potentially eligible structure or facility for the processing of an Attorney's Opinion of Compensability (one of the necessary steps in determining whether a facility or structure is eligible for replacement). Provided that the Attorney's Opinion of Compensability is affirmative, detailed relocations planning for the facility would commence. The redevelopment site selection, new facility/building design and construction would be fully coordinated with the public facility owner. Relocations planning would determine, in cooperation with the owner and regulating entities whether the existing structure met current regulations regarding size, facilities, and uses. Bona fide upgrades to meet current building/facility standards would be included in designs for relocated structures. Any upgrades that would exceed current standards for that specific building use would be considered "betterments" and would be subject to financing by the owner of the structure or a non-Federal project sponsor.

4.6.4 Replacements Costs

Costs for replacements were based upon estimated square footages for fire and police stations and city halls within the project area. Prices per square foot for standard frame construction were used to estimate new buildings and associated facilities construction. RS Means building construction online calculators (http:www.rsmeans.com/calculator for 2007) were used to determine building costs for each use type based upon a centralized zip code location (Gulfport, MS) within the project area. Square footage estimates for relocated schools were based upon numbers of students (using current online county school board databases) and square footage recommended per student (based upon 2006/2007 school construction in the four state region including MS). Using school construction information from a 2007 Construction Report published by School Planning and Management for a four state region (including MS), costs per square foot of building construction were determined. Per square foot costs were determined by school type (elementary, middle and high school). Land and parking requirements were based upon national standards for the various levels of schools (elementary, middle and high school) and the appropriate contingencies, E&D and S&A costs, overhead and profit were also added to the replacements estimates. Since all of the schools and fire stations in the project area were not specifically identified in the parcel database, an average cost for replacements was calculated for those structures identified in the database and applied to all listed public structures.

For those public structures located outside of the three high-hazard zones and where depths of flooding did not exceed 13 feet, methods for protection in-place would be explored in greater detail. During more detailed nonstructural planning for protecting individual public structures, options for protection in-place such as veneer walls, ringwalls, or ring levees can be considered with respect to the suitability of the property to support certain protection methods as well as building access requirements, utilities, service entrances, ADA requirements and other building use needs that would determine the appropriate type of in-place protection. A more in-depth field investigation of each structure would be necessary prior to implementation of a nonstructural project in these areas.

Approximately 43 public structures may be eligible for floodproofing in some form (elevation, veneer wall, ringwall, ring-levee, etc.). For the purposes of determining a preliminary cost for this nonstructural appendix, it was assumed that each of the structures within the floodproofing area would be protected by a ringwall. Building footprints and perimeter lengths for ringwall length were determined based upon aerial photographs and student numbers for schools. Recent ringwall costs for protecting a high school (portions of I-wall and T-wall construction) were indexed and applied to the wall lengths determined by the methods described above. Appropriate contingencies, E&D and S&A, profit and overhead were added to the estimated per linear foot ringwall costs. The cost estimates assumed that all floodproofing construction would occur on property owned by the municipal or county government so no costs were included for land acquisition.

Estimated costs for floodproofing public structures such as fire stations were based upon a standard building size of 5000 square feet for the project area. Ringwall length was predicated on a 20 footwall setback from the building for interior drainage, closures and vehicle access. Construction costs were estimated according to the procedures listed in Section 4.3.7.8 Ringwalls and Ring Levees.

4.6.5 Replacement Sites

For those critical facilities determined to be public facilities, information on the use, service area, floor space size and special requirements will need to be determined so that an appropriately sized, located and equipped relocated structure can be estimated for construction. That detailed information was not available for each facility to be relocated at this level of planning study. Site selection for these relocated facilities is a critical component of the replacement process given the sensitivities to the service area (police, fire and schools), land area requirements and the need for some emergency services facilities to be protected while remaining relatively close to the event area. In accordance with FEMA guidelines, certain critical facilities should be located above the 500 yr frequency event as defined in the FIRM. A determination of the required or preferred level of protection for each type of publically owned and operated facility or structure will be made during the detailed relocations planning process. Relocations agreements specifying all of the relevant requirements and facilities to be constructed are executed between the governmental unit and the Federal government (USACE) prior to construction.

Replacements of these public buildings, some of which are considered to be critical to the safety, security and administration of communities must be carefully accomplished in concert with other potential relocations of residential and commercial structures and facilities. Re-establishing service areas around relocated facilities that conform to state or national legal and funding requirements will be a challenging task. In some cases, regional facilities could be relocated initially while public facilities with a smaller service area would be moved after substantial numbers of residences and commercial uses have been relocated out of hazard zones. Close coordination with local government units and service providers will be critical to the success of replacing eligible public buildings.

4.6.6 Moss Point Public Buildings Replacement

During the delineation of the coastal high-hazard zone (HARP footprint) and the non-floodproofing zone (where surge inundation depths would exceed 13 feet at the BFE), it became apparent that a number of structures within the municipal facilities complex of Moss Point, MS would be included in the area where permanent acquisition would be the recommended action to reduce flood damages. As stated previously, public facilities, when determined to be eligible for substitution in lieu of acquisition, (the substitute facility doctrine discussed in Section 4.5.9.4 above) can be relocated to a flood-safe area. For public facilities that are considered to be critical components of a local or regional post-disaster response and recovery system, relocation to a flood-safe site enables that facility to operate both during and immediately after the disaster to reduce loss of life and maintain essential emergency services.

Coincidently, the NS PDT became aware of local efforts by the leadership of Moss Point, MS to address surge inundation damages to several public buildings within that same municipal complex. Members of the NS PDT met with the Mayor of Moss Point and other city officials to discuss whether the proposed acquisition of those structures under the Corps MsCIP may lead to a plan for relocating those facilities that would be in concert with the replacement concepts described above.

As a result of those meetings, the NS PDT developed a preliminary public facilities replacement plan for Moss Point, MS. The purpose of this replacement component of the HARP (in addition to protection of critical public facilities) would be to demonstrate to the other 10 affected municipalities that replacement of critical facilities is an effective way of maintaining services within the community while protecting those structures from flood damages. Communities that face such issues outside of the delineated Corps' HARP area could use their Capital Improvements Programs to fund fully or partially (cost-sharing situation) the necessary relocations. For those public structures that may be located in the high-hazard zone (HARP) or where surge inundation depths would preclude floodproofing, the Moss Point Public Facilities Replacement would yield valuable information to the Corps on new building construction costs under the latest IBC requirements.

The public buildings replacement project would include the Moss Point city hall, police station, fire station and community recreation center. Each of these four facilities was severely damaged during Katrina by surge inundation and waves and prevented local authorities from assisting citizens during the emergency. The City of Moss Point identified several strategic locations within the city where relocated public facilities would be safe from future events. Tentative replacement locations for each of the four facilities to be relocated are shown on Figure 55. The final arrangement of the replacement facilities (multi-use single structure, multiple-structure complex or dispersed facilities) would be determined in collaboration with the municipal officials during the relocations planning phase of the project.

Members of the NS PDT provided a preliminary replacement assessment of the required building square footages, parking requirements and land area needed based upon data from the city officials in Moss Point and field measurements. Using this base data, Corps estimators developed a fully-funded total cost for relocating these four structures of approximately $11.4 M which has been incorporated into the total cost of the HARP.

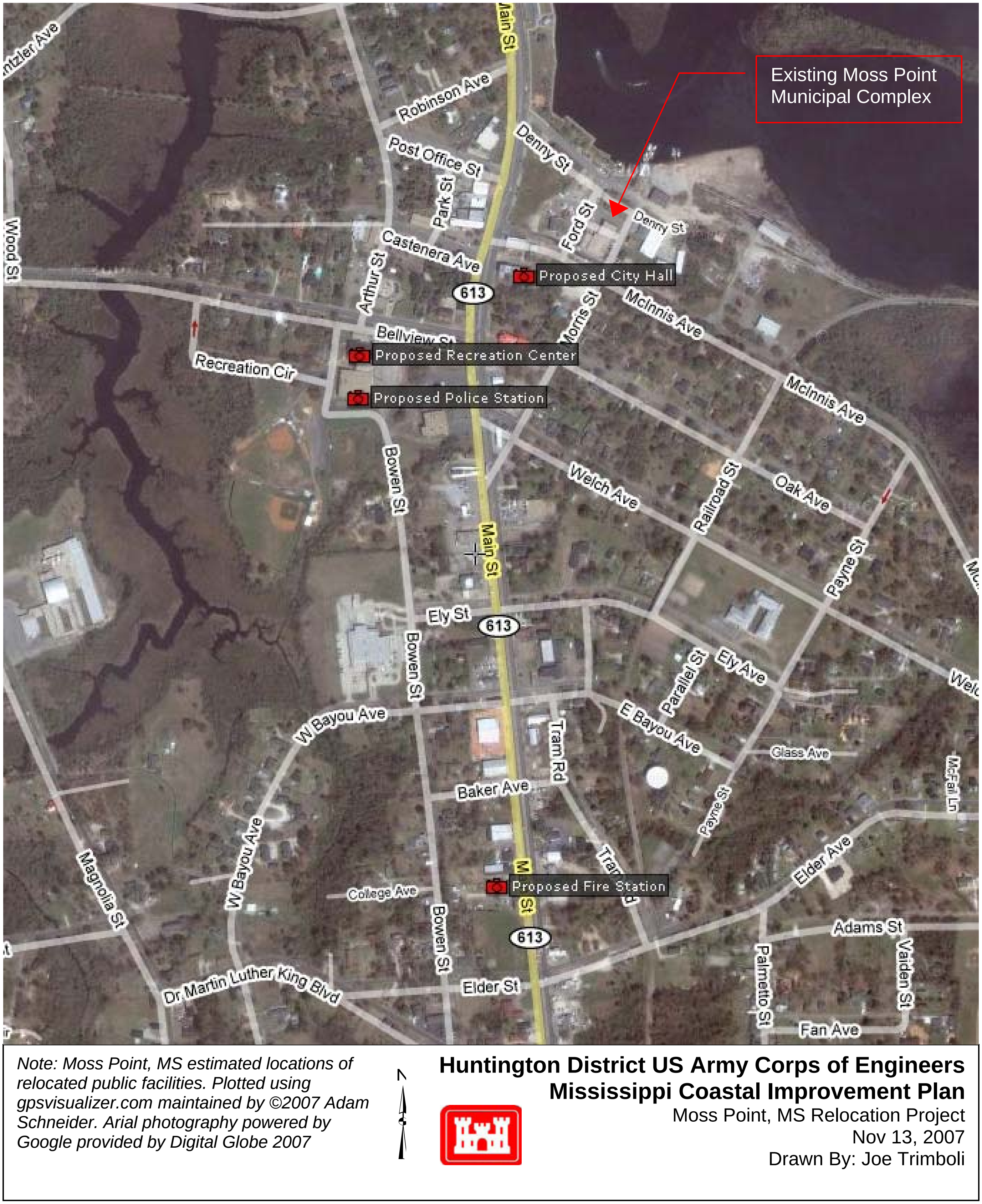


Figure 55 – Moss Point Public Buildings Replacement Location

CHAPTER 5. SUMMARY OF NONSTRUCTURAL MEASURES

As shown above, there are a number of potential nonstructural measures that could be implemented within the project area and would result in significant reductions in flood damages as well as reducing the threats to occupants of the coastal zone. Some of the measures are generally associated with Federal actions that could be implemented through standing or new project authorities and some are purely within the purview of state and local jurisdictions acting through their police powers. Many of the measures have been proven in other locations to be both effective and reliable and some, although theoretical in their construction, if implemented should have dramatic effects on the existing development patterns along the coast that contributed to the high losses from Katrina.

Given the current conditions within the project area with regard to pending insurance settlements and the uncertainties surrounding the anticipated new flood insurance rate mapping, redevelopment along the coast has been relatively minimal. However, when the regulatory and financial components of redevelopment are finally resolved, new construction along the coast is anticipated to proceed at a feverish pace. Opportunities to assure that new development is located in less hazardous areas than in the past and to reduce the future damages associated with large hurricanes and storms are slipping by each day. Some of the measures described above can forestall unwise development along the coast if they are implemented in the near term. Those measures are discussed in the subsequent formulation and evaluation sections of this Nonstructural Appendix.

Although many of the measures are shown to be effective in reducing damages and threats to life, some of them could result in significant social and economic impacts if administered within a short time period to large areas of the coast. Significant numbers of permanent acquisitions and relocations would result in the movement of thousands of families, hundreds of businesses and many facilities regarded to be critical to the functioning of existing communities. Some of the impacts associated with these activities can be mitigated through available programs, but without careful planning and collaboration between Federal, state and local agencies and jurisdictions, the potential exists for significant impacts to the social fabric and economic viability of the coastal communities.

An important feature of the nonstructural measures is the capability to “tier” or layer the measures in different zones over an extended implementation period. Such “tiering” facilitates a constant stream of flood damage reduction benefits through the application of one or more coordinated measures along the coast. As the following formulation process will demonstrate, multiple measures can be implemented simultaneously on a single parcel or across several reaches, each tier providing ever-increasing layers of protection and damage reduction. The tiering approach also eases the social and economic impacts of significant movements of households, businesses and supporting public facilities from high-hazard zones to more flood-safe areas over time.

Collaborative planning among Federal agencies, the state, counties and municipal jurisdictions will be paramount for successful implementation of the nonstructural plans described in the following chapters. Meaningful and continuous public involvement and consensus building will also be key components of a successful nonstructural program. Few other types of flood damage reduction are as personal as are the nonstructural measures and working with homeowners and landowners could be challenging.

CHAPTER 6. NONSTRUCTURAL PLAN FORMULATION

Formulation or "building" alternatives or plans out of identified management measures is a process of creative thought mixed with planning experience and input from various disciplines. Combining various measures into alternative courses of action that address the planning objectives, work within the constraints and that can be implemented by both the Corps of Engineers and other partners in the project is the foundation of the formulation process. Careful manipulation and combinations of proven and reliable tools that reduce flood damages and threats to life and property can result in imaginative solutions to complex problems.

Formulation of successful plans requires a cooperative effort between team members, stakeholders and project partners. Although implementation of certain identified measures within plans may be beyond the limits of the Corps' authority to implement, that does not restrict their inclusion in the formulated plans. Every opportunity to engage the abilities and authorities of our local partners and cooperating agencies in meeting project objectives should be explored. Since nonstructural measures normally include actions that can only be implemented within the statutory scope of local governments, the opportunities for formulating innovative plans abound.

Formulation of plans must consider the intent and direction of the planning objectives. Although the objectives can be revisited and revised during the planning process, the initial or preliminary objectives of the project, based upon the study or project authorization and a careful examination of the stated problems and opportunities, must be satisfied by the formulation process. Failure to meet or exceed the planning objectives calls into question the entire formulation process.

Plan formulation must also consider the temporal aspects of various measures with respect to the size and complexity of the problems to be solved (extended implementation times) and the sequence of applying nonstructural measures to a large population (cumulative social and economic impacts). Since nonstructural measures tend to impact individual properties (residential and commercial) as well as potentially disrupting community systems (education, security and safety, health, and public services), formulation of plans for this project area will consider tiering of measures over an extended period of time. Attempting to relocate large segments of the coastal population as well as commercial resources and critical facilities away from hazardous areas to less flood-prone areas in a relatively short period of time would be an administrative and social nightmare. On a more practical level, the human and financial resources necessary to complete the full suite of nonstructural measures discussed in this appendix in a relatively short period of time are unavailable at this time.

Formulation must consider the various affects or impacts that alternatives or plans may have on the natural and community resources of the project or program area. Each action or activity will generate some differences in the natural, social or economic conditions of the area. Both beneficial and adverse impacts are anticipated from most nonstructural actions, but formulating plans with those potential affects clearly in view can reduce needed mitigation and plan costs. Since communities by definition and function are composed of a mixture of land uses, people and infrastructure systems, each one contributing valuable benefits to the community as a whole, it was determined by the NS PDT that alternatives that targeted one of the individual land uses or components for protection in such a way to totally remove that component from the community structure (i.e. relocation of all residences or just all commercial uses) would not be presented in the nonstructural plan. In cases where a particular structure type (i.e. mobile homes) would be placed in extreme jeopardy through a nonstructural measure (elevation into hurricane-force winds), acquisition of those structure types in lieu of elevation may be warranted. Although it would be possible to envision the separation of community land uses in some future coastal development plan so as to provide greater levels of flood protection and more efficient land use, the social and economic impacts of affecting such a community dispersion in a Federally-funded program would be virtually impossible to describe or justify.

Prior to initiating the nonstructural formulation process, three components of nonstructural measures must be considered: 1) program eligibility of structures and properties, 2) level of protection being provided, and 3) nonstructural measure evaluation criteria. Unlike structural projects where a line of protection or an area of reduced inundation gathers hundreds or thousands of properties, many nonstructural measures (i.e. floodproofing) address individual properties and each must be evaluated with specific criteria for their eligibility in the program options. Each of these three components is discussed below.

6.1 Nonstructural Plan Data Use and Analysis

Formulation of nonstructural measures relied heavily upon many sources of data and information provided by the local counties and municipal areas, as well as from other Federal and state agencies. One of the primary data sources was provided by the three counties (Jackson, Harrison and Hancock) tax assessors offices. Tax parcel databases from the three counties that were geospatially constructed for use with standard Geographic Information Systems (GIS) computer models allowed the NS team to account for the many surge-affected parcels correlate their common site characteristics and display that data graphically for formulation purposes.

As is the case with many county property tax databases, tax parcels may be composed of one or more legally-described tracts of land that are listed under one ownership in the tax system – this is the case for the three county tax parcel databases used in this project formulation. For the purposes of the nonstructural formulation all of those “tracts” were just referred to as “parcels” to avoid confusion. Also, prior to Katrina, a great many interspersed parcels were recorded in the tax database as being vacant without any residential or business structure located on the property. Since these interspersed vacant parcels could be built upon in the future and suffer damages due to hurricane surge inundation those tax parcels located within the permanent acquisition zones were included within the acquisition category of nonstructural measures. An additional number of parcels that had structures located on them prior to Katrina (as determined in the tax base) had been made vacant due to Katrina. Estimates based upon field observations were made in the project database as to that number of newly vacated parcels that would also be eligible for acquisition. It is out of that estimated number of vacated parcels that the proposed initial phase of the High Hazard Area Risk Reduction Plan (HARP - see Section 4.5.9.5) would purchase parcels prior to landowner reconstruction.

For the purposes of nonstructural formulation and the determination of national economic benefits associated with the nonstructural measures, several future-without-project scenarios were developed (see the Economics Appendix). Those alternative scenarios allow comparison of with-project and without-project conditions with regard to inundation damages, potential loss of life and other factors. Each of those 6 scenarios include the assumption that by the year 2012, all of the parcels of land vacated as a result of Katrina would be rebuilt upon with either residential uses or a mixed-use of residential and commercial structures. In keeping with those scenarios of the future-without-project condition, the several plans formulated and evaluated in the pages that follow show a full compliment of developed parcels (existing and new structures in place) within the various inundation zones of the project area. For the same reasons, the costs displayed in the various nonstructural plans (those including the land acquisition measure) represent acquisition of land and structures with associated relocations assistance payments and structure demolition for each parcel within the proposed acquisition footprint.

6.2 Nonstructural Plan Eligibility

In contrast to structural projects where the line and level of protection can actually encompass structures, facilities and lands that were not directly affected by the design flood event, nonstructural measures are directly targeted at structures and facilities which had or would have damages to the first floor and contents from specified inundation events. This difference requires that program eligibility criteria be developed to determine whether the owner of a particular structure or facility can participate (either mandatory or voluntarily) in the program. Usually the ability to participate in a nonstructural program is dependent upon the incidence of damages to the first habitable or sales floor of a structure or facility from a specified flood event. Normally nuisance damages to sub-floor utilities in a crawl space or basement (i.e. ductwork, furnace, hot-water heater, pumps, etc.) do not qualify a structure for program eligibility in nonstructural projects.

Of prime importance in determining program eligibility is the water surface elevation of the flood event that was the genesis of the study or project authorization. The study authorization for the MsCIP specifies *"…..to expedite studies of flood and storm damage reduction related to the consequences of hurricanes in the Gulf of Mexico and Atlantic Ocean in 2005,.."* Obviously the largest and most damaging of those hurricanes in 2005 was Katrina. Although both structural and nonstructural measures can be formulated that address a wide range of storm and hurricane events including the theoretical Probable Maximum Intensity (PMI) hurricane, the program eligibility for nonstructural measures must settle on one logical event level.

For this study, the extent and water surface elevation of the Katrina surge inundation was determined to be the limits of nonstructural eligibility. Although the most cost effective project may actually provide a lower level of protection than that necessary to protect structures against a recurrence of a Katrina-intensity event, those structures and facilities that experienced first floor damages from Katrina would be eligible for the nonstructural program at some determined level of protection. It would be possible, depending upon the identification of the most cost effective plan, that structures damaged by Katrina would not receive any program benefits should a lower level of protection than the Katrina inundation level be the basis of the most cost effective plan. This declaration of eligibility for properties damaged by Katrina provides the basis for identifying these landowners as "displaced persons" for the purposes of applying the benefits of the Uniform Act.

6.3 Nonstructural Level of Protection

Determining an appropriate level of protection for nonstructural measures is somewhat unique since most measures apply directly to individual parcels and structures or facilities on those parcels rather than a vast area contained within a structural line of protection. Although many nonstructural measures are unaffected by the concept of level of protection (flood preparedness, land use zoning, etc.), measures such as floodproofing and permanent acquisitions are very sensitive to this parameter. Since a maximum height of elevation in place has been established and since the costs of dry floodproofing are also sensitive to water depth, the level of protection selected can significantly affect which of these measures is applied to individual structures. Increasing or decreasing the level of protection has a corresponding affect on the numbers of structures that can be protected in place rather than relocated by acquisition.

Also unique to nonstructural measures such as floodproofing by elevation is the fact that nationally accepted standards for flood protection upon which the nation's entire flood insurance program is based are already in place within the project area. For formulation purposes, a variety of storm events each having a specific level of inundation that would result in flood damages to structures could be modeled and the benefits of specific applied measures calculated. Somewhere in that array of storms, measures and benefit calculations, the most cost-effective combination of measures and appropriate level of protection could be discerned. Selection of the most cost effective level of protection and array of measures would meet the planning objectives and fulfill the planning process.

However, the National Flood Insurance Program (NFIP) has determined that the Base Flood Elevation (BFE) is the appropriate level of protection with regards to the application of floodproofing (either through wet or dry floodproofing) and other nonstructural measures. The BFE is normally associated with the theoretical 1% annual chance flood event or a level of inundation that corresponds with a storm event of that frequency of occurrence. Since each of the 11 municipal areas and 3 counties continues to be a regular participant in the NFIP, proposing a level of protection less than the BFE in a nonstructural plan for flood damage reduction would not only not be well received by the local population, but would, if implemented, place each of these local units of government potentially in violation of their own ordinances and in jeopardy of being suspended by FEMA from the flood insurance program. For these reasons, the formulation of the nonstructural measures is based upon a minimum level of inundation that approximates the theoretical BFE within the project area. Other higher levels of protection could be formulated for the nonstructural alternatives, but the result of such additional iterations would be merely moving structures from the floodproofing option to the permanent acquisition or replacements (public buildings) option.

For the purposes of this comprehensive plan, the nonstructural formulation appendix bases its development of alternatives and their evaluation on a level of protection approximating the theoretical BFE within the project area. This would be the lowest level of protection that could be provided if floodproofing were a component of the plan. Greater levels of protection would result in fewer structures being protected in place and potentially more structures being acquired and relocated.

6.4 Nonstructural Plan Participation

For the purposes of nonstructural formulation in this appendix, implementation of the identified measures was assumed to be mandatory (thus assuring 100% participation) so that the full range of benefits and costs could be disclosed across the project area and within each reach. Formulation based upon mandatory participation was also necessary so that direct comparisons (costs and benefits) could be made between structural and nonstructural options for protection of particular communities in the project area (i.e. Pearlington, MS). As structural measure protection is in effect mandatory for all those enclosed within or behind a line of protection, nonstructural measures for those same structures and facilities would have to be formulated as a mandatory (100% participation) program for the sake of comparing cost effectiveness of the measures.

Implementation of the floodproofing and replacements of public buildings would be a voluntary action. Other local, regulatory-based nonstructural measures (i.e. land use zoning, building codes, etc.) can be considered mandatory once legally enacted by the municipal or county government. Such measures, implemented by the local governments, are enabled through state legislation and thus carry the authority of the state’s legal standing in land use matters. Landowners could seek relief (code variances) from local mandatory measures should the measures be found to be so restrictive as too diminish property values below limits that constitute a taking.

Under the permanent acquisition measure, mandatory acquisition could be enforced since the Federal government would be obtaining an interest in the property as part of the action. Mandatory acquisitions through the use of condemnation proceedings are common for construction of public projects that are found to be in the public’s interest and where the Federal government requires fee title to the property to construct permanent public assets. Using mandatory acquisition for coastal zones determined to be high-hazard areas is an option, but the public acceptability of such a program and the political viability of mandatory acquisitions is questionable. Mandatory acquisitions on a large scale generate significant social and economic hardships even in the presence of mitigative actions.

The quantification of project benefits and costs and evaluation/comparison of other non-monetary benefits (reducing loss of life) is more problematic when participation is not mandatory. Landowner participation in a nonstructural program is based upon the owner's perception of the costs and benefits to his own self (rather than the nation's) weighed against the owner's perception (or misperception) of the risks of future flood damages to the property. The severity of the damages to the property as a result of Katrina or a similar type storm may weigh heavily on the owner's decision – loss of life during the same event weighs even heavier. Included within the owner's determination may be years of current land ownership and perhaps past generations of ownership that have been handed down to this time. Family values, traditions, cultural biases and other social factors also influence the owner's decision whether to participate in the program. Added to these factors is the uncertainty of the outcome should the owner choose to participate – any changes in lifestyle can be daunting in the current economic environment, changes with great uncertainty can be paralyzing.

The only certain factor in the nonstructural participation process is that it is full of uncertainty. Who and how many landowners would participate at what time during the project's implementation is at best guesswork at this preliminary level of analysis. Feedback from workshops and meetings and from the media about possible public participation in certain measures is not a reliable yardstick – only when the official agency offer to participate is made and landowners are provided with credible information of their options and benefits does the real participation rate become evident. Past nonstructural projects have experienced participation rates as high as 80-90 percent for permanent acquisitions and floodproofing following major flood events. Participation in certain nonstructural measures has also increased measurably following landowners' observation of pilot or prototype projects showing the benefits of participation. Experience has shown that participation rates in nonstructural projects decrease with each ensuing year following a disaster provided there are no repeat events.

In an attempt to address the problems of nonstructural participation in plan formulation, the various levels of participation for each of the measures can be shown and the effects on costs and benefits can thus be observed. However, since the participation process is largely random (unless specific geographic zones or land use types are selected for sequential implementation in the program) there is no way to determine which properties will be included in the program at which time. In addition, participation rates will vary between NS program component. Participation in permanent acquisitions for those whose structure was only partially damaged may be relatively low, while those landowners who lost their house and have no flood insurance may have a higher participation rate. A large percentage of those landowners eligible for floodproofing may participate in the program when that component of the project is offered since that form of protection is common in the project area and widely accepted. Participation in the replacements options may vary between each municipal and county area depending upon the extent of damages to their public structures and the local population needs. Therefore the stream of costs and benefits will be erratic with varying levels of both costs and benefits as each property enters the acquisition or floodproofing process.

Acquired properties that have the potential for also generating ecosystem restoration benefits will produce more benefits than properties generating only flood damage reduction benefits and obviously more lavish residences or big-box retail commercial will cost more to acquire than a mobile home. Using total permanent acquisition, floodproofing and replacement units and costs to display the ranges of units protected and cost by participation rate provides a general idea of the effect of varying participation rates. Table 11 shows the total units and costs of permanent acquisition, floodproofing and replacements for Plan NSC-1 (see Section 6.6.2.1. and Table 17) displayed by levels of program participation between 10 percent and 100 percent. Although the ensuing graph from that table would generally display positively-sloped, straight lines showing cumulative units protected and costs from the various reaches, the random nature of the participation process would actually produce very erratic, stepped lines during implementation.

In affect, the eligible landowners in the project area are consumers of a service or program for protection of their property and lives. Not unlike purchasing flood insurance, landowners can choose to partake or not of the Corps' nonstructural program as well as any of the other Federal assistance programs discussed in Section 3.5 above. It is the Corps of Engineers intent that each eligible landowner would be afforded sufficient information on the benefits and liabilities of each available program so that his or her selection will be well informed. It is improbable that participants would have the option of selecting more than one Federal assistance program for reducing flood damages without some off-setting reduction in program benefits – a "double-dipping" issue.

In an effort to more precisely determine what levels of participation may surface in a nonstructural project or program, delivery of an OMB–approved survey (randomly-selected or targeted sample) to eligible landowners in the project area during preparation of a more detailed implementation report would begin to better clarify an expected level of participation and therefore expected project costs and benefits. This sample survey process has been used successfully in past nonstructural programs to better determine expected project costs and benefits. Such information is also beneficial in addressing project impacts through NEPA documentation and to project sponsors for budgeting cost-sharing contributions. Using a standard deviation around an expected mean participation rate for each nonstructural measure provides a range of possible costs and benefits that can better inform decision-makers.

Table 11
Effect of Participation Rates on Project Structures and Costs – Plan NSC-1

Participation Rate	Permanent Acquisition Structures - Cost	Floodproofing Units - Costs	Relocations Units - Costs	Plan Total Units - Costs
10%	1,714 - $792,841,130	2,542 – $1,080,530,165	1 - $7,316,697	4,252 - $1,878,492,984
20%	3,429 - $1,585,682,260	5,083 - $2,161,060,331	1 - $7,316,697	8,504 - $3,756, 985,968
30%	5,143 - $2,378,523,390	7,625 - $3,241,590,496	2 - $15,365,065	12,756 - $5,635,478,951
40%	6,858 - $3,171,364,520	10,167 - $4,322,120,662	3 - $20,486,753	17,008 - $7,513,971,935
50%	8,572 - $3,964,205,651	12,709 - $5,402,650,827	4 - $30,730,130	21,260 - $9,392,464,919
60%	10,286 - $4,757,046,781	15,251 - $6,483,180,992	4 - $30,730,130	25,512 - $11,270,957,903
70%	12,000 - $5,549,887,911	17,793 - $7,563,711,158	5 - $35,851,818	29,764 - $13,149,450,887
80%	13,715 - $6,342,729,041	20,335 - $8,644,241,323	6 - $46,095,195	34,016 - $15,027,943,870
90%	15,430 - $7,135,570,171	22,877 - $9,724,771,489	6 - $46,095,195	38,268 - $16,906,436,854
100%	17,144 - $7,928,411,301	25,419 - $10,805,301.654	7 - $51,216,883	42,520 - $18,784,929,838

For the sake of an example showing the effects of varying participation rates on the plan units and costs, the safe harborages included in Plan NSC-1 were not included in this table illustration (only 3 proposed). The costs by measure are based upon the average for each option times the units under each percentage rate of participation. Actual plan costs could be any number of combinations of participation rates (and costs) between the three components of the plan.

6.5 Nonstructural Criteria/Design Parameters

All structures and facilities located within the eligibility footprint (Katrina surge limits) that can be addressed by the nonstructural flood damage reduction program as defined herein will be subject to on-site evaluation based upon the criteria listed below. Separation into one of the nonstructural measures identified in Section 4.0 above will be based in part upon the results of that on-site evaluation. The nonstructural criteria are listed below:

6.5.1 Location with Respect to High-Hazard, Moderate Hazard and Limited Hazard Zones

High-hazard zones are defined as those comprised of the FEMA-identified V-zone, the FEMA-identified “catastrophic damage zone”, and a 800 feet wide zone bordering the coast within Jackson County identified by the nonstructural PDT as a high-hazard area based upon observed damages. Moderate hazard areas are those areas where the depth of flooding at the structure exceeds 13 feet at the specified inundation level. Limited hazard zones are those areas where the depth of water at the structure was at or less than 13 feet at the specified inundation level.

6.5.2 Depth of Flooding at the Structure

As described above, the determining inundation depth at the structure that separates structures that can be safely elevated from those that can only be voluntarily acquired is 13 feet at the specified inundation level. This depth is measured from the lowest ground elevation along the perimeter of the structure first floor.

6.5.3 Post-Floodproofing Occupancy Requirements and DSS Status

The proposed floodproofing/elevation program would be implemented in accordance with the requirements of the NFIP as a minimum standard. The goal of elevating or otherwise floodproofing a residential structure is to provide a dwelling unit whose first floor elevation has been raised in accordance with the most current local floodplain management ordinance and for which an occupancy permit can be obtained (should one be required). All floodproofing work would be accomplished in accordance with existing building codes for the purposes of obtaining an occupancy permit from the local jurisdiction following elevation. Any existing structure for which an occupancy permit could not be secured (due to structural instability or other reasons) would be subject to acquisition under P. L. 91-646, considered for an on-site elevated rebuild or regarded as a non-participant in the program.

For existing structures that were not considered DSS prior to or as a result of Katrina damages, no project floodproofing funds would be used to bring the structure up to current DSS standards. Either private or other Federal or State funds may be used to attain any DSS requirements. Such additional, privately-funded construction could be accomplished during the floodproofing work by the contractor provided that such work would be described in a separate contract and paid for with non-Corps funds.

6.5.4 Structural Stability

Residential, commercial or institutional buildings that are determined by a qualified engineer or architect to be structurally unsound are not eligible to be elevated as a means of protecting the first floor form inundation. Any structures determined to be structurally unsound would only be eligible for either acquisition or an on-site, elevated rebuild.

6.5.5 Structure Use and Type

Feasible nonstructural options for structures are determined in part based upon the use and type of the structure or facility. Access requirements vary between residential, commercial and institutional uses considering ADA codes, service areas, parking needs, utility needs, lot size, zoning issues, and other characteristics of the building type and use. A critical facility may have stringent service area restrictions that severely limit options to move the structure from its local population. The ability to either protect a structure or facility in place or acquire or relocate the building is partially dependent upon its use or structure type.

6.6 Applicable Nonstructural Measures

6.6.1 General

Section 4.0 of this Appendix identifies and describes in detail the various types of nonstructural measures that could be applied to the project area for the purpose of reducing loss of life and flood damages as a result of storms and hurricanes along the coast. That section also makes a preliminary determination as the applicability of those individual measures to all or portions of the project area based upon the existing conditions, expected effectiveness of the measure itself in reducing damages and protecting lives and potential social, economic and environmental impacts. Based upon that determination, Table 12 provides an overview of the potential nonstructural measures that could be formulated into several plans either as single measures or as combinations of measures.

Table 12.
Applicable Nonstructural Measures

Measure Acronym	Measure Name
FWEE	Hurricane/Storm Flood Warning and Emergency Evacuation
FM&Z	Floodplain Management and Zoning (NFIP)
LLUR&Z	Local Land Use Regulation and Zoning
BC&E	Building Codes and Enforcement
FP	Floodproofing by Elevation and Other Means
PRM ACQ	Permanent Acquisition
DIF	Development Impact Fees
TDR & PDR	Transfer of Development Rights & Purchase of Development Rights
RELO	Replacements of Public Buildings

As this table shows there are a number of nonstructural measures that have been determined to be potentially effective in reducing damages and preventing loss of life in the project area. These nonstructural measures include three measures that could be primarily applied by Federal agencies (i.e. US Army Corps of Engineers (USACE) and Federal Emergency Management Agency (FEMA) using federal funds and locally supplied matching funds. Those measures are floodproofing (FP) by structure elevation or other means, permanent acquisition (ACQ) and replacements (RELO) of public buildings and facilities.

Prior to the process of formulating alternatives or plans using the above discussed measures, at least three steps must be taken to characterize the measures so that formulated plans do not contain conflicting measures or incomplete measures or that formulated plans have not correctly sized the measure. These three characterizations included scaling, dependency and combinability.

6.6.2 Scaling

Scaling addresses the appropriate sizing of each measure with respect to spatial coverage, timing of the measure application over the period of analysis, number and type of component processes, and size of the measure (number of units or parcels affected in nonstructural terms). In short, formulating 5 different acquisition programs consisting of differing numbers of units acquired would not constitute separate plans, just different scales of the same measure. Likewise formulating 4 alternatives/plans for floodproofing structures that would take place sequentially over 10 years would not constitute 4 separate plans, but one plan implemented over an extended period. Also, raising the level of protection offered by the nonstructural measures from a minimum BFE (approximately the 1% annual chance event) that meets local floodplain ordinances to several inundation depths (i.e. 20 ,30, or 40 feet of depth) would also be scaling the basic plan (i.e. Tables 25 through 29 for Plan NSC-6).

Finally, formulating plans composed of modified zoning or building codes for all 11 municipal areas would not constitute 11 separate plans but one plan applied in 11 separate areas – a scaling exercise. The appropriate scales for each of the nonstructural measures being considered will depend upon the wishes of the potential project sponsors (and the extent of their legal boundaries for those measures being implemented by local jurisdictions) and issues of combinability. In actual implementation, nonstructural measures can be applied to a single parcel of land or many thousands of parcels as funds and resources allow. The ability to have an infinite number of plan scales is one of nonstructural measures primary strengths.

6.6.3 Dependency

It is possible to have nonstructural measures that are dependent upon one another for their effectiveness. Obviously building codes are best applied when the structure has not been acquired from the lot and altering property taxes to discourage development works best when the property is in the ownership of a private individual rather than the county or municipal government (post acquisition OMRR&R). Many measures are not effective in the absence or presence of a structure on the particular tract of land. Independent measures should be grouped together as a single measure or at least depicted as working in concert to meet planning objectives.

6.6.4 Combinability

The concept of combinability addresses whether measures may or may not be mutually exclusive of one another. This character trait can be further divided into combinability with respect to location, function or overlap. Obviously in the nonstructural arena, one cannot both purchase and demolish a structure and then elevate that same structure as a floodproofed structure on the same lot. Once acquired and demolished, no structure is left on the site to elevate. In the same way, application of building codes on property where structures are acquired in the program and reserved for ecosystem restoration is impractical. Some nonstructural measures can negate the benefits of others: modification of the flood insurance program to suspend the program cannot co-exist with a measure to apply new structure design guidelines through the same suspended program. These issues of combinability can usually be addressed through a “pair-wise” matrix evaluation in which the measures are evaluated against one another to determine where conflicts or compatible measures may exist. The pair-wise comparison matrix for the above described measures is shown in Table 13.

Most notable in the table is the combinability and potential juxtaposition of improved components of the storm warning and emergency evacuation system, local land use controls, floodplain management, permanent acquisition, and various types of floodproofing across the project area. Since some of the measures require direct action to be taken on a property (acquisition and demolition, floodproofing or replacements) and others are primarily regulatory or administrative in nature, some of the measures are very combinable and reinforce each other in their application. Combining the flood warning system and emergency evacuation system improvements, upgraded building codes and floodplain management and zoning modifications with floodproofing by elevation on a single parcel (with an existing structure) accomplishes several of the planning objectives at minimal construction and annual O&M costs.

Being more than 80 miles in extent and addressing more than 70,000 individual parcels, the project area provides many opportunities for application of a variety of nonstructural measures that are usually applied on a lot-by-lot basis. In practice, adjacent structures can have different nonstructural measures applied to accomplish project objectives. These measures can be applied as a suite of components that would most effectively reduce damages and threats to loss of life. In some areas of the coast, careful application of these measures could approximate the “100%” solution to flood damages and loss of life with minimal OMRR&R costs while providing ecosystem restoration benefits as well.

Of particular note in the table is the combinability of some of the measures that work in a symbiotic relationship. Such a relationship exists between the flood warning and emergency evacuation measures and floodproofing by elevation or other means. Considering the uncertainty and risks associated with habitation of an elevated structure during a hurricane surge/wave event that may surround the structure, the NS PDT would not recommend that anyone seek shelter within an elevated structure. Therefore, the flood warning and emergency evacuation system is a necessity for a nonstructural program featuring so many potentially elevated structures. Likewise having a reliable and timely warning system enables the safe use of structure elevation to maintain community structure. Likewise, although many structures may be relocated from their present high-hazard location, upgraded building codes can be applied to reconstruction of new housing to resist hurricane force winds.

Nonstructural measures can be divided into two groups for the purposes of combinability. Those measures that concern modification of private and public structures and associated facilities or the ownership of the land upon which they are located and those measures that concern regulation, taxation, fees and assessments and enforcement of regulations and codes that apply to the land. By Congressional action the Corps can be authorized to implement certain nonstructural measures that result in modification of buildings and facilities through contractual arrangements with the landowners to reduce damages and loss of life. However, as certain private and public rights and responsibilities have been conferred to the states by the Federal government and then subsequently passed down to local governments as police powers, the Corps is unable to implement or administer certain nonstructural measures described in Section 4.0. These ‘local measures” can be just as effective in reducing damages although the benefit stream may be more difficult to identify for formulation processes. It is possible to combine both measures implemented by the Corps and measures implemented by local jurisdictions on one parcel of land and realize the full benefit potential of their combination.

Table 13.
Pair-wise Comparison of Nonstructural Measures

Measures	FWEE	FM&Z	LLUR&Z	BC&E	FP	PRM ACQ	DIF	TDR or PDR	RELO
FWEE		Compatible	Compatible	Compatible	Compatible and required	Compatible for new housing wind damages	Compatible	Not Compatible	Not Compatible
FM&Z	Compatible		Compatible	Compatible	Compatible	Not Compatible	Compatible	Not Compatible	Not Compatible
LLUR&Z	Compatible	Compatible		Compatible	Compatible	Not Compatible	Compatible	Compatible	Compatible
BC&E	Compatible	Compatible	Compatible		Compatible	Not Compatible	Compatible	Not Compatible	Compatible
FP	Compatible and required	Compatible	Compatible	Compatible		Not Compatible	Compatible	Not Compatible	Not compatible unless relocated structure is FP
PRM ACQ	Compatible for new housing (wind damages)	Not Compatible	Not Compatible	Not Compatible	Not Compatible		Not Compatible	Not compatible, but vacated land may be in PDR/TDR	Not Compatible
DIF	Compatible	Compatible	Compatible	Compatible	Compatible	Not Compatible		Not Compatible	Not Compatible
TDR or PDR	Compatible, wind related	Not Compatible	Not Compatible	Not Compatible	Not Compatible	Not compatible, but vacated land may be in TDR/PDR	Not Compatible		Not Compatible
RELO	Compatible, wind related	Not Compatible	Compatible	Compatible	Not compatible unless relocated structure is FP	Not Compatible	Not Compatible	Not Compatible	

FWEE = Hurricane/Storm Flood Warning and Emergency Evacuation
FM&Z = Floodplain Management and Zoning (NFIP)
RELO = Replacements of Public Buildings
LLUR&Z = Land Use Regulation and Zoning
BC&E = Building Codes and Enforcement
FP = Floodproofing by Elevation and other Means
PRM ACQ = Permanent Acquisition (a k.a. HARP)
DIF = Development Impact Fees
TDR & PDR = Transfer and Purchase of Development Rights

Table 14 shows a listing of the various nonstructural measures identified above and whether the Corps of Engineers or another Federal agency (FEMA) or State or local governments would be the appropriate entity to implement the measure. This table also indicates by this division of responsibility the various combinations of measures that could be instituted as a joint effort by the Federal government and the State and local governments in the project area. Of particular interest is the measure “Hurricane Warning and Emergency Evacuation” which has components that can be implemented by both the Federal and non-Federal partners. In addition, although permanent acquisition and floodproofing would normally be Federal roles, local entities could implement these components either through FEMA’s HMGP or as local initiatives financed through state resources.

Table 14.
Nonstructural Measures by Responsible Entity.

Responsible Entity	**Federal Government**	**State and Local Governments**
Measures		
Hurricane Warning and Emergency Evacuation	X	X
Floodplain Management and Zoning (NFIP)		X
Local Land Use Regulation and Zoning		X
Building Codes and Enforcement		X
Floodproofing	X	
Permanent Acquisition	X	
Development Impact Fees		X
Transfer or Purchase of Development Rights		X
Replacement of Public Buildings	X	

As these tables show, there are numerous individual measures that could be applied across the project area that would be effective to a certain degree in reducing damages and saving lives. As effective as some single nonstructural measures can be (i.e. just permanent acquisition or just floodproofing or just zoning) in reducing damages and loss of life, they would be applied on the notion of “one size fits all” and could fail to address longer term problems or result in unintended impacts. On the other hand, combinations of these measures have the potential for addressing not only damages that could be expected to occur in the short term (existing development) but long term potential damages that would occur due to different levels and types of future development. Combinations of measures can also be more “tailored” to the specific conditions at each neighborhood or community thus reducing anticipated socio-economic impacts.

The formulation process will address both single-measure plans and combined measures plans to determine the full range of possible nonstructural protection scenarios. As is the case with structural measures, differing levels of protection can be addressed by nonstructural measures by adjusting the measure’s response to inundation depths (i.e. floodproofing versus acquisition) or modifying the spatial coverage by each measure.

Since this appendix is accompanying a “Comprehensive Plan” that addresses the entire project area, nonstructural plans that could be tailored to a single community (i.e. Pascagoula) or a single planning unit (i.e. Harrison County) are not included in this formulation as they are scaled-down, more detailed plans of the more comprehensive alternatives described below. More detailed planning documents or implementation plans, formulated in collaboration with local jurisdictions would be needed address specific communities should construction authorization be provided.

6.7 Nonstructural Plans

6.7.1 Single-Measure Nonstructural Plans

Of the identified measures, eight measures could be applied singularly to meet one or a number of the planning objectives. The principals among those singular measures are:

- Permanent acquisition – High Hazard Area Risk Reduction Plan (HARP)
- Floodproofing by elevation or other methods (dry and wet)
- Replacements of Public Buildings
- Floodplain zoning and ordinance enforcement
- Upgrading and enforcement of existing building codes
- Land use regulations and zoning
- Flood Preparedness and Public Education
- PDR and TDR

Each of these measures implemented as a singular measure across the project area is able to reduce the incidence of flood damages and reduce the threats to life from storms and hurricanes. However, many of them, implemented as a single measure are unable to reduce all of the potential for future flood damages or loss of life along the coast. The closest single solution would be permanent acquisition of all structures damaged by Katrina or a specific subset of that population, but without significant changes to State laws and the economic base of the area, permanent acquisition cannot address all of the damages or threats to life either as described below. In addition, the social and economic impacts of a compete buyout of the project area are unacceptable to the population.

For the purposes of inter-agency and public recognition, the single-measure nonstructural plans have been designated with a two-letter prefix “NS” and all combined measure plans are designated with the prefix “NSC” (**N**on **S**tructural **C**ombined). The suffixes “HHZ” and “PA100” used for the single measure plans refer to “**H**igh **H**azard **Z**one” and “**P**ermanent **A**cquisition in the **100**-year flood zone” (a delineated zone in the flood insurance rate maps). Both numbers and letters (letters are used to designate scales of surge inundation in plans NSC-1 and NSC-6) are used to further differentiate the plans with the prefix NSC.

6.7.1.1 Permanent Acquisition – Katrina Level of Protection

A single-measure plan, featuring the permanent acquisition of all structures and facilities found to be eligible for the nonstructural program literally removes every structure and facility within the proscribed level of inundation across the entire coast. This measure could be implemented by the Federal government as a flood damage reduction program component. Application of a very high level of protection (i.e. Katrina level) would be very effective in reducing flood damages and threats to life from surge and waves generated by storms and hurricanes. In all, approximately 74,000 parcels of land would be purchased at an approximate cost of $17.0 billion (using an average cost per structure based upon RE estimates of nonstructural acquisitions). Although effective, acquisition of all eligible properties across the project area would be expensive when compared to other effective alternatives and would result in catastrophic consequences for the socio-economic fabric of the three counties and 11 municipal areas. Also, it has been determined that certain structures and facilities closely associated with the Gulf (ship-building, power plants, energy resource exploration and production) or locked to a location by State law (casinos) cannot be moved from their high-hazard location. For these reasons, a singular plan featuring permanent acquisition at a high level of protection (Katrina inundation or higher) should not be carried forward. However, permanent acquisition as a single measure for more modest levels of protection (1% annual chance event) or for specific high-hazard zones may be acceptable and cost effective (see Plans below).

Obviously, both of the following permanent acquisition plans would have to be closely coordinated with FEMA and HUD disaster-assistance programs currently being administered in the project area. Opportunities for landowners to “double-dip” into Federal funds would be carefully scrutinized by the agencies through sharing of databases on program participants. Initial coordination of the various programs between USACE, FEMA and HUD was undertaken prior to completion of this appendix.

6.7.1.1.1 Plan NS-PAHHZ - Permanent Acquisition of the High-Hazard Zone

Permanent acquisition of structures and property within the high-hazard zones identified in this appendix would significantly reduce damages and potential loss of life in this hazardous area. Approximately 14,900 parcels of land (including approximately 7,500 structures) are located in the high-hazard zones that could be acquired through the Uniform Relocations Act. Field observations indicated a substantial number of properties without structures (vacated parcels) in the high-hazard zones following Katrina. The proposed initial phase of the HARP may be able, if authorized and funded, to acquire a substantial number of the vacated parcels before new structures are rebuilt at an overall cost savings to the program. However, this alternative does not contemplate that many properties would be vacated when this plan is implemented. In view of the future-without-project condition predictions of redevelopment along the coast, this alternative assumes that a substantial number if not all properties would be rebuilt upon by the time the normal project implementation process begins to acquire parcels. The costs of this plan (acquisition, relocations assistance and demolitions) therefore are based upon structures being present on the parcels when the plan is implemented.

Approximately 57,000 acres of land could be acquired in the high-hazard zone were there to be 100 percent participation in the acquisition program. The vacated property could be used for ecosystem restoration of wetland habitat, passive recreation uses that are consistent with the identified flood hazard or just maintained as open space for passive public uses. Of the total acres that could be purchased in this zone, approximately 4,000 acres of land have been determined to be suitable for ecosystem restoration as wetlands.

Sufficient financial resources would be made available through the Uniform Relocations Act so that suitable replacement DSS housing could be secured for eligible households in this area. The estimated cost for real estate acquisition, relocations assistance and structure demolition for this alternative is $5.9B. This plan is identified as Plan NS–PAHHZ. The numbers of parcels to be acquired by reach and the costs are shown in Table 15. The high-hazard acquisition areas are displayed on Figures 56 through 60.

In addition to the cost of the real estate acquisition, relocations assistance and structure demolition associated with this alternative, the large number of displaced households may trigger the need for replacement DSS housing over and above what normal market resources could provide. Based upon current housing construction capacity in the project area, as much as 40 percent of the need may be unmet by the market area (based upon current levels of housing construction permits). In view of this anticipated shortage of suitable DSS housing, the plan would include several redevelopment sites (at least one in each county) that would hold approximately 3,000 residential lots. Lot sizes would vary within the redevelopment sites but would be no less than quarter-acre in size. At an average cost of $45,000 per lot for site acquisition, site development, infrastructure and site amenities, the total cost of these redevelopment sites would be approximately $135.0M

This alternative could be supplemented by the addition of either the TDR or PDR program to address redevelopment of interspersed property that was vacant prior to the destruction wrought by

Katrina. As this interspersed vacant property within the high-hazard zone was probably encumbered in some way so as to hinder development, either the TDR or PDR program could be applied to restrict any future development that would be subject to inundation damages. Development right values would be established through comparison of tax assessments for the "with" and "without" development scenarios. Either of the two programs would be administered as a joint effort by the counties and municipalities with an estimated start-up cost of $1.5M. Annual costs for the TDR program would be local and minimal administrative expenditures while the PDR annual costs could be supplied by the state and local jurisdictions and would reflect a percentage of the total assessed value of those properties.

The High Hazard Area Risk Reduction Plan (HARP) could be an initial component of this alternative whereby the highest-risk properties that were vacated (structures demolished) by Katrina and not as yet rebuilt upon could be acquired at a fraction of the cost that would be required once a new structure is rebuilt. Avoiding the costs of acquiring a new structure, relocations assistance (for relocating a household to a DSS replacement house) and demolition of the existing home would significantly reduce the overall program cost and assure that families would not be re-entering a high-hazard area. The estimated cost of the initial HARP program is $397.0 M and would affect approximately 2,000 parcels. Those 2,000 initial acquisitions would be extracted from the designated high-hazard zone (approximately 7,400 total vacated parcels in the HHZ) extending the east-west length of the project area. Figure 52 shows areas with potential for restoration of high quality wetland ecosystems that are within that acquisition footprint.

Table 15 – Plan NS-PAHHZ
Permanent Acquisition in the High-Hazard Zones

Economic Reach	County	Parcels for Acquisition	Cost
1	Hancock	0	0
2	Hancock	1056	$459,548,812
3	Hancock	2099	$851,631,850
4	Hancock	823	$202,919,893
5	Hancock	971	$107,653,678
6	Hancock	210	$114,862,969
7	Hancock	125	$9,562,216
8	Harrison	1565	$431,782,512
9	Harrison	5	$6,652,740
10	Harrison	1695	$736,216,496
11	Harrison	0	0
12	Harrison	450	$138,318,777
13	Harrison	595	$821,785,431
14	Harrison	0	0
15	Harrison	66	$88,566,796
16	Harrison	36	$14,594,008
17	Harrison	0	0
18	Harrison	285	$608,152,730
19	Harrison	12	$17,246,403
20	Harrison	1150	$316,031,090
21	Jackson	2082	$695,355,710
22	Jackson	62	$39,368,916
23	Jackson	0	0
24	Jackson	138	$45,373,108
25	Jackson	0	0
26	Jackson	31	$11,221,913
27	Jackson	37	$5,996,209
28	Jackson	583	$10,167,976

Economic Reach	County	Parcels for Acquisition	Cost
29	Jackson	132	$14,287,454
30	Jackson	81	$24,818,841
31	Jackson	37	$9,281,900
32	Jackson	0	0
33	Jackson	0	0
34	Jackson	0	0
35	Jackson	0	0
36	Hancock	0	0
37	Hancock	0	0
38	Hancock	0	0
39	Harrison	0	0
40	Harrison	0	0
41	Jackson	0	0
42	Jackson	0	0
43	Jackson	0	0
44	Jackson	0	0
45	Jackson	0	0
46	Jackson	0	0
47	Harrison	0	0
48	Harrison	0	0
49	Harrison	0	0
50	Harrison	96	$24,190,783
51	Jackson	0	0
52	Jackson	275	$68,789,089
53	Jackson	300	$46,723,811
54	Jackson	0	0
Subtotals		14,997	$5,921,102,106
H&CD sites	Jackson, Harrison, Hancock	3,000 constructed lots	$135,000,000
Total cost			**$6,056,102,106**

Based upon the county assessors data and the future without project conditions scenarios, there could be as many as 14,997 structures located on the HHZ parcels by 2012. Costs for acquisition, relocations assistance and structure demolitions are included in the total cost.

Figure 56– Plan NS- PAHHZ – Permanent Acquisition in HHZ (A1)

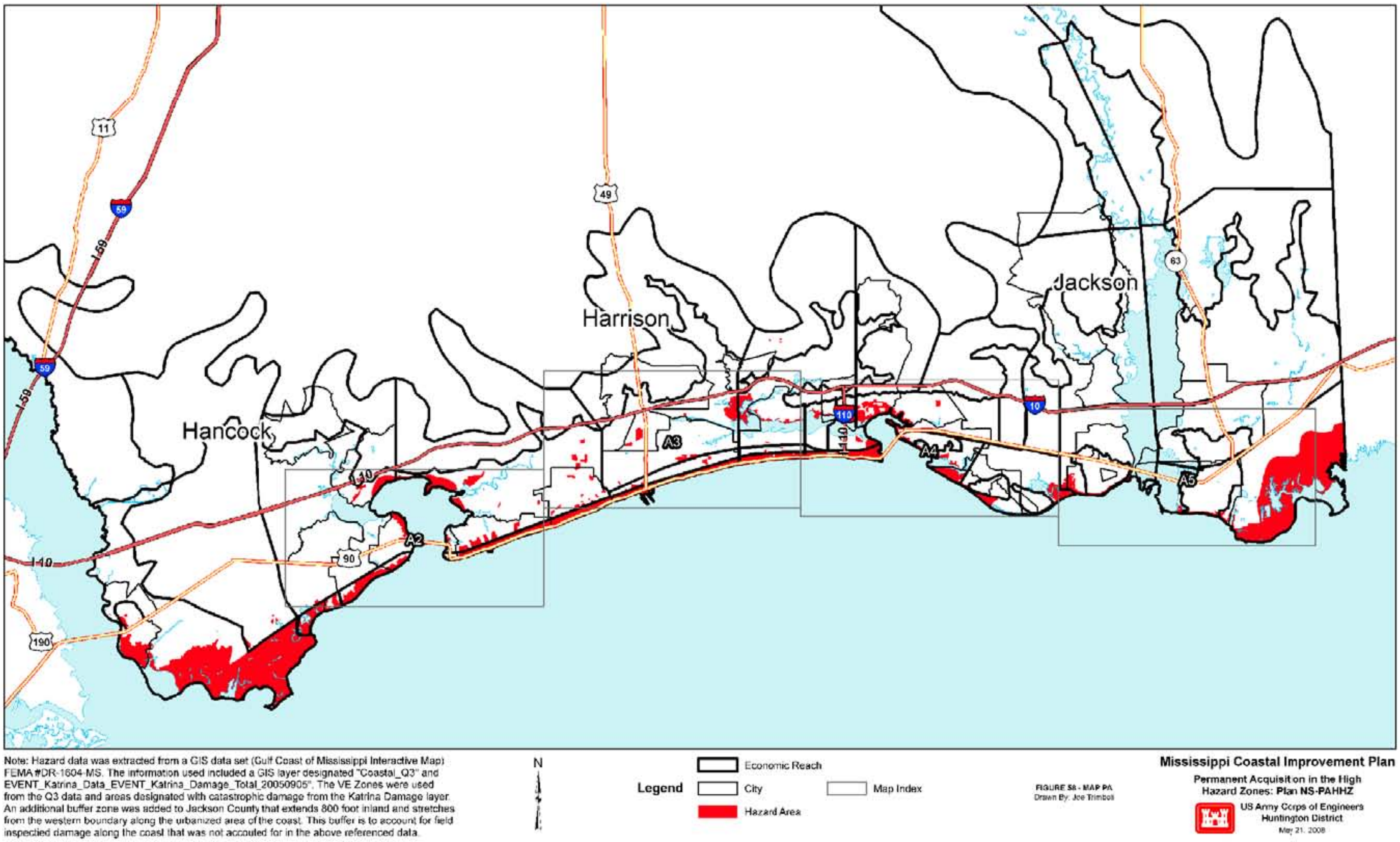


Figure 57 – Plan NS- PAHHZ Permanent Acquisition in HHZ (A2)

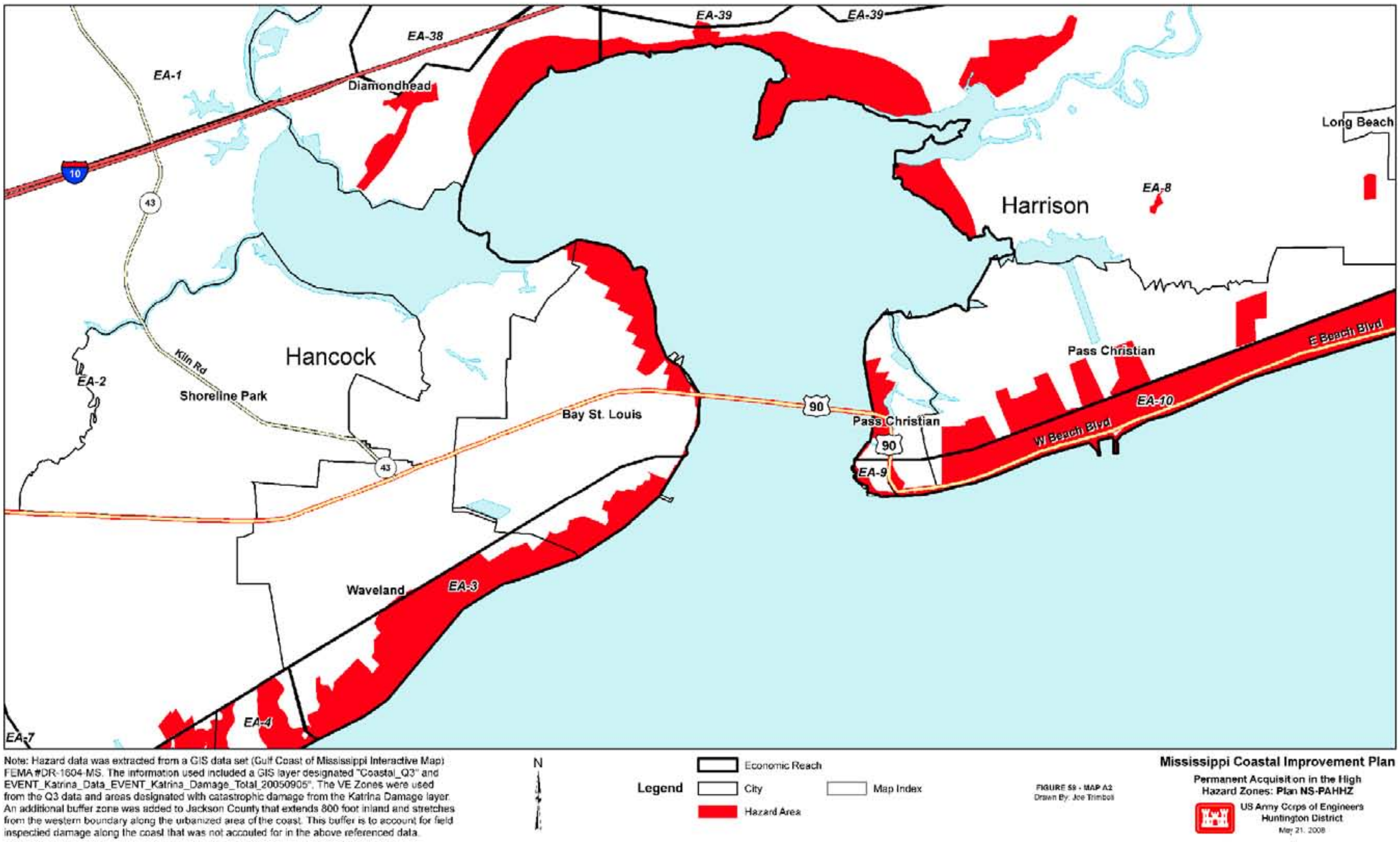


Figure 58 – Plan NS – PAHHZ Permanent Acquisition in HHZ (A3)

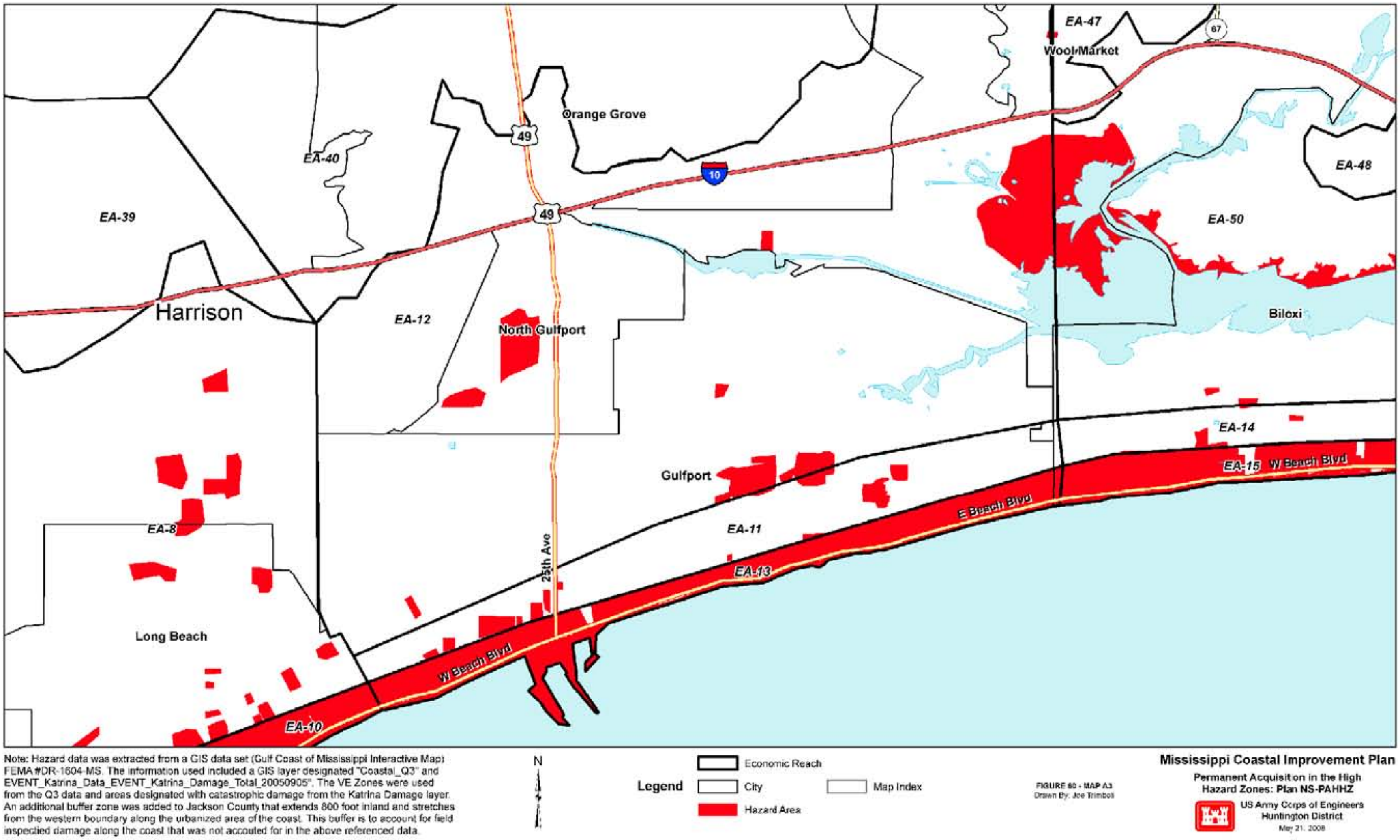


Figure 59 – Plan NS- PAHHZ Permanent Acquisition in HHZ (A4)

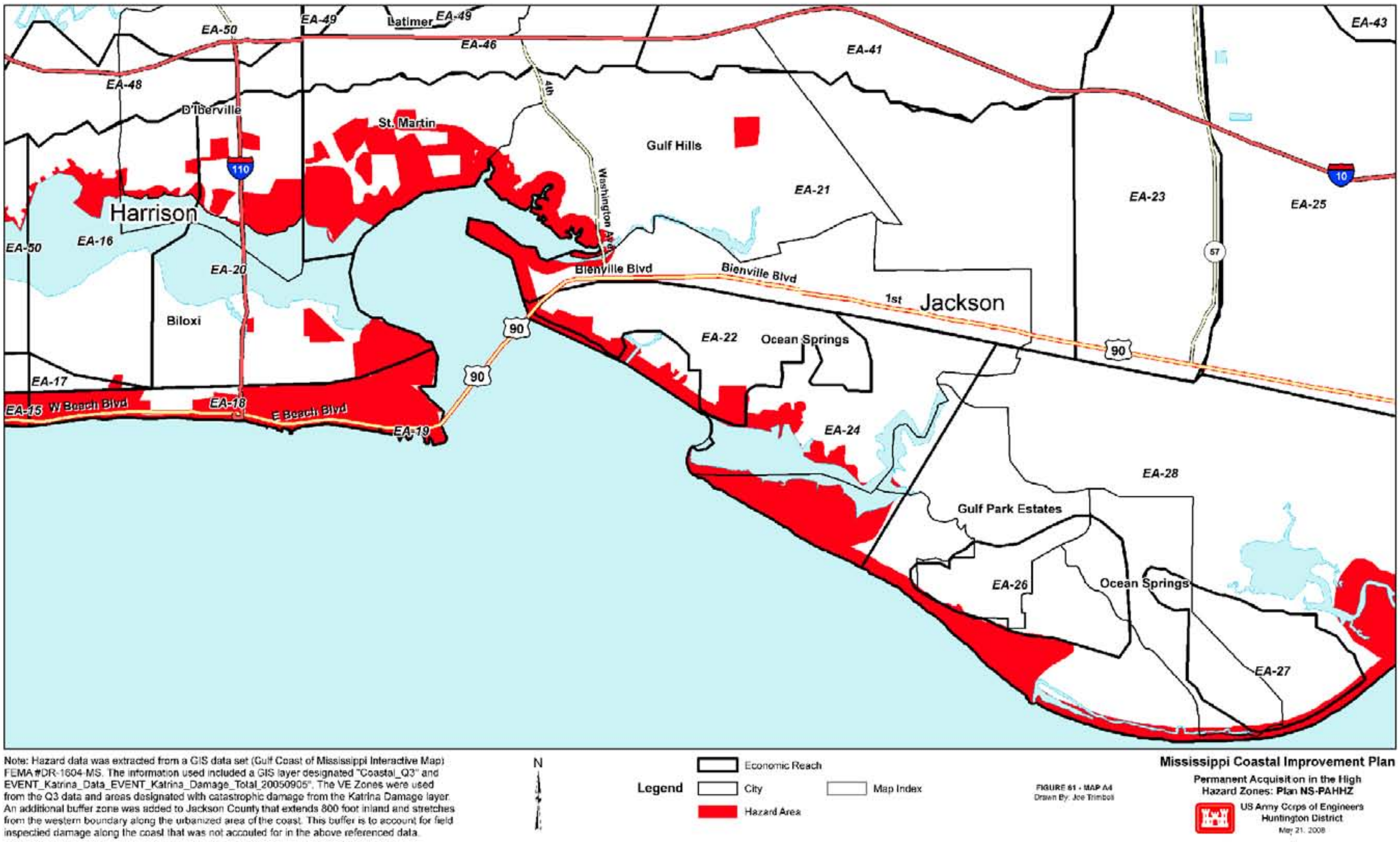
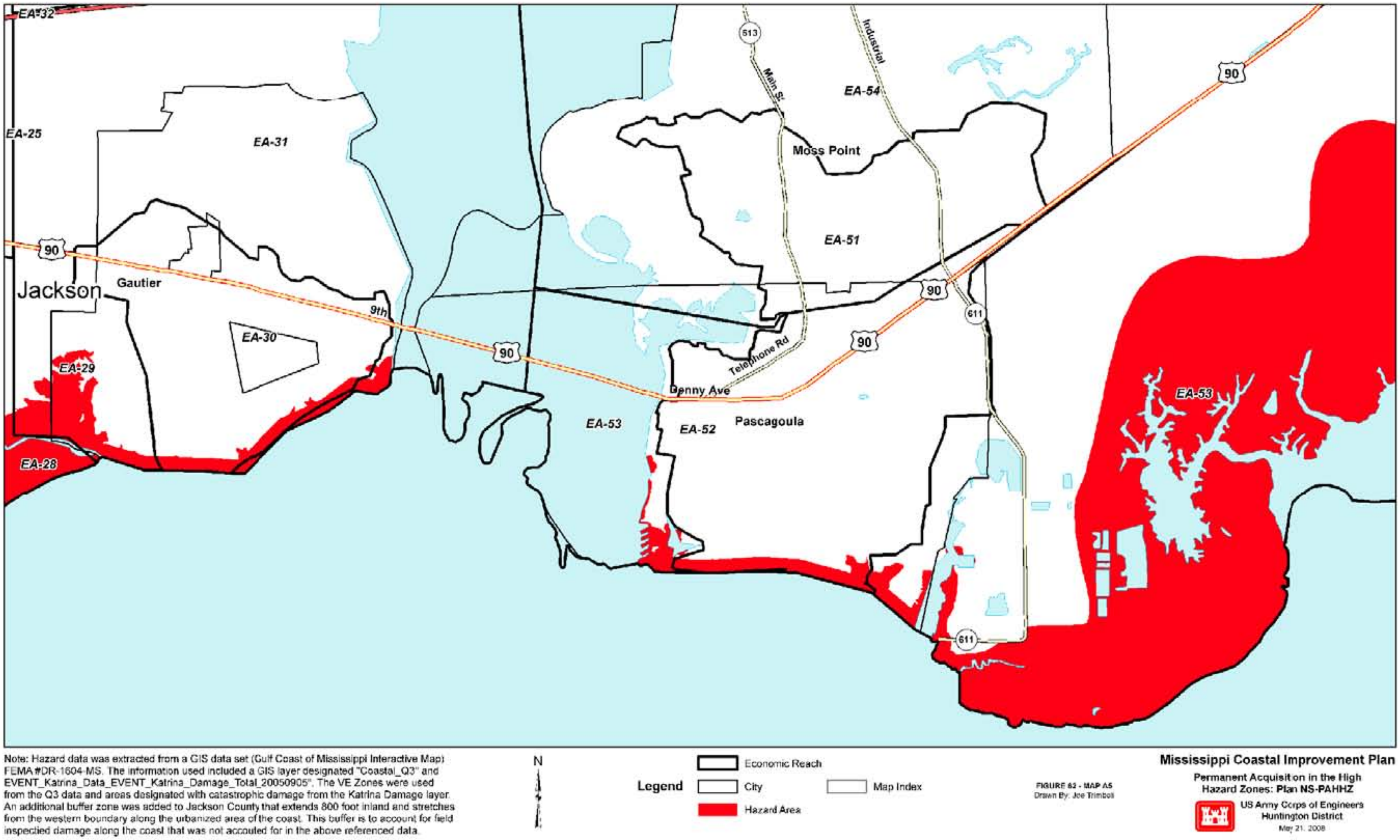


Figure 60 – Plan NS- PAHHZ Permanent Acquisition in HHZ (A5)



6.7.1.1.2 Plan NS-PA100 - Permanent Acquisition within the One Percent Annual Chance Floodplain

Permanent acquisition of structures and property within the FEMA-designated 1% annual chance floodplain (as amended by the adoption of the ABFE's by the communities) that are located within the high-hazard zones and in areas where water depths exceeded 13 feet would significantly reduce future flood damages and threats to life by storms and hurricanes. Approximately 33,200 parcels of land (approximately 17,100 structures) are located within these two areas that could be purchased through the Uniform Relocation Act (P. L. 91-646). Field observations indicated a large number of vacated parcels within the high-hazard zone. This plan contemplates that most if not all of the interspersed parcels originally made vacant by Katrina would be redeveloped by the time this acquisition option was implemented as described in the future without-project condition. Therefore the cost of the plan (acquisition, relocations assistance and demolitions) reflects structures and families in place when the plan would be implemented.

Approximately 57,000 acres could be purchased in the high-hazard zones were there to be 100 percent participation in the acquisitions program. Of that total, approximately 4,000 acres have been determined to be suitable for ecosystem restoration of wetlands. An additional 37,000 acres of land could be purchased within the area where water depths exceeded 13 feet were there to be 100 percent participation in the acquisitions program in that zone. Of that total acres approximately 5,200 acres of land has been determined to be suitable for ecosystem restoration as wetlands. In total over 9,000 acres of wetlands could be restored as a result of the purchase and restoration of these hazard zones.

Sufficient financial resources would be provided through the Uniform Relocations Act so that suitable replacement DSS housing could be secured for each household in this buyout area. The vacated property could be used for ecosystem restoration of wetland habitat, passive recreation consistent with the flood hazard or just maintained as open space for public uses. The estimated cost of land and structure acquisition for this alternative is $7.9B. This plan is identified as Plan NS-PA100. The numbers of parcels to be acquired by reach and the costs are shown in Table 16. The acquisition areas within the 1% annual chance area (as amended by the adoption of the ABFE by the communities) are shown in Figures 61 through 65.

In addition to the cost of the real estate acquisition, relocations assistance and structure demolition associated with this alternative, the large number of displaced households would probably trigger the need for replacement DSS housing over and above what normal market resources could provide. Based upon current housing construction capacity in the project area, as much as 40 percent of the need may be unmet by the market area. In view of this anticipated shortage of suitable DSS housing, the plan would include several redevelopment sites (at least one in each county) that would hold approximately 6,000 residential lots. Lot sizes would vary within the redevelopment sites but would be no less than quarter-acre in size. At an average cost of $45,000 per lot for site acquisition, site development, infrastructure and site amenities, the total cost of these redevelopment sites would be approximately $270.0M. Added to the total land acquisition figure above, the total plan cost would be $8.2B.

This alternative could be supplemented by the addition of either the TDR or PDR program to address redevelopment of interspersed property that was vacant prior to the destruction wrought by Katrina. As this interspersed vacant property within the high-hazard zone was probably encumbered in some way so as to hinder development, either the TDR or PDR program could be applied to restrict any future development that would be subject to inundation damages. Development right values would be established through comparison of tax assessments for the "with" and "without" development scenarios. Either of the two programs would be administered as a joint effort by the counties and municipalities with an estimated start-up cost of $1.5M. Annual costs for the TDR program would be local and minimal administrative expenditures while the PDR annual costs could be supplied by the state and local jurisdictions and would reflect a percentage of the total assessed value of those properties.

The High Hazard Area Risk Reduction Plan (HARP) could be an initial component of this alternative whereby the highest-risk properties that were vacated (structures demolished) by Katrina and not as yet rebuilt upon could be acquired at a fraction of the cost that would be required once a new structure is rebuilt. Avoiding the costs of acquiring a new structure, relocations assistance (for relocating a household to a DSS replacement house) and demolition of the existing home would significantly reduce the overall program cost and assure that families would not be re-entering a high-hazard area. The estimated cost of the initial HARP program is $397.0 M and would affect approximately 2,000 parcels. Those initial 2,000 parcels would be extracted out of the high hazard zone footprint that extends the entire east-west length of the project area. Figure 52 shows the potential high-quality wetland ecosystem restoration areas where the HARP acquisitions may occur.

Table 16 – Plan NA-PA100
Permanent Acquisition within the 1% Annual Chance Zone (ABFE-2 feet)

Economic Reach	County	Parcels for Acquisition	Cost
1	Hancock	997	$194,118,218
2	Hancock	9911	$2,990,789,131
3	Hancock	2202	$668,691,437
4	Hancock	922	$120,307,916
5	Hancock	2714	$238,362,794
6	Hancock	567	$107,292,775
7	Hancock	450	$33,210,174
8	Harrison	3623	$476,088,333
9	Harrison	44	$16,132,783
10	Harrison	1945	$432,581,234
11	Harrison	0	$0
12	Harrison	1047	$179,614,825
13	Harrison	650	$583,121,543
14	Harrison	0	$0
15	Harrison	85	$44,354,843
16	Harrison	78	$16,399,728
17	Harrison	0	$0
18	Harrison	1502	$409,411,532
19	Harrison	46	$292,728,063
20	Harrison	1397	$238,433,082
21	Jackson	2108	$301,798,272
22	Jackson	61	$26,330,663
23	Jackson	0	$0
24	Jackson	220	$65,229,820
25	Jackson	0	$0
26	Jackson	37	$9,210,336
27	Jackson	53	$12,880,944
28	Jackson	961	$90,294,697
29	Jackson	147	$23,394,829
30	Jackson	90	$29,459,003

Economic Reach	County	Parcels for Acquisition	Cost
31	Jackson	51	$14,946,829
32	Jackson	1	$216,228
33	Jackson	0	$0
34	Jackson	0	$0
35	Jackson	12	$682,228
36	Hancock	32	$3,834,485
37	Hancock	0	$0
38	Hancock	50	$21,424,866
39	Harrison	0	$0
40	Harrison	0	$0
41	Jackson	0	$0
42	Jackson	0	$0
43	Jackson	0	$0
44	Jackson	0	$0
45	Jackson	0	$0
46	Jackson	0	$0
47	Harrison	0	$0
48	Harrison	0	$0
49	Harrison	0	$0
50	Harrison	495	$89,247,661
51	Jackson	0	$0
52	Harrison	285	$102,951,211
53	Harrison	399	$113,015,335
54	Jackson	9	$1,114,862
Subtotals		33,191*	$7,947,670,680
H&CD Sites	Jackson, Harrison, Hancock	6,000 constructed lots	$270,000,000
Total Cost			**$8,217,670,680**

* This parcel total (33,191) includes 17,144 structures anticipated to be redeveloped by 2012 in the future-without-project condition - this anticipated condition is reflected in the total cost.

Figure 61 – Plan NS - PA100 Permanent Acquisition in 1% Annual Chance Flood Zone (A1)

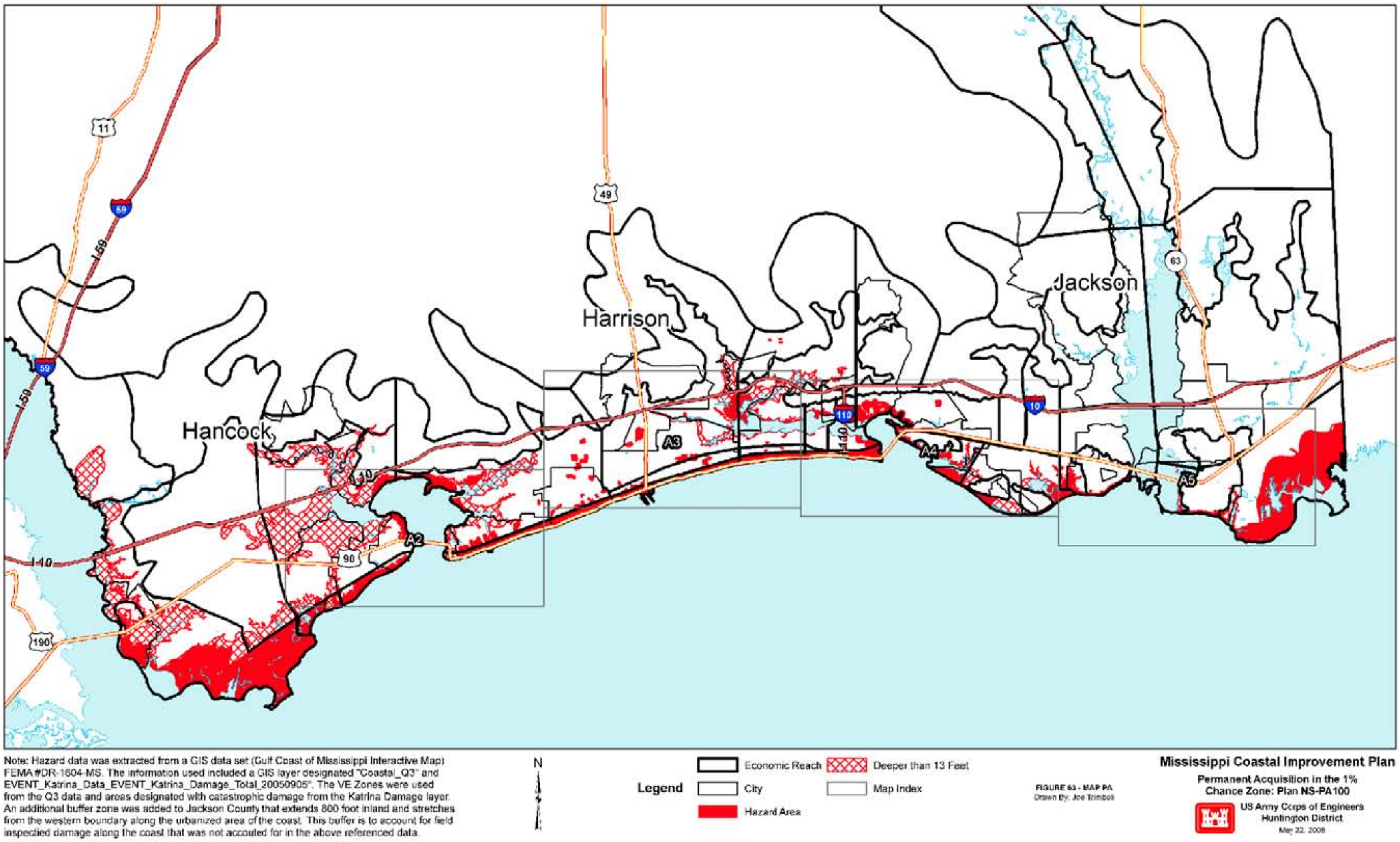


Figure 62 – Plan NS- PA100 Permanent Acquisition in 1% Annual Chance Flood Zone (A2)

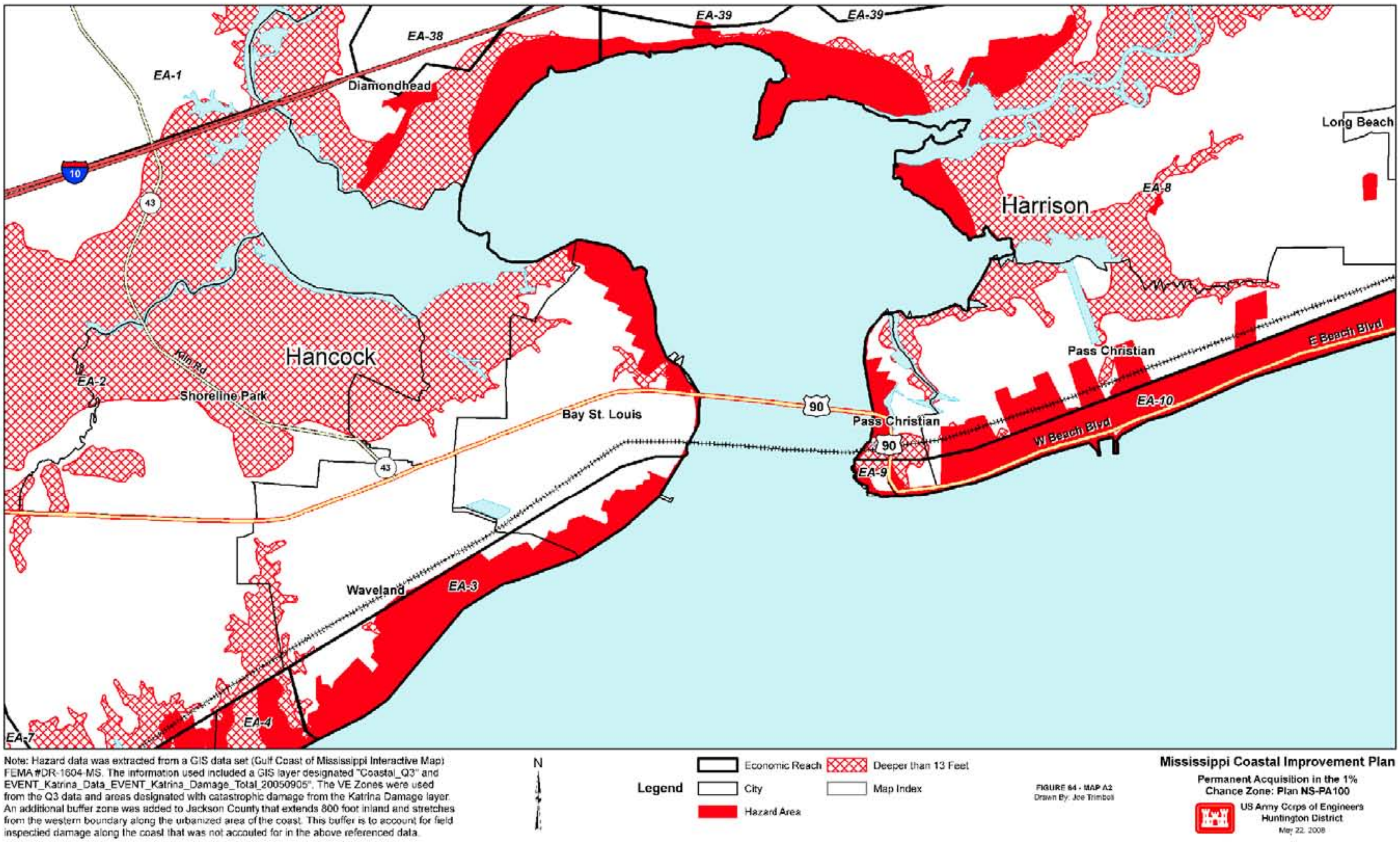


Figure 63 – Plan NS – PA100 Permanent Acquisition in 1% Annual Chance Flood Zone (A3)

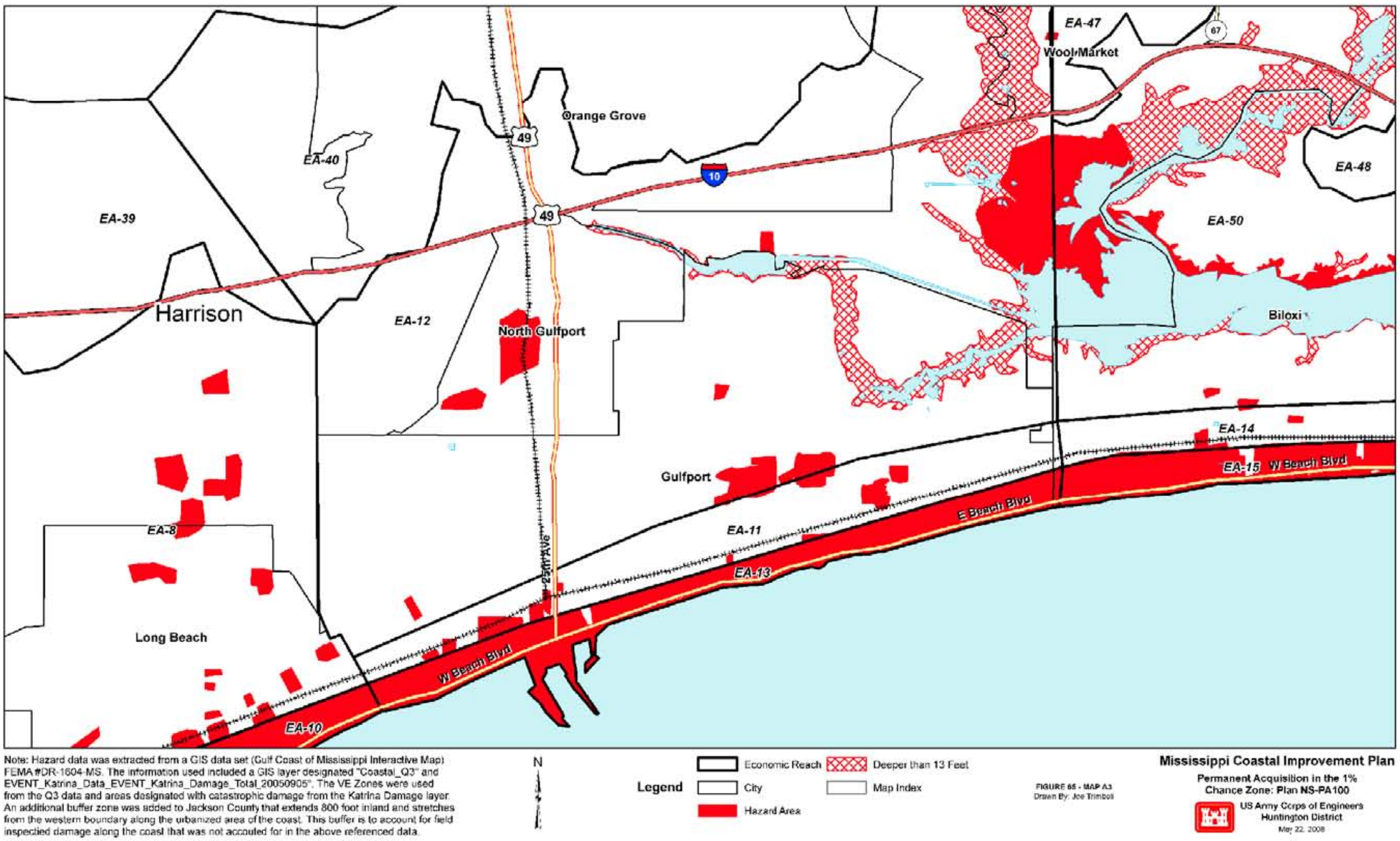


Figure 64 – Plan NS-PA100 Permanent Acquisition in 1% Annual Chance Flood Zone (A4)

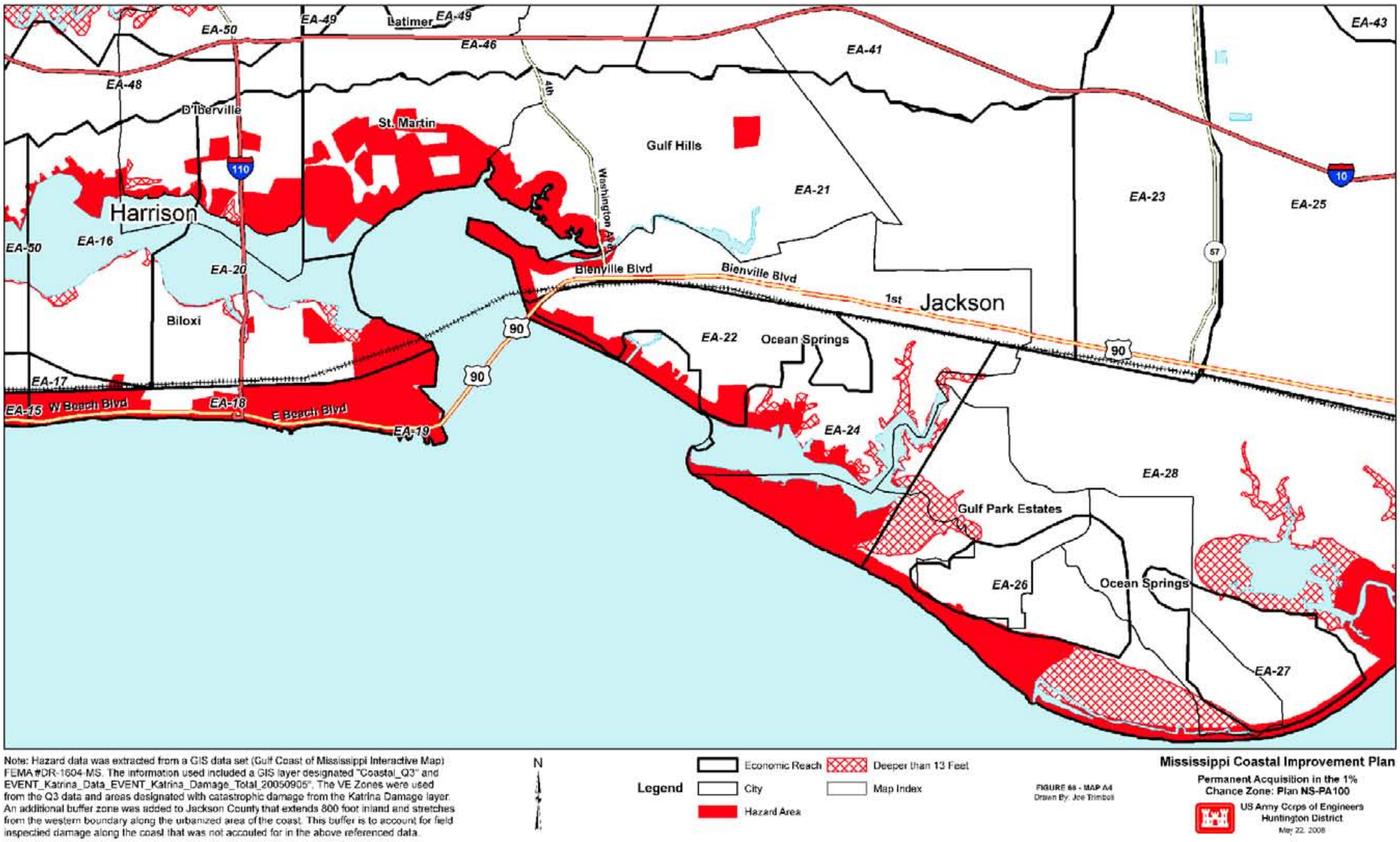
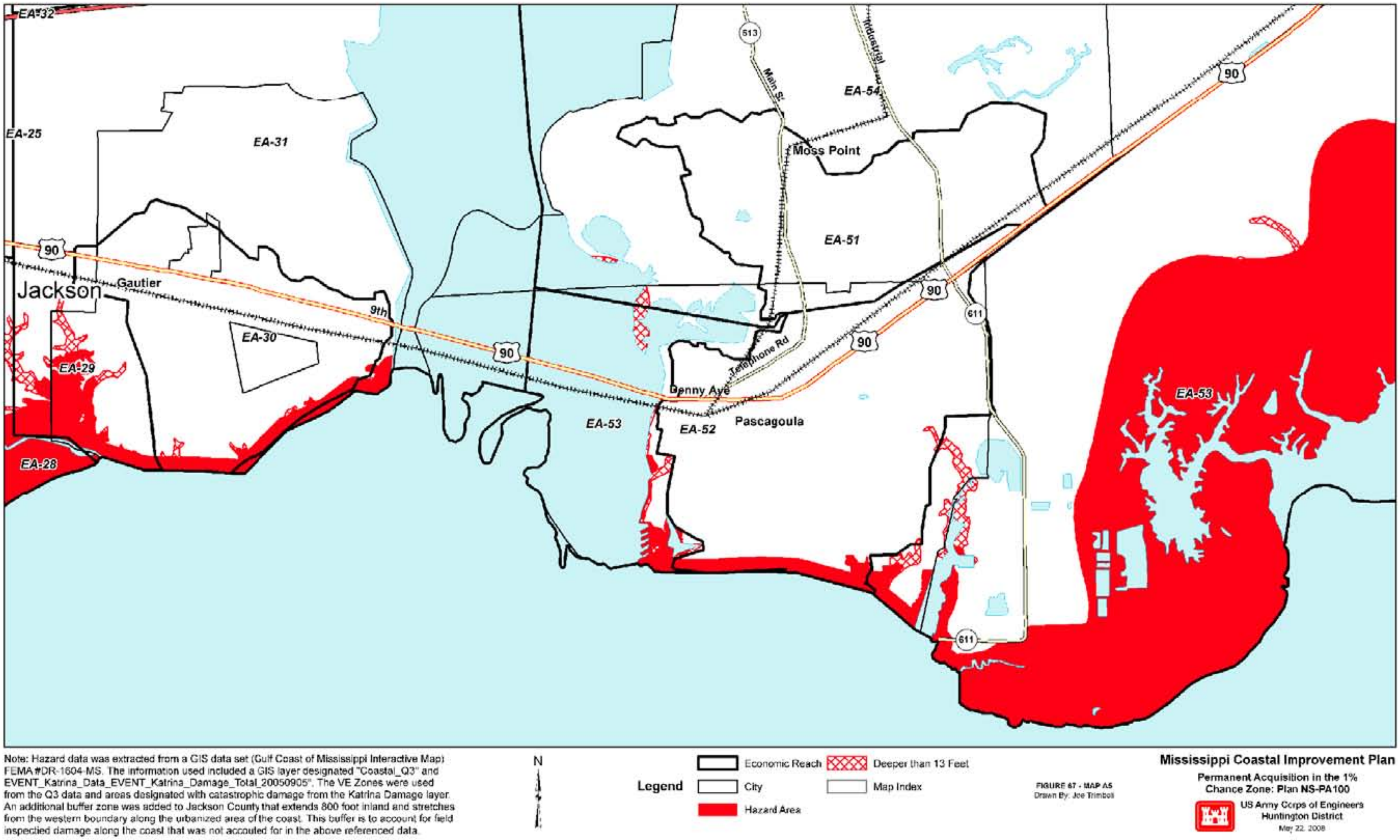


Figure 65 – Plan NS- PA100 Permanent Acquisition in 1% Annual Chance Flood Zone (A5)



6.7.1.2 Floodproofing

A single-measure plan, featuring floodproofing activities and using both dry and wet floodproofing techniques including ringwalls, ring-levees, elevation and veneer walls would significantly reduce flood damages in the project area. This measure could be implemented by the Federal government as a component of the flood damage reduction program. Unfortunately, because of the restrictions of height for elevation (15 feet maximum height of raise), excessive depths of inundation where veneer walls are impractical and unsafe and limited space for constructing ringwalls and ring-levees on small urban lots, a single measure featuring floodproofing would not address many of the structures and facilities at risk. In addition, although there are many parcels located within the project area where the combination of surge and waves would not be a limiting factor, many thousands of parcels are located in high-hazard surge and wave zones where floodproofing in any manner for certain types of structures would be dangerous.

Also, implementing a single-measure floodproofing plan without adding improvements to the existing flood warning and emergency evacuation system could result in many structure owners deciding to "ride-out" a hurricane that could seriously endanger not only their lives but the lives of rescue personnel. This single measure plan would address approximately 25,400 parcels of land in the project area and would cost approximately $10.8B. Based upon the limitations of floodproofing due to inundation depths, surge and wave dangers, and spatial constraints and the necessity of adding all proposed upgrades to the existing flood warning and emergency evacuation plan, a single measure plan featuring floodproofing should not be carried forward. Floodproofing has been included as an effective measure in some of the combined-measure plans described below.

6.7.1.3 Replacements

A single-measure plan, featuring the replacement of public buildings would be effective in protection of many of the critical facilities located in the project area. Since these structures and the services they provide (i.e. police, fire, city administration, emergency management, education, etc.) are considered critical to the everyday life and security of the communities that they serve, protection of them by either floodproofing in-place (see above) or replacement to a flood-safe site is a significant component of any protection plan. Data from FEMA's HAZUS program and local tax assessments indicates that at least 75 buildings and facilities in the project area are considered to be "critical facilities". Of those, many are publicly-owned and operated. A total of 49 were found to be attached to identified-parcels within the project database. Of those, 7 may be eligible for replacement in lieu of acquisition and the balance would be eligible for some form of protection (floodproofing) in place. Based upon preliminary information on the types and uses of those structures and their approximate locations, the cost of replacing the 7 structures would be approximately $51.3M. Although this measure would be an effective method of addressing damages to these important facilities, replacement/relocation accomplished in accordance with Corps Real Estate regulations does not address the other privately-owned facilities considered also to be critical (privately owned schools, medical facilities, etc.) or the vast numbers of residential and commercial structures that are also at risk from inundation. Therefore, replacement/relocation of public facilities as a single measure plan would not be an effective alternative by itself. Replacement or relocation of public structures as a means of reducing damages is included in some of the combined plans described below.

6.7.1.4 Floodplain Zoning/Floodplain Management Ordinances

A single-measure plan, featuring floodplain zoning and floodplain management ordinance enforcement could be very effective in many locations within the project area. Implemented by the 11 municipalities and 3 counties in the project area, these measures would affect approximately 74,000 separate parcels of land (exceptions being military bases and installations). This measure would be implemented solely by the local governments with technical input from FEMA. Estimated cost for applying this measure across all parcels is approximately $280,000. Although the combination of these two activities seldom is effective in reducing damages to existing structures and reducing threats to life because of the existence of “grandfathered” development, the number of empty lots across the project area that would be subject to more stringent zoning and ordinances that dictate development makes this singular measure palatable and effective. Current floodplain zoning based upon previous ordinances could be replaced with more stringent ordinance requirements and floodplain mapping based upon updated Digital Flood Insurance Rate Maps (DFIRM’s) being prepared by FEMA. As the municipalities and counties adopt and enforce more stringent regulations based upon updated mapping, potential damages and losses of life from future storms and hurricanes to new development would be lessened significantly.

Ironically, a significant number of structures and facilities did survive Katrina’s onslaught with rather minor damages; damages that would not trigger all of the new requirements for elevating structures above the modified BFE or result in any significant improvements in the structure to resist storm damages. However, of the many modifications to the NFIP that could be instituted, instituting cumulative storm-related damages over a period of years (that period to be determined locally) as the trigger for requiring compliance with NFIP regulations and local floodplain management ordinances is worthy of consideration. In fact the City of Pascagoula already has instituted this procedure as a part of their local floodplain ordinance administration. Outside of the ordinance requirements under the NFIP there are few incentives to retrofit existing structures or adhere to upgraded building codes if new requirements are not strictly enforced locally. For this reason, floodplain zoning and floodplain management ordinance enforcement as a single measure plan should not be carried forward. However, both of these measures (upgraded zoning and ordinance enforcement) are used in combined plans described below.

6.7.1.5 Building Codes

A single-measure plan, featuring updated building codes based upon new versions of the IBC and the FEMA 550 guidelines could substantially reduce storm damages to new construction in those areas where units were totally destroyed by Katrina. Implemented by the 11 municipalities and 3 counties these codes would affect over 74,000 parcels and existing or new structures. Other buildings (residential. commercial and institutional) damaged less severely by Katrina would be subject to these updated codes for repairs resulting in some reduction of future damages. Costs for upgrading and applying the buildings codes is negligible since the administration and enforcement of the building codes is supported by building construction permit fees.

However, as in the case of floodplain zoning and floodplain management ordinance enforcement, there are many structures and facilities that were only minimally damaged by Katrina and they would be largely unaffected by the new building codes and therefore still susceptible to flood damages. Although the institution of updated building codes and the FEMA 550 guidelines would reduce future damages to new construction and those structures requiring substantial repairs as a result of Katrina, as a single measure building codes do not address a sufficient number of the planning objectives to be carried forward. Instituting upgrades to the existing building codes and conducting educational seminars for those people in the design, construction, inspection, real estate and mortgaging professions who would be using the codes are included in some of the combined plans described below.

6.7.1.6 Land Use Regulation and Zoning

A single-measure plan, featuring modification and enforcement of new land use zoning by the local governments on areas inundated by Katrina (or any lesser area of inundation) could significantly reduce damages and threats to life by inundation from storms and hurricanes. As described in Section 4.3.4, land use zoning applied through the police powers of counties and municipalities can direct the types and densities of development that occur in each regulated area. Owing to that fact that so many structures were totally destroyed by Katrina and that redevelopment of those areas has been largely delayed due to lack of rebuilding capital and updated floodplain mapping, it would be possible to modify existing zoning ordinances such that either redevelopment of high-hazard areas was severely restricted (restrictions that may trigger a taking and therefore be more like the permanent acquisition measure) or that redevelopment of high-hazard areas was permitted for only those uses that could afford to invest sufficient funds to provide the high levels of protection needed in that area.

Implementation of these zoning changes to the approximately 7,500 parcels contained within the high-hazard zones could dramatically reduce future damages during redevelopment. Rezoning all of the project area where the most severe damages occurred (total destruction of buildings and facilities) to open space or recreation park land (devoid of damageable structures) may result in a determination that such a diminution of property value and use by private owners would constitute a taking and require full compensation of its market value. In effect, that result would be much like the single measure of permanent acquisition described above.

On the other hand, rezoning of those same areas that would permit mixed-use development featuring high-density commercial (casinos and malls) and high-density residential (condominiums) in structures elevated above pre-determined inundation levels could provide numerous local benefits and meet several of the planning objectives. Such mixed-use high density zoning along the beachfront area could encourage high-end developers to invest the required resources needed to create multi-story structures perched upon layers of parking garages that would be able to withstand the rigors of future storms and hurricanes. An example of this type of zoning is the present location of the Beau Rivage casino and hotel complex at Biloxi, MS. That sturdily-constructed complex weathered the Katrina storm with relatively minor damages compared to other beachfront structures.

This rezoning concept would confer great value on beachfront property that in a post-Katrina market has far less value in the hands of single-family homeowners, would potentially create additional jobs and tax revenues through construction and operation of the mixed use development, could generate additional tourism along the coast, and could create a wave and wind shadow effect for redevelopment located farther inland from the beach area. Large, well-designed and constructed mixed use buildings with first floors appropriately elevated on parking garages to reduce flood damages would provide many benefits to the local economy as well as addressing the reduction of damages and through improved emergency evacuation procedures reduce loss of life along the coast. In effect, current landowners along the beachfront would have the option to sell their land to potential developers at an inflated price above that now available and with appropriate application of floodplain zoning ordinance requirements and building codes, investors could make the best use of this prime beachfront property.

Careful rezoning of the lands subject to inundation by storms and hurricanes could attain one or more of the planning objectives, but accomplishing the rezoning would fall into the hands of the local municipal and county governments. The Federal government is not able to direct or otherwise coerce local governments to rezone private property as a plan alternative. Similar to the concept of allowing local floodplain zoning and ordinance administration to control new development on vacated property (in lieu of offering federal funds to elevate new structures on interspersed vacant land) and thereby accomplish planning objectives with no cost to the project, allowing rezoning of high-hazard areas such that permitted uses would be substantially protected from future damages would lead to the same benefits at no Federal cost. The estimated cost of modifying the existing zoning along the coast is approximately $500,000 including modification of or amendments to local comprehensive plans that support local zoning ordinances. This single measure is not carried forward as a separate plan into the formulation process since it primarily reduces damages on future development and would have little effect on existing structures, but this measure is included in some of the combined plans described below.

6.7.1.7 Flood Preparedness and Public Education

A single-measure plan, featuring flood preparedness and public education would be effective in meeting portions of the planning objectives. Implementing various components of an improved storm warning system and emergency evacuation plan across the project area could significantly reduce the threats to life from storms and hurricanes and possibly reduce damages to structure contents that could be moved out of the inundation zone prior to the arrival of the storm event. In all, approximately 74,000 parcels of land, the structures on them and the families and individuals living within them would be provided an increased level of protection for structure contents and loss of life.

A sustained program of public education regarding the potential threats posed by storms and hurricanes applied to all sectors of the resident and itinerant population in the project area could significantly increase the population's awareness of the dangers and options for reducing the threat. A good public education program could save lives in the event of another large hurricane. The estimated cost of applying this measure across the project area is $2.9M. Unfortunately, without the application of other nonstructural measures, structures and facilities left behind by fleeing residents or business owners would still be subject to inundation damages. Some improvements to structures and facilities as a part of the flood preparedness measures could be undertaken to reduce building damages, but without other measures (i.e. floodproofing, acquisition, building codes, etc.) structure and facility damages would still occur. Therefore, as a singular measure plan, flood preparedness and public education was not carried forward. Flood preparedness and public education was included in some of the combined plans as described below.

6.7.1.8 Transfer of Development Rights and Purchase of Development Rights

A single-measure plan consisting of transfer of development rights and/or purchase of development rights could be effective in addressing interspersed properties within hazard zones that were vacant prior to Katrina or were vacated as a result of Katrina. If these programs were instituted by the three counties in cooperation with the municipal areas, future development of interspersed vacant private property in hazard zones that are entered into either of the two programs could be thwarted (mitigated by cash payments from receiving property owners) thus reducing future flood damages. Likewise, receiving areas designated under a TDR program would be given the opportunity to develop flood-free property at higher densities that could provide housing for displaced landowners within the hazard areas. Under the PDR option, owners of interspersed vacant properties in hazardous zones would sign over their rights to further develop their property for a lump sum of cash provided by the implementing local entity. According to RE data, over 33,000 interspersed vacant parcels exist within the project area, many of which are located within the high-hazard zones.

Purchasing or transferring the development rights of these interspersed vacant parcels would limit future development of damageable property. The estimated cost to establish the TDR/PDR programs is approximately $1.5M ($500,000 per planning unit) with annual sums of state and/or local capital with which to purchase the development rights. However, neither of these programs can accomplish flood damage reduction objectives for existing structures that survived Katrina because neither of the programs modify or remove an existing structure from the property to avoid future damages but only thwart future additional development of the site from the day of the agreement or purchase of the rights to further develop the property. Although effective in reducing further damages from new development on interspersed vacant property, these programs do little to reduce damages to existing structures and facilities in hazard areas. For this reason, TDR and PDR are not effective as a single measure plan, but could be combined with other measures (such as permanent acquisition) that would address damages to existing and future development.

6.7.1.9 Development Impact Fees

Development impact fees can be used as a financial disincentive to steer development away from hazardous locations and allow jurisdictions to recover the external development costs for emergency services and post-storm recovery activities. Normally the fees are paid by the developer as a one-time lump sum on a per-lot basis rather than a continuing repetitive payment on developed lots that may be located in a hazardous zone. The estimated cost to enact development impact fees across the project area is $370,000. The total number of undeveloped acreage that may be converted to residential or commercial use in the project area is unknown at this time, but the institution of impact fees may limit development on those acres located in flood-prone areas. Although the use of such fees has proven to be effective in modifying the behaviors of developers in high-growth areas, the fees by themselves do not reduce flood damages to existing development nor do they absolutely prohibit such development from occurring. Since the project objectives emphasize reduction of flood damages to existing development, development impacts fees would not be an effective single-measure plan. However, given their ability to redirect growth away from hazardous or environmentally sensitive areas and to recover external costs, development impact fees would be effective when combined with other measures as described below.

6.7.2 Combined Measures Nonstructural Plans

As shown in Section 6.5.1., none of the nonstructural measures in and of themselves (except for lower levels of protection or single measures concentrated on very specific coastal areas such as permanent acquisition) fully meets the planning objectives of the study. Closest to the mark is permanent acquisition of all property damaged by Katrina and yet within that seemingly complete solution are holes bored by legal restrictions and economic imperatives such that it too is unable to fully address the objectives. Two alternatives featuring permanent acquisition as the only measure (described above as NS-PAHHZ and NS-PA100) are effective in reducing damages, but neither of them fully meets the planning objectives stated in the report.

In view of the inability of single-measure alternatives to address a majority of the planning objectives, combinations of measures, each with its unique ability to address portions of the objectives must be considered. Combining the best attributes of measures that can be implemented by Federal agencies and both state and local governments can provide substantial benefits. Using the results of the pair-wise evaluation in Table 13, combinations of measures were developed that can cost-effectively reduce damages, while providing for ecosystem restoration of wetlands and minimizing long-term social, economic and cultural impacts.

Two of the nonstructural measures already functioning in the study area can be components of any combined plan since they involve administrative and regulatory activities that would remain effective in any nonstructural plan. As shown in the pair-wise analysis, these two measures combine favorably under any future development scenarios. Flood Preparedness composed of Hurricane & Storm Warnings and Emergency Evacuation and Floodplain Management and Zoning both operate at the Federal, State and local levels of government to reduce losses of life and property damages. Only in the permanent acquisition measure, with a high degree of participation, does either of these two measures lose their effectiveness (very limited damageable property would remain in place), but with remnants of development (casinos and associated development) remaining even under that acquisition scenario, these two measures would remain in effect and be necessary for those facilities to safely maintain their location on the coast. For this reason the existing components of both Flood Preparedness and Floodplain Management and Zoning are incorporated into each combined plan although in Plan NS-PAHHZ and Plan NS-PA100 (described above) they are assumed to function only at their present level of operation without the improvements recommended in Plan NSC-1.

As stated above with respect to the two single-measure plans for permanent acquisition, all of the combined measures plans described below would have to be closely coordinated with current FEMA and HUD disaster-assistance programs before implementation so that opportunities for “double-dipping” could be eliminated and so that eligible landowners would be provided with the optimal solution for their individual structure or facility.

The combined nonstructural plans are described below:

6.7.2.1 Plan NSC-1 Federal Agencies Plan

This plan alternative would consist primarily of four measures that could be implemented by Federal agencies in cooperation with state and local agencies. This plan would provide protection for structures determined to be eligible for the program as a result of suffering inundation damages from Katrina. Although the level of protection for this plan was based upon the ABFE minus 2 feet, if approved and implemented, the Base Flood Elevation established by the anticipated revised DFIRM’s from FEMA would be the minimum level of protection afforded by this plan in accordance with the local ordinances. Those four plan measures include 1) permanent acquisition of approximately 33,200 parcels (approximately 17,100 structures) located in the three high-hazard zones and areas where water depths exceed 13 feet, 2) floodproofing by elevation and other means for approximately 25,400 parcels, 3) construction of three safe harborages within three separate inlets, and 4) replacement of 7 public buildings. Figures 66 through 70 show the coverage of the different nonstructural measures applied to the project area. Table 17 shows the costs of these various components. The estimated total cost of this plan would be $19.1B.

Structures and facilities located within the three high-hazard zones as identified in this plan would be subject to acquisition with full application of relocations assistance under the Uniform Relocations Act. Where required to resolve title issues or market value, condemnation under the eminent domain provisions of the Uniform Act could be exercised by the project sponsor (or Federal government). Relocations assistance payments would be provided to displaced landowners for the purpose of re-establishing businesses and households.

A variance in this permanent acquisition plan component would be for FEMA through their Hazard Mitigation Grant Program (HMGP) to acquire all insured (insured through the National Flood Insurance Program – NFIP) structures (with the exceptions listed in 3.3.2) within the identified V-zone. The Corps of Engineers would purchase all uninsured structures, through the provisions of P. L. 91-646, that are located within the V-zone, the “catastrophic damages zone” and within the 800 foot buffer in Jackson County as well as structures where water depths at the structure exceed 13 feet. Land acquisition costs would be similar to the all-Corps plan for acquisitions in these identified zones ($7.9 billion in Plan NS-PAHHZ), but relocations assistance payments may be less through the FEMA HMGP program.

Implementation of the HARP would enable the Corps to acquire many parcels made vacant by Katrina before landowners could re-establish their residence. This early action would reduce acquisition costs and demolition costs and make the program more palatable to landowners. Once a new residence was constructed, landowners would be less willing to accept an offer to purchase the property and new home even with relocations assistance.

All structures and pavements on acquired property will be either demolished or salvaged by the owner or disposed of by auction and removed from the site. Demolished construction materials will be disposed of in approved landfills or accumulated in designated staging areas for submerged habitat purposes. Utilities that are no longer necessary for service could be removed by the utility companies and unnecessary roadways could be demolished and abandoned by MDOT.

It is estimated that approximately 57,000 acres of land could be acquired in the high-hazard zones (were there to be 100 percent participation in the program). Of that total acreage, approximately 4,000 acres have been identified as suitable for ecosystem restoration as wetland areas. Those acres could be restored by numerous methods as described in the Environmental Appendix. In addition, there are approximately 37,000 acres of land that could be acquired in those areas where water depths at the AFBE-2 feet exceeded 13 feet (no floodproofing by elevation). Of that total acreage, approximately 5,200 acres have been identified as suitable for ecosystem restoration as wetland areas. Those acres as well could be restored by numerous methods as described in the Environmental Appendix. Additional acquisitions could occur in the areas designated for floodproofing by elevation or other means should specific structures be determined unsuitable for floodproofing during more detailed investigations or where elevation costs exceed acquisition costs. Lands acquired within the designated floodproofing areas that could be restored for ecosystem benefits would be investigated by the environmental team for their use as future wetlands.

Total estimated costs for all permanent acquisitions would be approximately $7.9B. Table 17 shows the approximate numbers of units and acquisition costs by economic reach. Figures 66 through 70 show the extent of the permanent acquisition area [shown in red and dark green] in the project area.

In an effort to reduce the overall project costs and forestall the re-establishment of many households in the high-hazard zones, implementation of the High Hazard Area Risk Reduction Plan (HARP) would concentrate on properties in the high-hazard zones that were made vacant by Katrina (structures demolished by the storm). This initial acquisition program described in Section 4.3.8.5 of this Appendix could significantly reduce the overall program cost by purchasing vacated property that has a high likelihood of redevelopment. Foregoing the high costs of purchasing new, larger residences, paying household relocation assistance and demolishing buildings and disposing of the debris, the HARP could save more than $270.0M in the permanent acquisition program and significantly reduce the threats to loss of life for those who would be re-establishing residences in high-hazard zone. The initial HARP program cost is estimated to be $397.0M and would affect approximately 2,000 parcels of property. Figure 52 shows those areas of the project where high-quality wetland ecosystem restoration opportunities correlate with the proposed acquisition in the HARP. Acquisition of interspersed vacant property (no structures) would require relatively minimal restoration to achieve ecosystem benefits.

Depending upon the type of redevelopment/resettlement options that are agreed upon by the local communities and the availability of existing DSS market housing for displaced landowners, one or more redevelopment sites may be developed in association with the permanent acquisition component of this nonstructural plan. These redevelopment sites would be constructed by the Federal government on lands acquired by the non-Federal sponsor (or the Federal Government by sub-agreement). All site improvements and community amenities would be installed prior to new housing or commercial building construction. To handle the anticipated number of displaced households a total of at least three redevelopment sites would be needed, one in each county (planning unit). Total estimated costs for three redevelopment sites (total of 6,000 lots) based upon an average developed cost per lot of $45,000 would be $270.0M.

Floodproofing of selected residential, commercial and institutional structures by elevation or other means would be implemented by Federal agencies with cooperation from state and local agencies. The floodproofing component would be on a voluntary basis only. During implementation of the floodproofing component of the plan each structure would be carefully evaluated to determine the appropriate method of protection. The most cost effective solution would be offered to the landowner. The existing structure could be either elevated in-place, purchased voluntarily and demolished or demolished and a new structure rebuilt on-site in an elevated condition. Guide plans and specifications based upon the engineering standards proscribed in the FEMA 550 guidelines would be prepared for each structure to be elevated. Specific plans and specifications for floodproofing measures at larger commercial or institutional buildings would be completed for each structure. The estimated cost for floodproofing 25,419 structures is $10.8B. Table 17 shows the floodproofing costs by economic reach. A total of 43 public buildings are included in the total number of structures eligible to be floodproofed. Figures 66 through 70 show the extent of the area where floodproofing by elevation would be practical and safe (shown in green).

In order to demonstrate the effectiveness of floodproofing by elevation to the general populace within the project area, this plan would request authorization to proceed with floodproofing construction by elevation in selected communities where elevation could be accomplished safely and at a much lower cost than any other measure (structural or nonstructural) heretofore identified. A neighborhood within Waveland, MS has been identified where elevation of residential structures using the FEMA 550 guidelines for floodproofing in the Gulf Coast would be within the program guidelines. An early-action floodproofing program would provide an opportunity to evaluate the FEMA 550 guidelines, demonstrate to potential program participants the appearance of structure elevation according to the guidelines and provide valuable information to the Mobile District on anticipated floodproofing and administrative costs for the remainder of the project area. Approximately 25 residential structures would be included in this project. The total, fully-funded project cost is estimated to be $4.6 M with a project duration of four years depending upon the flow of project funds. A Detailed Project Report (DPR) or Project Implementation Report (PIR) would be prepared for approval by Corps Division offices prior to implementation of this program.

To address the emergency evacuation requirements of the many fishing and pleasure vessels in the project area, three safe harborages would be constructed within the three major inlets in the project area. Safe harborages would be constructed on the Bay St. Louis embayment, Biloxi embayment and Pascagoula River embayment. An alternate harborage location would be at the Pearlington site on the Pearl River should the Pearlington redevelopment site be constructed. Material from the excavated safe harborage could be used as a portion of the fill for raising the Pearlington community. Construction at these sites would entail excavation of the harbor areas, dredging (if deemed necessary) of channels between the Gulf and the safe harbor area, a berthing area(s) of sufficient size to accommodate fishing vessels, security fencing, lighting and a gravel parking area. The total estimated cost for these three safe harborages is approximately $23.1M. This amount reflects the cost-shared (non-Federal 10%) project cost with a maximum Federal cost per project of $7.0M (Federal project limit revised in WRDA 2007).

Public buildings that cannot be safely protected in place by floodproofing or that were located in the high-hazard zone could be replaced at a flood-safe location in lieu of acquisition in accordance with Corps regulations (ER405-1-12).. A detailed engineering assessment of each public structure or facility would be made by USACE personnel to determine what a suitable replacement structure would require in terms of floor space, facilities, access, equipment, and maintenance. Building design would be based upon current-day standards for the particular facility (school, police station, fire station, city hall, etc.) being relocated. Replacement costs would account for land acquisition of a new flood-free site, building/facility design costs, construction costs and demolition costs of the old building. The existing flood-prone public property would be turned over to a non-Federal local sponsor for future OMRR&R. The 7 identified public buildings for replacement include schools and fire stations. Based upon available information for the affected public buildings, the estimated replacement costs would be approximately $51.2M. Table17 shows the numbers of public structures that would be subject to replacement or a floodproofing option and associated costs by economic reach. Figures 66 through 70 show the approximate locations of these existing structures within their economic reach.

The aforementioned Moss Point public buildings replacement could be implemented to demonstrate the effectiveness of facility replacement in reducing flood damages. The four public structures within the municipality that compose the city administrative offices and community recreation facility could be replaced at less flood-prone locations within Moss Point to demonstrate to other communities in the project area the usefulness of this nonstructural technique. The total, fully-funded estimated cost of this replacement project is $11.4 M with a project duration of four years.

As stated above, flood preparedness and floodplain management zoning and ordinance enforcement as well as building code enforcement would continue as well as the NFIP program in the project area. There wouldn't be any significant improvements to these three local systems beyond what is currently in-place following Katrina. Costs for these in-place, ongoing local processes are purely non-federal costs and are not captured in this alternative plan.

Other scales of Plan NSC-1 include providing the same suite of protection measures for several levels of inundation (each greater in magnitude than the minimum ABFE) including 20 foot, 30 foot and 40 foot storm surge inundation levels within the project area. The primary differences in this sub-set of Plan NSC-1 are the total number of parcels being protected and the division of the parcels between the floodproofing and either permanent acquisition or replacement (public buildings) measures within the plan. As the level of storm surge increases (ABFE-2 to 20 feet, 30 feet, and 40 feet), the total parcels treated by the measures would be steadily increased and more parcels (and attendant structures if not vacant) would be acquired (water depths greater than 13 feet) than floodproofed.

The only category of parcels whose total number would remain constant across the scaled versions of NCS-1 would be those in the high-hazard zones that are not affected by water depth, but by their proximity to the shoreline. In view of study time constraints and the limitations of the databases to accurately capture public buildings at these higher levels of inundation, municipal buildings listed in the tax assessor's database were considered as commercial structures to determine acquisitions and floodproofing costs at the 20, 30 and 40 foot levels of inundation. Total units and costs for each measure for the three, scaled versions of Plan NSC-1 (NSC-1a, NSC-1b, and NSC-1c) are shown in Tables 18, 19 and 20 by economic reach.

As shown in Tables 18, 19 and 20, the numbers of parcels increases dramatically with each increase in inundation depth between the ABFE and the 40 foot depth of inundation. Also evident is the movement of parcels eligible for floodproofing to the permanent acquisition category based upon depth of water at the structure. In addition, because of the dramatic increases in the numbers of parcels eligible for permanent acquisition, the numbers of potential H&CD lots required to handle the anticipated displaced landowners increases dramatically (as well as the costs and acres of land that would be required to accommodate the displaced households). This close relationship between inundation depth and numbers of permanent acquisitions (as well as needed lots for displaced landowners) remains fairly constant throughout the continuum of inundation depths.

From a total plan cost standpoint, greater levels of surge inundation do result in costs actually decreasing slightly because of the slightly lower cost for permanent acquisition as opposed to floodproofing used in this analysis. As more structures are added to the eligible list (deeper surge depth covers greater land area and more parcels), the overall cost of the plan does not rise at the same rate of increase through each increment of surge depth. Although somewhat counterintuitive, the difference in measure cost and the movement of structures from one category to another (floodproofing to permanent acquisition) drives this slight reduction in cost. As discussed in Section 6.3 – Nonstructural Program Participation, participation in the program at higher levels of surge protection may drop as landowners who would have been willing to have their homes elevated (at a lower level of protection) may decline to have their homes purchased at the higher level of protection. Although a change in the participation rate would further decrease the plan cost, its effectiveness in reducing damages from surge inundation would also be reduced.

Table 17.
Plan NSC-1 – Federal Agencies Plan (ABFE)

Economic Reaches	Permanent Acquisition Parcels	Cost	Floodproofing Structures	Cost	Public Buildings Relocations	Cost	Safe Harborages	Cost
1	997	$194,118,218	394	$124,162,500	0	0		
2	9911	$2,992,128,131	3294	$1,940,527,762	0	0		
3	2202	$668,691,437	376	$333,327,500	0	0		
4	922	$120,307,917	16	$30,715,000	0	0		
5	2714	$238,388,794	119	$79,272,500	0	0		
6	567	$107,292,775	590	$332,629,236	1	$8,536,147		
7	450	$33,303,080	232	$186,928,125	0	0		
8	3623	$476,153,333	1730	$696,585,161	4	$25,608,442		
9	44	$16,145,783	16	$16,552,500	0	0		
10	1945	$432,607,234	62	$24,201,250	0	0		
11	0	0	8	$2,105,000	0	0		
12	1047	$179,783,825	1136	$443,587,036	0	0		
13	650	$583,121,543	0	0	0	0		
15	85	$44,354,843	9	$28,406,250	0	0		
16	78	$16,399,728	121	$38,542,500	0	0		
18	1502	$409,463,532	5	$1,396,250	0	0		
19	46	$292,728,063	0	0	0	0		
20	1397	$238,563,082	2050	$876,852,680	1	$8,536,147		
21	2108	$301,824,272	419	$193,663,144	0	0		
22	61	$26,330,663	92	$44,933,750	0	0		
23	0	0	44	$24,735,000	0	0		
24	220	$65,229,821	178	$58,153,750	0	0		
26	37	$9,210,336	952	$331,648,993	0	0		
27	53	$12,880,944	1029	$275,385,243	0	0		
28	961	$90,294,697	122	$59,837,500	0	0		
29	147	$23,394,829	168	$63,560,625	0	0		
30	90	$29,459,003	467	$197,030,000	0	0		
31	51	$14,959,829	447	$209,015,000	0	0		
32	0	0	208	$64,368,750	0	0		
35	12	$682,228	1406	$431,113,125	0	0		
36	32	$3,834,485	2	$6,312,500	0	0		
38	50	$21,424,866	78	$19,440,625	0	0		
39	0	0	6	$1,204,375	0	0		
43	0	0	1	$206,250	0	0		
48	0	0	2	$445,000	0	0		
50	495	$89,312,661	848	$263,763,750	0	0		
51	0	0	786	$329,689,637	0	0		
52	285	$103,016,211	6838	$2,412,346,817	1	$8,536,147		
53	399	$113,054,873	360	$256,581,875	0	0		
54	9	$1,114,862	808	$406,074,697	0	0		
Subtotals	**33,191**	**$7,928,411,301**	**419**	**$10,805,301,654**	**7**	**$51,216,883**	**3**	**$23,100,000**
H&CD Sites		Hancock, Harrison and Jackson Counties			3 Sites – 3,000 total lots			$135,000,000
Total Cost								$18,943,029,838

Table 18
Plan NSC-1a – 20 Feet of Inundation

Economic Reach	Acquisition Parcels	Acquisition Cost	Floodproofing Parcels	Floodproofing Cost	Subtotal NS Cost by Reach
1	795	$242,760,352.63	1068	$111,644,220	$354,404,572.63
2	6119	$1,982,505,118.75	12206	$2,270,306,077	$4,252,811,195.75
3	2029	$869,599,919.38	502	$261,603,614	$1,131,203,533.38
4	769	$137,140,841.63	55	$41,048,722	$178,189,563.63
5	1907	$221,978,091.88	680	$93,803,252	$315,781,343.88
6	753	$84,228,949.38	167	$67,872,872	$152,101,821.38
7	343	$28,183,289.75	1092	$123,833,026	$152,016,315.75
8	6585	$721,036,617.25	2761	$268,481,369	$989,517,986.25
9	23	$10,006,258.75	15	$4,155,724	$14,161,982.75
10	3052	$687,523,634.50	36	$9,985,596	$697,509,230.50
11	45	$13,955,967.50	882	$131,996,005	$145,951,972.50
12	1617	$398,388,336.75	2184	$925,803,107	$1,324,191,443.75
13	2284	$1,059,037,972.50	1	$275,000	$1,059,312,972.50
14	10	$3,531,145.00	3	$0	$3,531,145.00
15	407	$321,467,398.75	5	$195,994	$321,663,392.75
16	178	$45,986,843.00	420	$89,816,180	$135,803,023.00
17	0	$0.00	0	$0	$0.00
18	1650	$531,842,684.50	29	$7,968,172	$539,810,856.50
19	15	$238,143,653.50	0	$0	$238,143,653.50
20	1046	$197,002,707.50	1756	$491,997,409	$689,000,116.50
21	2142	$698,779,207.38	1688	$518,126,016	$1,216,905,223.38
22	314	$142,425,847.38	1921	$475,539,586	$617,965,433.38
23	59	$18,831,864.50	104	$23,208,676	$42,040,540.50
24	301	$134,113,558.00	854	$131,106,828	$265,220,386.00
25	0	$0.00	27	$3,700,964	$3,700,964.00
26	1117	$143,629,375.25	1094	$150,558,498	$294,187,873.25
27	203	$21,004,404.13	2725	$269,721,562	$290,725,966.13
28	1318	$162,484,163.75	444	$40,032,082	$202,516,245.75
29	491	$115,704,667.88	1081	$180,905,804	$296,610,471.88
30	612	$183,628,802.88	2158	$599,471,114	$783,099,916.88
31	472	$150,421,617.50	810	$206,865,030	$357,286,647.50
32	236	$44,686,667.38	461	$71,960,724	$116,647,391.38
33	0	$0.00	0	$0	$0.00
34	0	$0.00	0	$0	$0.00
35	630	$92,739,948.25	1277	$453,335,528	$546,075,476.25
36	0	$0.00	29	$0	$0.00
37	0	$0.00	5	$0	$0.00
38	33	$23,256,254.25	304	$16,587,864	$39,844,118.25
39	8	$1,627,170.00	287	$16,374,482	$18,001,652.00
40	1	$100,211.25	4	$0	$100,211.25
41	0	$0.00	0	$0	$0.00
42	0	$0.00	0	$0	$0.00
43	0	$0.00	4	$366,298	$366,298.00
44	0	$0.00	0	$0	$0.00
45	0	$0.00	0	$0	$0.00
46	0	$0.00	3	$114,092	$114,092.00
47	0	$0.00	5	$587,982	$587,982.00
48	1	$1,457,777.50	5	$587,982	$2,045,759.50
49	0	$0.00	63	$2,318,648	$2,318,648.00

Economic Reach	Acquisition Parcels	Acquisition Cost	Floodproofing Parcels	Floodproofing Cost	Subtotal NS Cost by Reach
50	574	$204,376,584.50	1915	$363,408,582	$567,785,166.50
51	1005	$220,389,345.63	883	$241,849,268	$462,238,613.63
52	1840	$535,059,176.25	7305	$4,108,479,076	$4,643,538,252.25
53	646	$134,435,107.63	613	$207,158,892	$341,593,999.63
54	1100	$276,596,580.13	655	$219,619,572	$496,216,152.13
Subtotal	**42730**	**$11,100,068,114**	**50586**	**$13,202,771,489**	**$24,302,839,603**
H&CD Sites	Hancock, Harrison & Jackson		Approx. 15,000 lots at $45,000/lot		$ 675,000,000
Total Cost					**$ 24,977,839,603**

Table 19
Plan NSC-1b – 30 Feet of Inundation

Economic Reach	Acquisition Parcels	Acquisition Cost	Floodproofing Parcels	Floodproofing Cost	Subtotal NS Cost by Reach
1	1591	$470,268,503.50	511	$80,353,606	$550,622,109.50
2	15864	$3,364,937,903.75	6331	$2,006,692,184	$5,371,630,087.75
3	2565	$1,036,199,788.88	557	$239,155,950	$1,275,355,738.88
4	823	$143,859,191.50	1	$195,994	$144,055,185.50
5	2545	$514,085,341.38	42	$8,818,078	$522,903,419.38
6	920	$108,477,101.25	0	$0	$108,477,101.25
7	1222	$127,404,692.38	267	$18,389,310	$145,794,002.38
8	8591	$913,966,937.50	755	$201,679,104	$1,115,646,041.50
9	38	$12,583,953.75	0	$0	$12,583,953.75
10	3088	$696,444,472.00	0	$0	$696,444,472.00
11	79	$17,236,421.25	848	$315,371,358	$332,607,779.25
12	3801	$1,250,095,756.75	0	$0	$1,250,095,756.75
13	2284	$1,059,037,972.50	1	$2,525,000	$1,061,562,972.50
14	10	$3,531,145.00	3	$0	$3,531,145.00
15	412	$326,617,775.00	0	$0	$326,617,775.00
16	598	$173,917,626.75	0	$0	$173,917,626.75
17	0	$0.00	0	$0	$0.00
18	1655	$533,199,240.00	24	$11,739,556	$544,938,796.00
19	15	$238,143,653.50	0	$0	$238,143,653.50
20	2144	$416,967,996.50	1802	$861,061,816	$1,278,029,812.50
21	3830	$1,483,891,217.50	0	$0	$1,483,891,217.50
22	2235	$872,740,336.25	0	$0	$872,740,336.25
23	163	$57,221,763.88	0	$0	$57,221,763.88
24	539	$264,338,265.75	616	$110,725,374	$375,063,639.75
25	27	$11,661,813.00	0	$0	$11,661,813.00
26	2211	$438,492,100.00	0	$0	$438,492,100.00
27	2928	$453,066,871.38	0	$0	$453,066,871.38
28	1687	$241,776,845.63	1742	$249,531,974	$491,308,819.63
29	1572	$359,722,100.25	0	$0	$359,722,100.25
30	2770	$942,794,462.50	0	$0	$942,794,462.50
31	1282	$415,121,092.13	0	40	$415,121,092.13
32	697	$173,934,340.75	0	$0	$173,934,340.75
33	0	$0.00	0	$0	$0.00
34	0	$0.00	0	$0	$0.00
35	1907	$416,542,564.88	0	$0	$416,542,564.88
36	15	$2,306,708.13	36	$0	$2,306,708.13
37	1	$340,434.38	4	$0	$340,434.38
38	198	$59,672,860.88	452	$74,116,316	$133,789,176.88
39	295	$34,977,357.00	0	$0	$34,977,357.00
40	5	$417,288.75	0	$0	$417,288.75
41	0	$0.00	0	$0	$0.00
42	0	$0.00	0	$0	$0.00
43	4	$1,269,975.00	0	$0	$1,269,975.00
44	0	$0.00	0	$0	$0.00
45	0	$0.00	0	$0	$0.00
46	3	$322,862.50	0	$0	$322,862.50
47	5	$1,720,815.00	0	$0	$1,720,815.00
48	6	$5,485,907.50	0	$0	$5,485,907.50
49	63	$8,814,550.50	0	$0	$8,814,550.50

Economic Reach	Acquisition Parcels	Acquisition Cost	Floodproofing Parcels	Floodproofing Cost	Subtotal NS Cost by Reach
50	1652	$665,887,180.75	837	$176,952,378	$842,839,558.75
51	1888	$447,319,912.38	0	$0	$447,319,912.38
52	9145	$3,199,336,671.63	0	$0	$3,199,336,671.63
53	1234	$464,412,757.75	49	$26,056,898	$490,469,655.75
54	1755	$541,259,959.00	0	$0	$541,259,959.00
Subtotal	**86362**	**$22,971,824,488**	**14878**	**4,383,364,896**	**$27,355,189,384**
H&CD Sites	Hancock, Harrison & Jackson		Approx. 30,000 lots at $45,000/lot		$ 1,350,000,000
Total Cost					**$ 28,705,189,384**

Table 20
Plan NSC-1c – 40 Feet of Inundation

Economic Reach	Acquisition Parcels	Acquisition Cost	Floodproofing Parcels	Floodproofing Cost	Subtotal NS Cost by Reach
1	2102	$632,549,786.38	0	0	$632,549,786.38
2	22195	$5,686,835,321.25	0	0	$5,686,835,321.25
3	3122	$1,266,472,734.00	0	0	$1,266,472,734.00
4	824	$144,644,086.50	0	0	$144,644,086.50
5	2587	$519,349,802.25	0	0	$519,349,802.25
6	920	$108,477,101.25	0	0	$108,477,101.25
7	1489	$159,349,868.63	0	0	$159,349,868.63
8	9346	$1,119,589,307.50	0	0	$1,119,589,307.50
9	38	$12,583,953.75	0	0	$12,583,953.75
10	3088	$696,444,472.00	0	0	$696,444,472.00
11	927	$238,310,263.50	0	0	$238,310,263.50
12	3801	$1,250,095,756.75	0	0	$1,250,095,756.75
13	2285	$1,059,287,941.25	0	0	$1,059,287,941.25
14	13	$5,321,020.00	0	0	$5,321,020.00
15	412	$326,617,775.00	0	0	$326,617,775.00
16	598	$173,917,626.75	0	0	$173,917,626.75
17	0	$0.00	0	0	$0.00
18	1679	$542,567,877.25	0	0	$542,567,877.25
19	15	$238,143,653.50	0	0	$238,143,653.50
20	3946	$829,880,446.50	0	0	$829,880,446.50
21	3830	$1,483,891,217.50	0	0	$1,483,891,217.50
22	2235	$872,740,336.25	0	0	$872,740,336.25
23	163	$57,221,763.88	0	0	$57,221,763.88
24	1155	$598,237,712.00	0	0	$598,237,712.00
25	27	$11,661,813.00	0	0	$11,661,813.00
26	2211	$438,492,100.00	0	0	$438,492,100.00
27	2928	$453,066,871.38	0	0	$453,066,871.38
28	3429	$714,783,499.38	0	0	$714,783,499.38
29	1572	$359,722,100.25	0	0	$359,722,100.25
30	2770	$942,794,462.50	0	0	$942,794,462.50
31	1282	$415,121,092.13	0	0	$415,121,092.13
32	697	$173,934,340.75	0	0	$173,934,340.75
33	0	$0.00	0	0	$0.00
34	0	$0.00	0	0	$0.00
35	1907	$416,542,564.88	0	0	$416,542,564.88
36	51	$6,438,158.75	0	0	$6,438,158.75
37	5	$1,911,196.25	0	0	$1,911,196.25
38	650	$214,970,390.38	0	0	$214,970,390.38
39	295	$34,977,357.00	0	0	$34,977,357.00
40	5	$417,288.75	0	0	$417,288.75
41	0	$0.00	0	0	$0.00
42	0	$0.00	0	0	$0.00
43	4	$1,269,975.00	0	0	$1,269,975.00
44	0	$0.00	0	0	$0.00
45	0	$0.00	0	0	$0.00
46	3	$322,862.50	0	0	$322,862.50
47	5	$1,720,815.00	0	0	$1,720,815.00
48	6	$5,485,907.50	0	0	$5,485,907.50
49	63	$8,814,550.50	0	0	$8,814,550.50

Economic Reach	Acquisition Parcels	Acquisition Cost	Floodproofing Parcels	Floodproofing Cost	Subtotal NS Cost by Reach
50	2489	$1,063,036,000.75	0	0	$1,063,036,000.75
51	1888	$447,319,912.38	0	0	$447,319,912.38
52	9145	$3,199,336,671.63	0	0	$3,199,336,671.63
53	1283	$496,107,037.25	0	0	$496,107,037.25
54	1755	$541,259,959.00	0	0	$541,259,959.00
Subtotal	**101240**	**$27,972,036,750**	**0**	**0**	**$27,972,036,750**
H&CD Sites	Hancock, Harrison & Jackson		Approx. 35,400 lots at $45,000/per		$1,593,000,000
Total Cost					**$29,565,036,750**

Figure 66 – Plan NSC-1 Permanent Acquisitions and Floodproofing (A1)

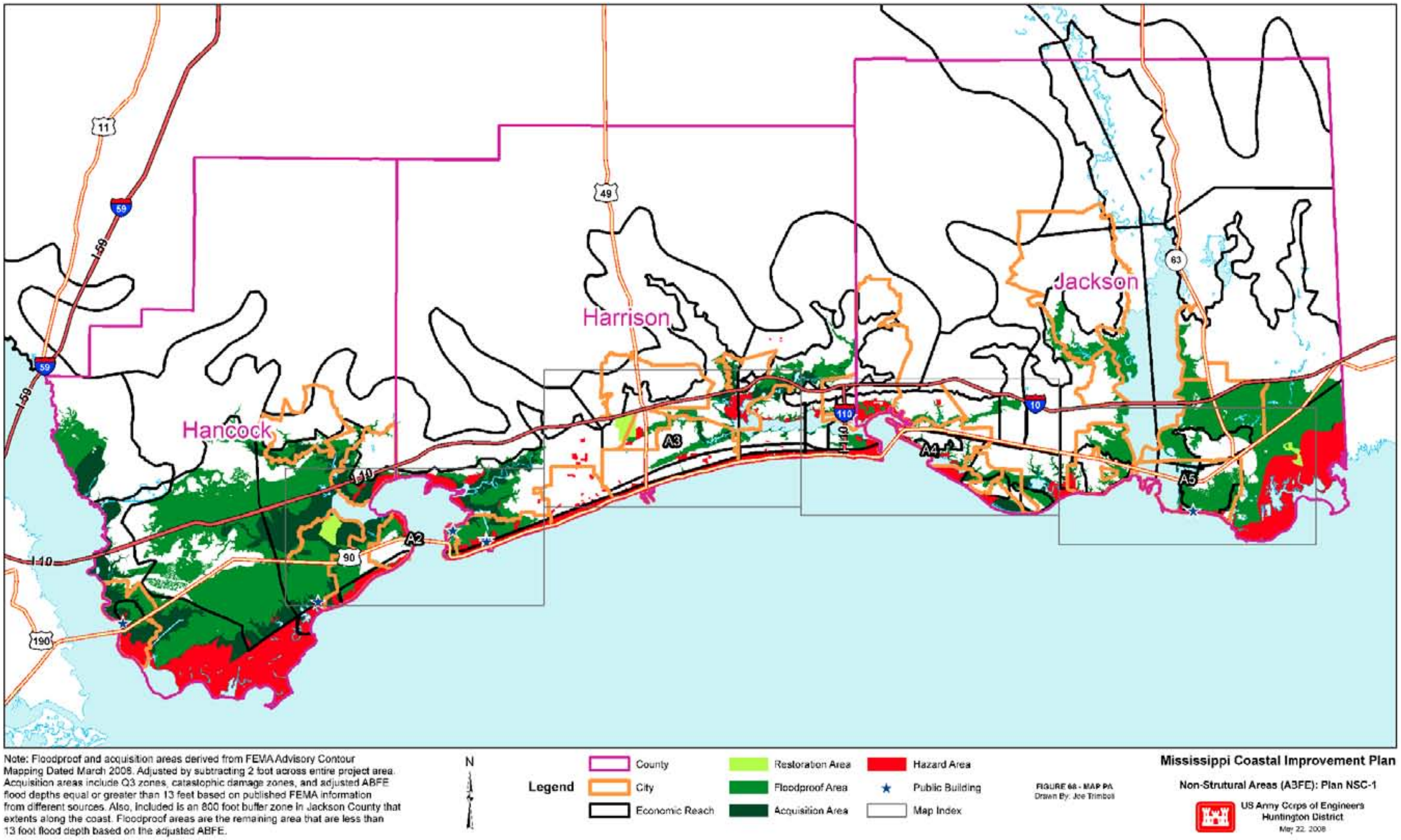


Figure 67 – Plan NSC-1 Permanent Acquisitions and Floodproofing (A2)

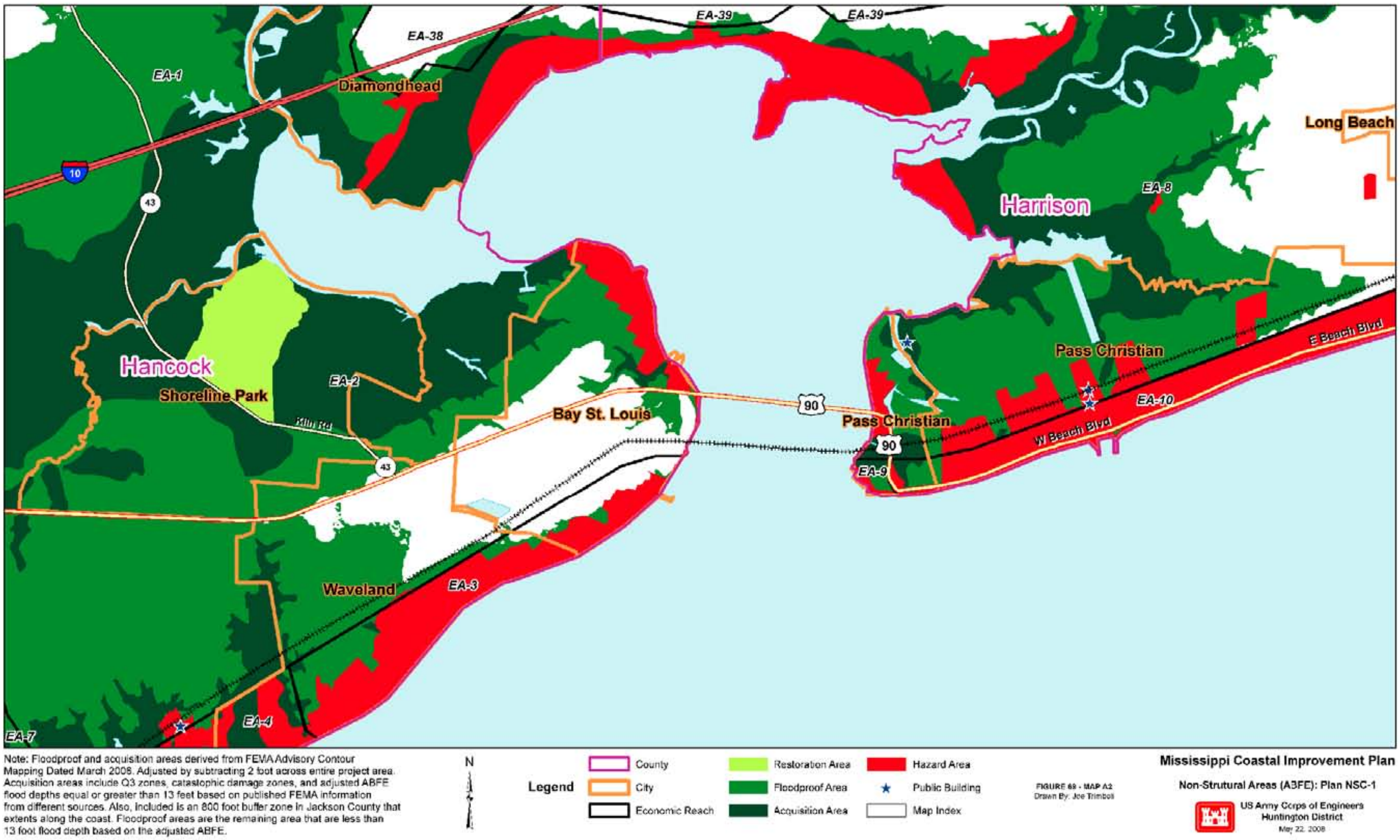


Figure 68 – Plan NSC-1 Permanent Acquisitions and Floodproofing (A3)

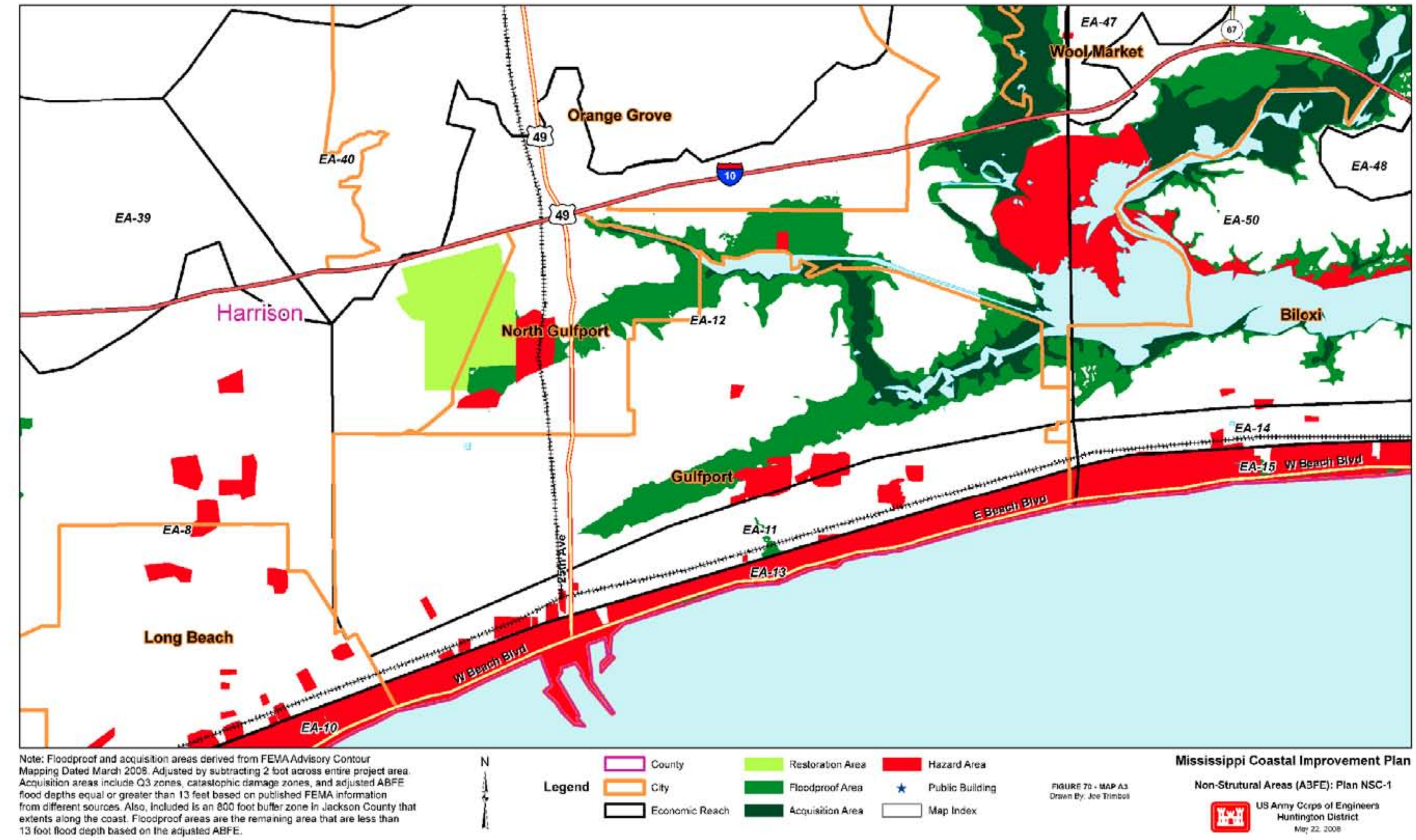


Figure 69 – Plan NSC-1 Permanent Acquisitions and Floodproofing (A4)

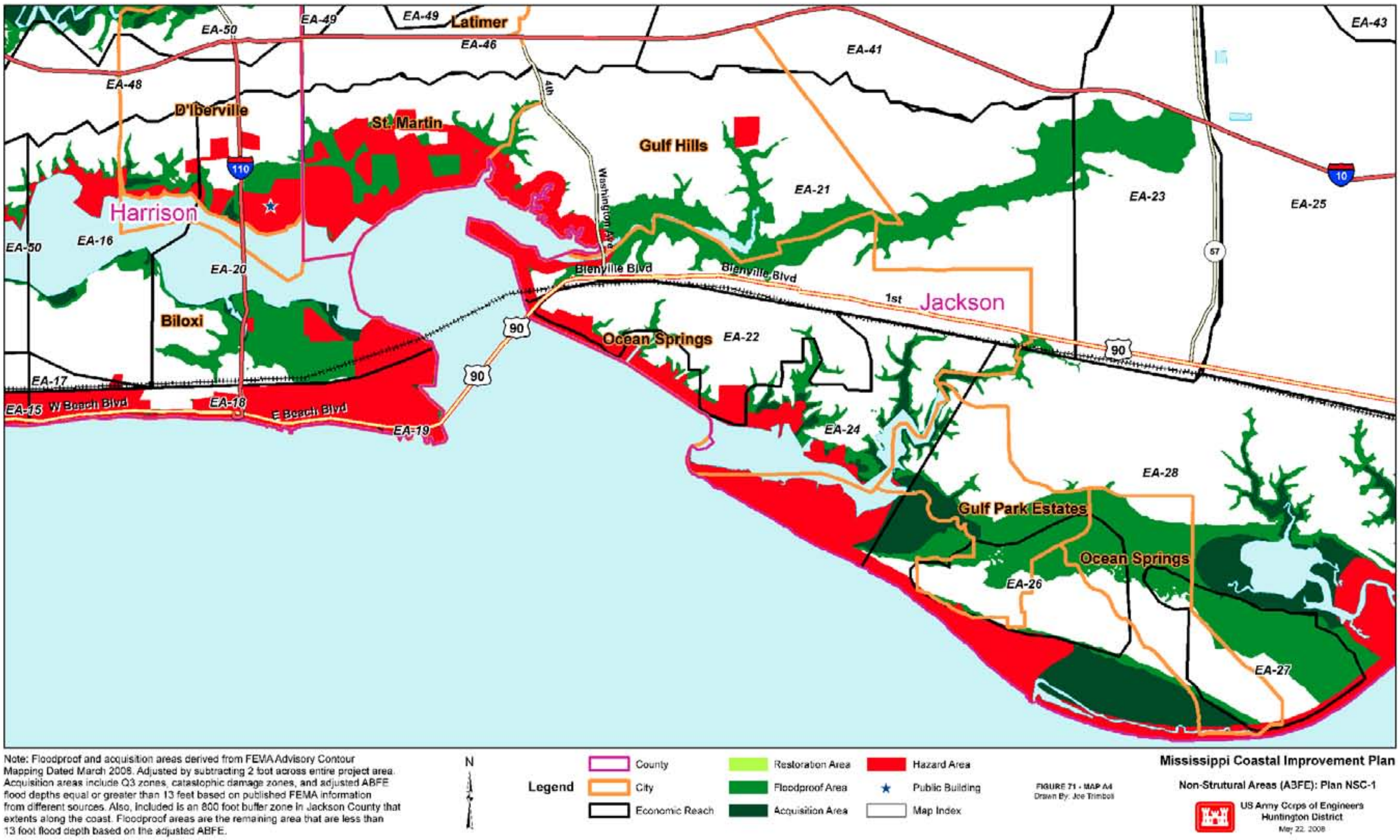
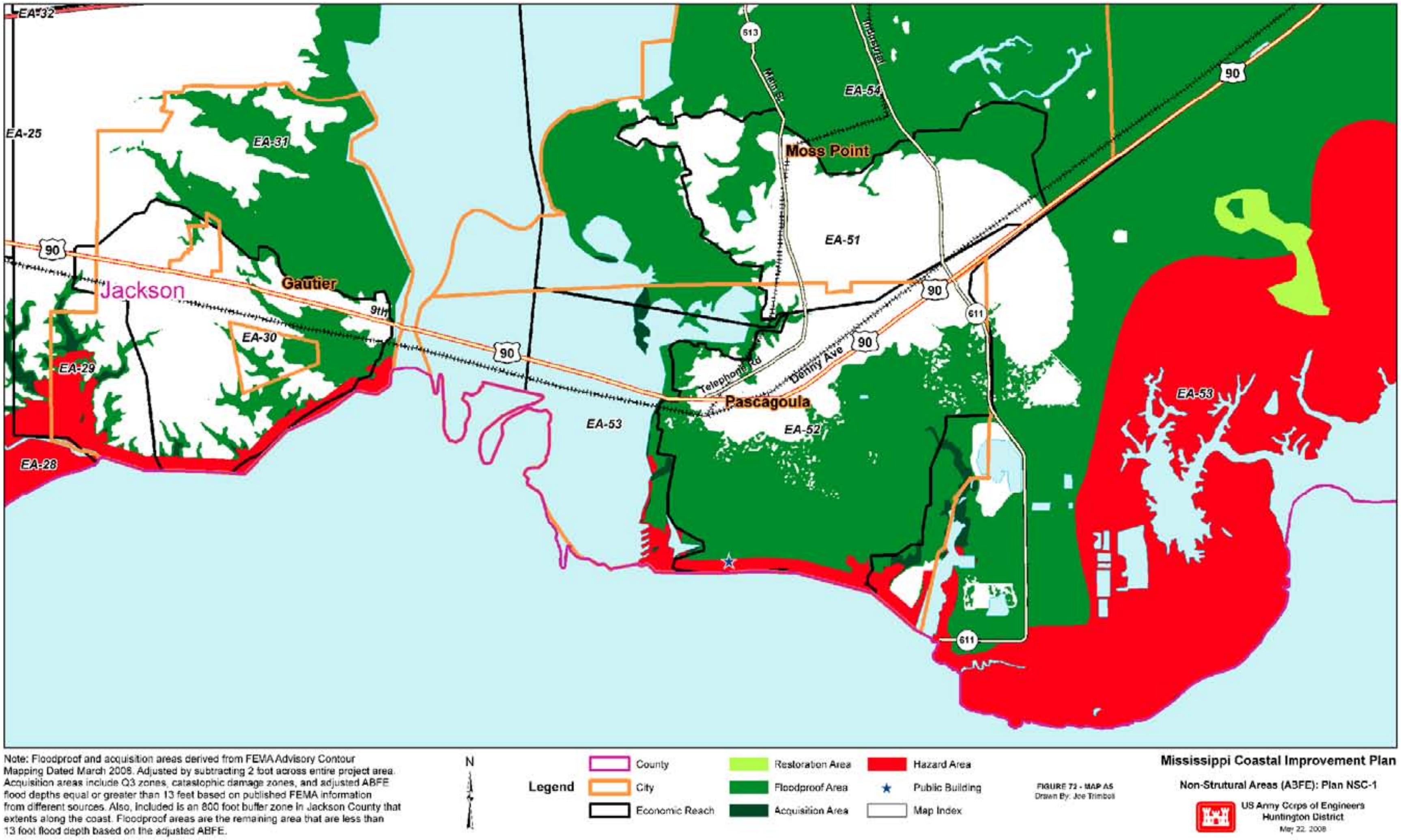


Figure 70 – Plan NSC-1 Permanent Acquisitions and Floodproofing (A5)



6.7.2.2. Plan NSC-2 – Dry and Wet Floodproofing Plan w/FWEE Upgrades

This plan is comprised of two primary measures: 1) dry and wet floodproofing of structures located outside of the high-hazard zones and in locations where water depths would not exceed 13 feet at the ABFE-2 feet flood event, and 2) upgrades to the flood warning and emergency evacuation system. As shown in the pair-wise comparison (Table 13 on page 124), these two measures need to be implemented in concert so that the occupants of elevated or otherwise floodproofed structures would have credible warnings of approaching storms provided in adequate time to prevent their being trapped inside the protected structure. Due to the H&H uncertainties surrounding the determinations of the final elevation of raised first floors and the many risks associated with "riding-out" a hurricane in an elevated structure, all occupants of floodproofed structures would be strongly encouraged (in some areas this could be a mandatory evacuation by local officials) to vacate their homes during hurricane events.

The two methods of floodproofing (dry and wet) would be applied to various structure types and uses including veneer walls, ringwalls and ring-levees (dry floodproofing) for larger commercial or institutional structures or complexes (industry, educational, medical/health facilities, military) and elevation of habitable or sales floors of residential, commercial or institutional structures (wet floodproofing) to protect the structure and its contents. Due to the ADA requirements of most public structures and the confined urban lots on which many of them are located, elevation of institutional structures has limited application. In any case, floodproofing would not be used as a method of protecting occupants of these structures, therefore emergency evacuation of people from floodproofed structures would be the norm.

The flood warning and emergency evacuation (FWEE) system upgrades would include installation of additional reporting buoys in the Gulf (coordinated with NOAA), modifications to existing warning times for category 4 and 5 hurricanes (to assure adequate evacuation time), installation of hurricane evacuation route signs throughout the project area (coordinated with MDOT), installation of messaging boards on primary north/south evacuation routes, installation of warning sirens and dissemination of weather hazard radios, various (but currently undefined) improvements to evacuation routes and intersections (signalization and lanes), and an ongoing public education and emergency evacuation training program. These upgrades to the existing FWEE system would increase public awareness (residents and tourists) of the risks posed by tropical storms and hurricanes, increase the credibility of advanced storm warnings, increase the safety and efficiency of large-scale evacuations in the face of large hurricanes and provide ongoing training and assistance to emergency response teams. In addition, this program would provide technical assistance and appropriate financial assistance to those facilities (casinos, industries, utilities) that are dependent upon their geographic location at the water's edge so that future damages can be reduced and both visitors and employees can be safely evacuated.

The total cost of Plan NSC-2 is estimated to be $10.8B. Of that total, the majority of the funds would be used to floodproof (dry and wet methods) 25,419 structures. Approximately $2.9M would be used for the FWEE upgrades for approximately 95,000 at-risk parcels within the project area. Table 21 shows the numbers of units affected by each component and the estimated costs by reach. Figures 71 through 75 show the extent of the floodproofing areas under this plan.

Table 21
Plan NSC-3 Wet and Dry Floodproofing with FWEE Upgrades

Economic Reaches	Floodproofing	Cost*	Flood Warning and Emergency Evacuations	Cost
1	394	$124,162,500	2062	$62,540
2	3294	$1,910,805,000	19363	$587,280
3	376	$333,327,500	2673	$81,072
4	16	$30,715,000	901	$27,327
5	119	$79,272,500	3109	$94,296
6	590	$311,335,000	1123	$34,061
7	232	$186,928,125	1574	$47,739
8	1730	$691,816,250	8716	$264,356
9	16	$16,552,500	52	$1,577
10	62	$24,201,250	1727	$52,380
11	8	$2,105,000	44	$1,335
12	1136	$438,818,125	2777	$84,226
13	0	0	500	$15,165
14	0	0	788	$23,900
15	9	$28,406,250	76	$2,305
16	121	$38,542,500	209	$6,339
17	0	0	6	$182
18	5	$1,396,250	1223	$3,7094
19	0	0	22	$667
20	2050	$853,008,125	3064	$92,931
21	419	$174,587,500	1867	$56,626
22	92	$44,933,750	157	$4,762
23	44	$24,735,000	65	$1,971
24	178	$58,153,750	524	$15,893
25	0	0	327	$9,918
26	952	$321,001,875	1279	$38,792
27	1029	$264,738,125	2145	$65,058
28	122	$59,837,500	1718	$52,107
29	168	$63,560,625	546	$16,560
30	467	$197,030,000	626	$18,987
31	447	$209,015,000	708	$21,474
32	208	$64,368,750	398	$12,071
33	0	0	77	$2,335
34	0	0	600	$18,198
35	1406	$431,113,125	1599	$48,498
36	2	$6,312,500	62	$1,880
37	0	0	540	$16,378
38	78	$19,440,625	1	$11,040
39	6	$1,204,375	364	$758
40	0	0	7824	$237,302
41	0	0	536	$16,257
42	0	0	667	$20,230

Economic Reaches	Floodproofing	Cost*	Flood Warning and Emergency Evacuations	Cost
43	1	$206,250	25	$61
44	0	0	2587	$78,464
45	0	0	2267	$68,758
46	0	0	3331	$101,029
47	0	0	1303	$39,520
48	2	$445,000	1	$61
49	0	0	338	$10,252
50	848	$263,763,750	1594	$48,346
51	786	$299,966,875	1089	$33,029
52	6838	$2,300,775,000	7628	$231,357
53	360	$256,581,875	1557	$38,125
54	808	$396,536,875	1548	$46,951
Totals	**25,419**	**$10,803,744,154**	**95,931**	**$2,899,820**

* Costs by reach include contingencies.

Figure 71 – Plan NSC-2 Dry and Wet Floodproofing w/FWEE Upgrades (A1)

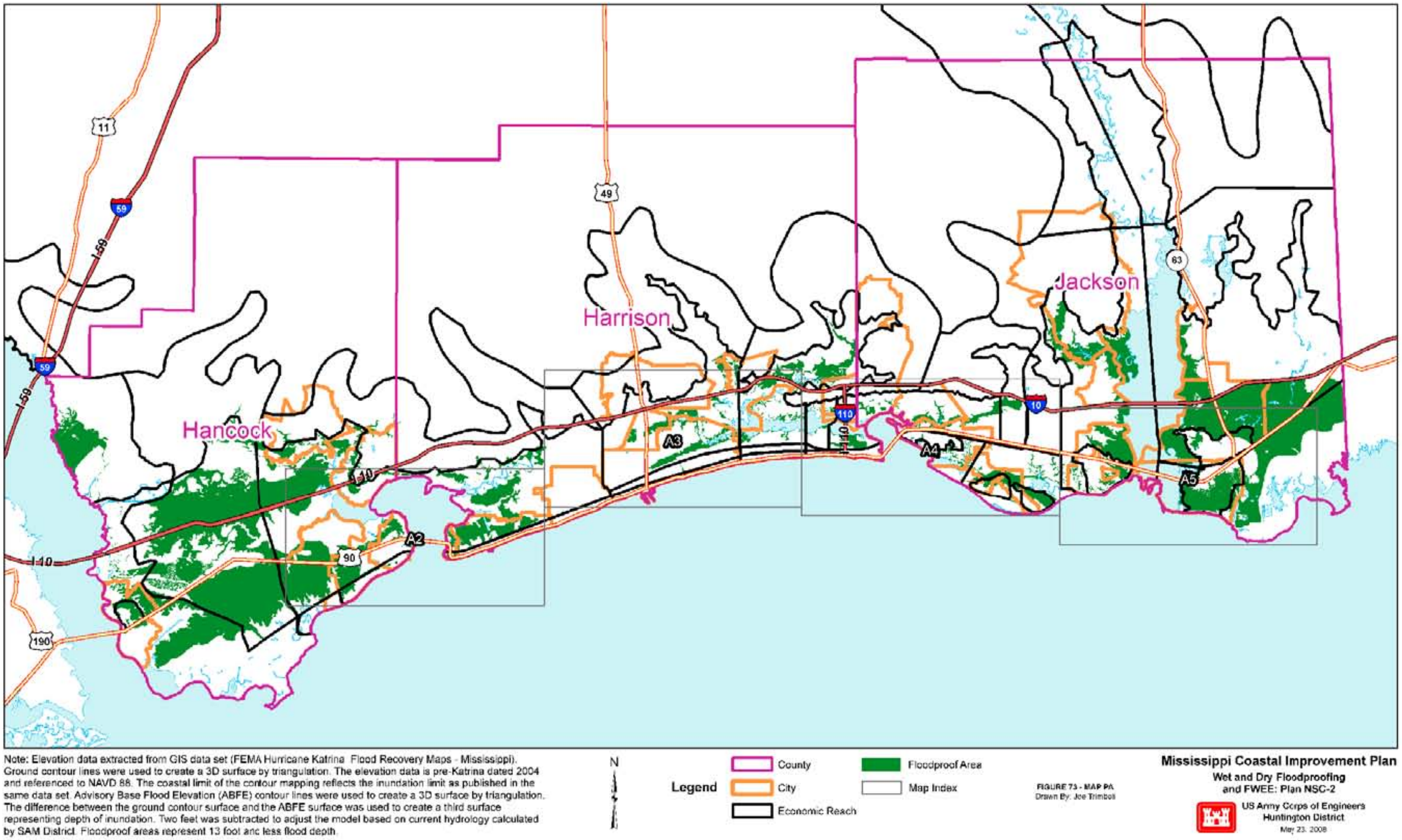


Figure 72 – Plan NSC-2 Dry and Wet Floodproofing w/FWEE Upgrades (A2)

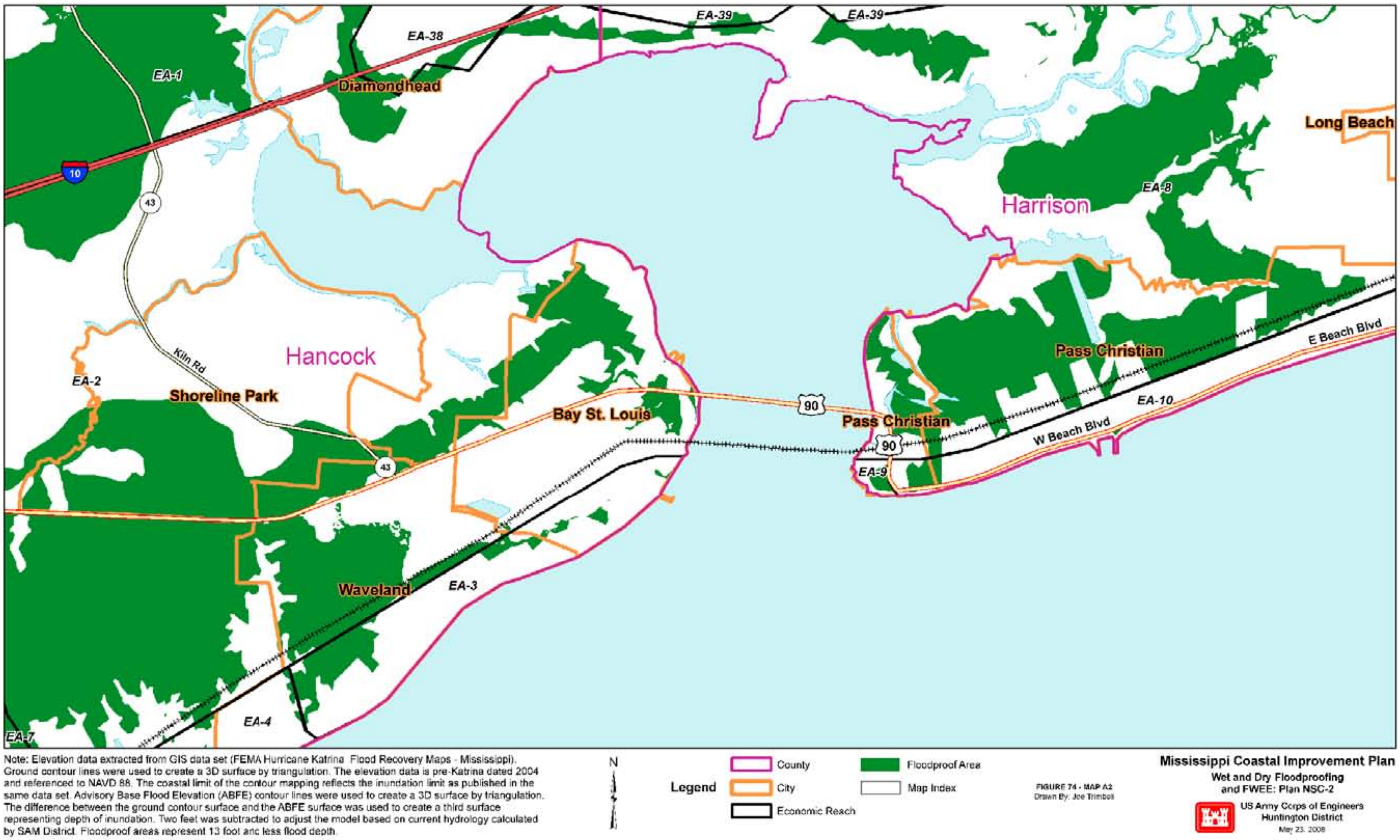


Figure 73 – Plan NSC-2 Dry and Wet Floodproofing w/FWEE Upgrades (A3)

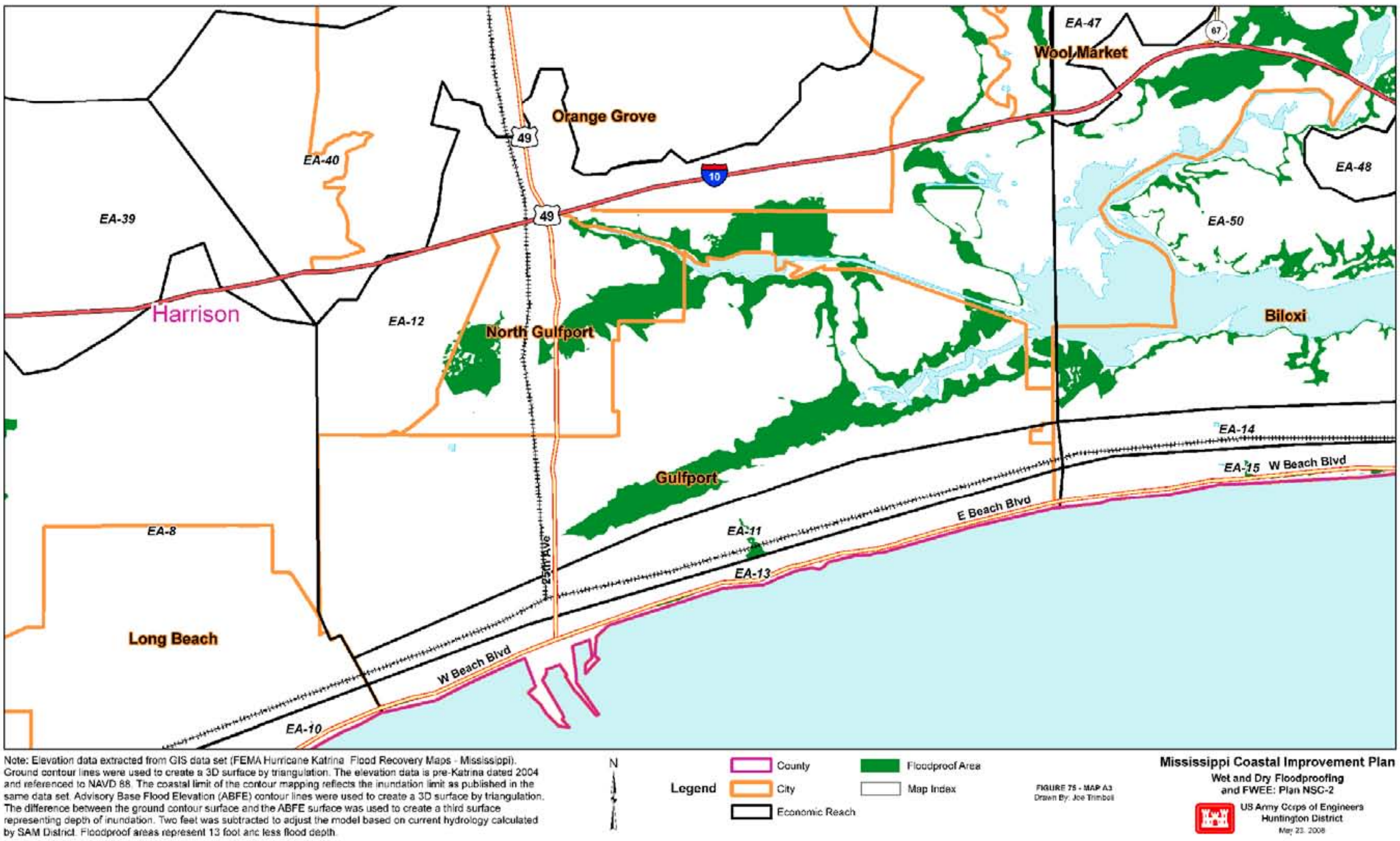


Figure 74 – Plan NSC-2 Dry and Wet Floodproofing w/FWEE Upgrades (A4)

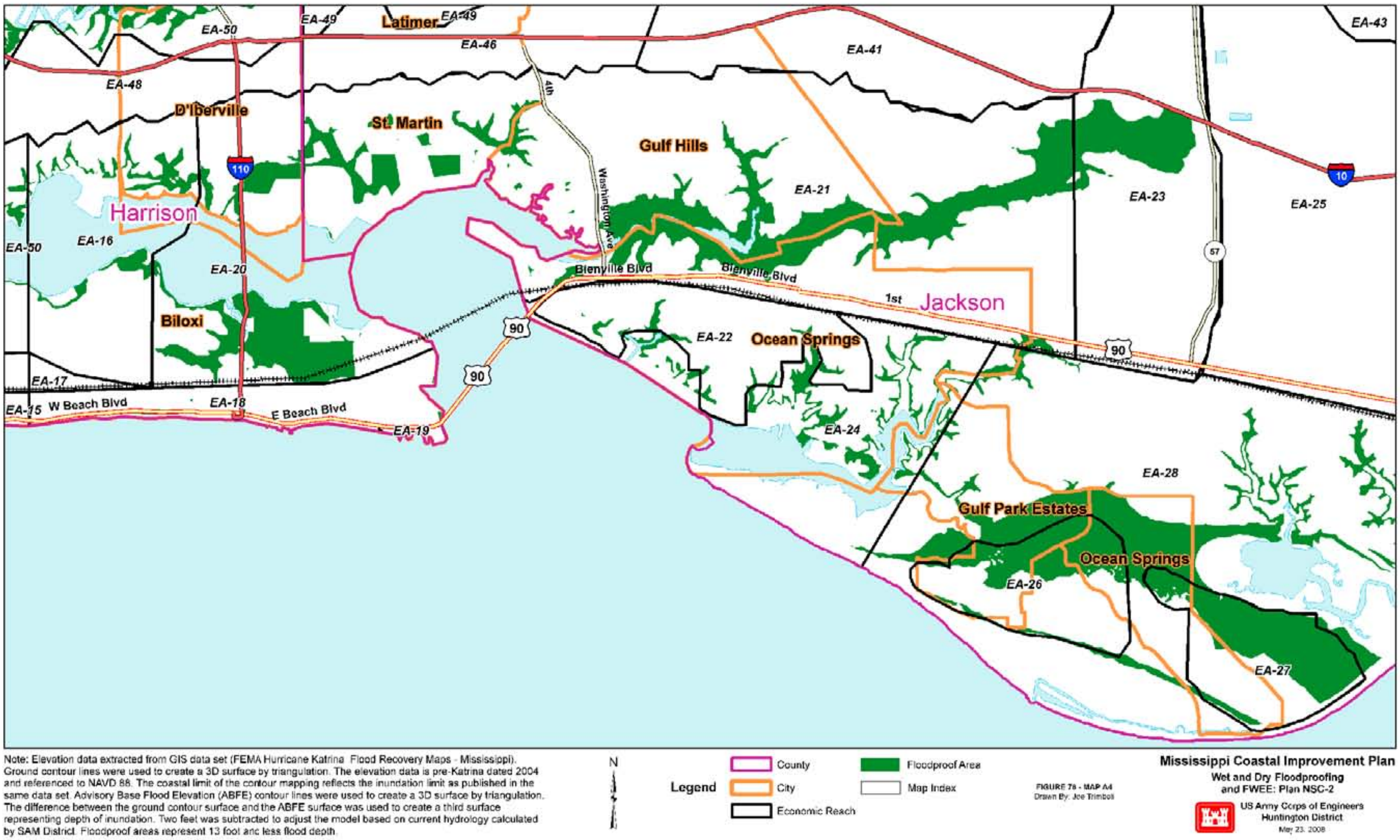
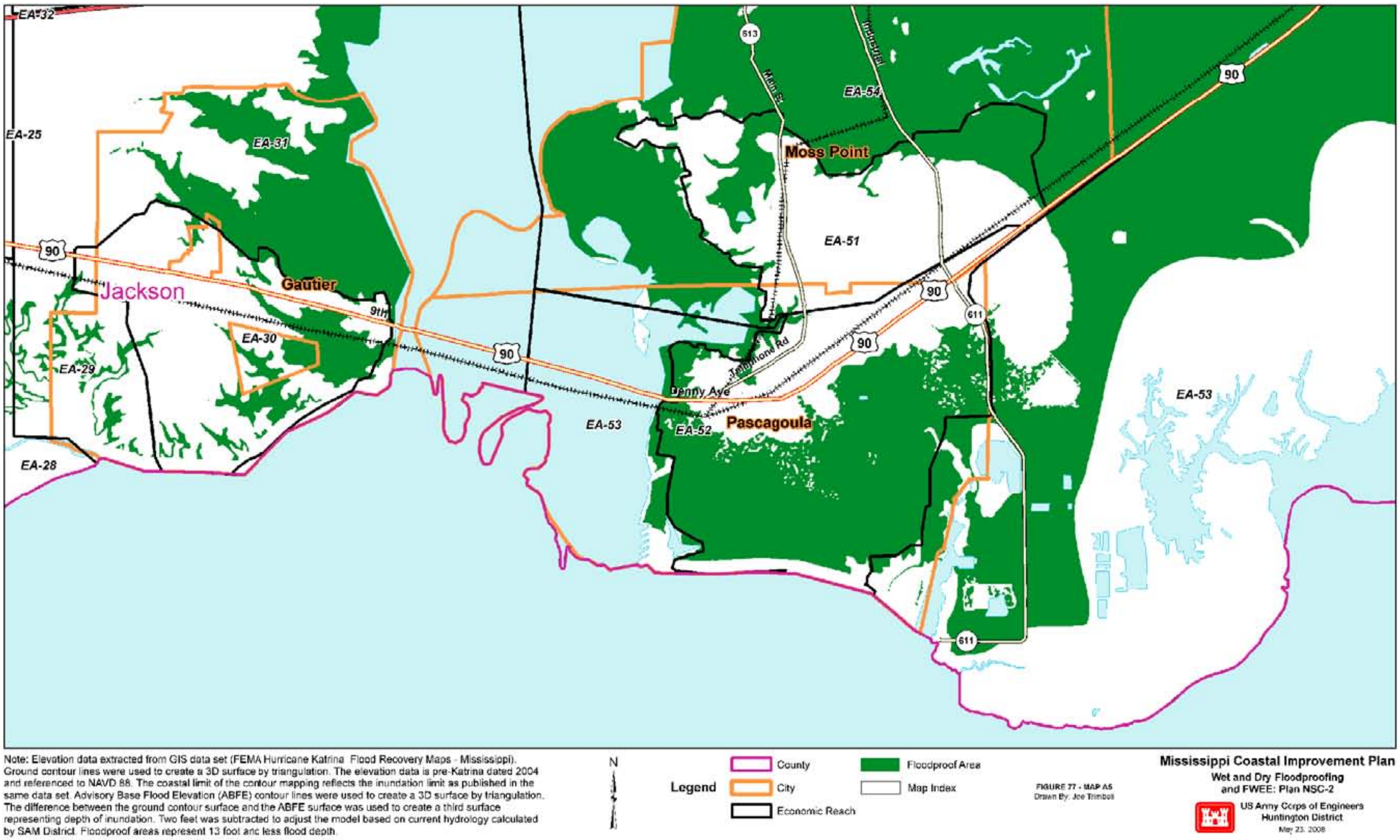


Figure 75 – Plan NSC-2 Dry and Wet Floodproofing w/FWEE Upgrades (A5)



6.7.2.3. Plan NSC-3 – Joint Federal/Non-Federal Jurisdiction Plan

This plan includes an integrated combination of measures that can be accomplished by the Federal government and State and local governments. In effect, this plan is a combination of Plan NSC-1 and Plan NSC-4 integrating all of the components found in both plans. Integration of the measures in each separate plan is complicated by the fact that some of the measures that can effectively reduce flood damages and address losses of life are similar in their effect, but widely different in their application (i.e. Permanent Acquisition and either TDR or PDR) on individual parcels – a combinability issue. Through a collaborative effort, the decisions as where to apply these dissimilar measures would be determined by the USACE, FEMA and State and local agencies and departments. Numbers of structures protected by this plan and the approximate costs are shown in Table 22. Figures 76 through 80 show the application of the various measures described below.

As in Plan NSC-1, this plan would provide protection for structures determined to be eligible for the program as a result of suffering damages from Katrina. The Base Flood Elevation established by the new DFIRM from FEMA would be the minimum level of protection afforded by this plan to be in concert with local floodplain ordinances. Briefly, the plan would consist of permanent acquisitions, floodproofing, replacements of public buildings, flood preparedness and emergency evacuations, floodplain zoning and ordinance enforcement, building codes, land use zoning, development impact fees, redirection of development and either TDR or PDR or both. This suite of nonstructural options applied judiciously across the project area could reduce damages substantially and significantly reduce losses of life due to surge flooding and waves from hurricanes and storms. This plan would require direct expenditures (outside of a normal cost sharing arrangement) of both Federal and non-Federal funds to accomplish the proposed measures – an opportunity for significant in-kind contributions by the non-Federal partner to the overall project cost.

Permanent acquisitions of structures and facilities located in defined high-hazard zones with application of full relocations assistance from the Uniform Relocations Act would reduce the numbers of at-risk structures in these hazardous areas. From a plan formulation standpoint, all acquisitions were considered to be mandatory. During actual project implementation landowners would have the opportunity to participate based upon their personal evaluation of the flood risks and the project benefits that could be made available for relocations to flood-safe properties.

In addition to the structures located in high-hazard zones, other structures located where water depths exceed 13 feet would be acquired as well. Approximately 33,100 parcels (approximately 17,100 structures) would be purchased in this action. Although many of the parcels in the high-hazard zone were found to be vacated immediately after Katrina, it is anticipated (as described in the future without-project condition) that most if not all of the vacated parcels will be rebuilt upon by the time this plan would be implemented. The acquisition costs contain structure and land costs, relocations assistance and structure demolition. The total estimated cost of the permanent acquisition measures (high-hazard zones and areas with water depth greater than 13 feet) is $7.9B.

The acquisition plan could be implemented jointly by the Corps through an authorized project and through FEMA's HMGP program discussed earlier. Since the HMGP funds are administered locally by municipal and county governments in accordance with approved mitigation plans, coordination of those plans with the proposed nonstructural acquisitions in the Corps plan would be paramount in achieving a successful program. In addition, since the HMGP targets primarily insured structures and properties, the Corps' acquisition program could concentrate its resources on uninsured properties in the high-hazard zones. Under any number of possible acquisition scenarios, the high-hazard zones would be cleared of existing structures and facilities (with the exception of certain entertainment, military and industrial uses). Site specific emergency evacuation plans would be prepared for those land uses that could not be removed from high-hazard zones.

In comparison to Plan NCS-1 which relies heavily on direct purchase of properties through the acquisition program, Plan NSC-3 opens the potential for using either TDR or PDR to secure property development rights indefinitely without owning the property. Using these proven techniques, the counties could secure the development rights of those interspersed vacant properties indefinitely while leaving the owner responsible for maintaining the property and paying property taxes (at a somewhat reduced rate). As those programs are funded and administered by state or local governments, costs to the Federal government for reducing flood damages on that interspersed vacant property would be zero while accomplishing the same results indefinitely. A beneficial impact of using the TDR program would be the potential for increasing development densities north of the I-10 corridor where redevelopment communities could be established under the program. The TDR and PDR programs would cost approximately $1.5M to establish and would require annual non-Federal sponsor funding to purchase properties.

In consideration of the number of households that could be displaced as a result of a large acquisition program as described above and the slow redevelopment process in the project area, one or more redevelopment sites would be constructed to accommodate these displaced homeowners and renters. Those redevelopment sites would be selected in close coordination with local planning agencies and community leaders. The redevelopment sites would be planned with standard subdivision amenities and designed and constructed according to local subdivision regulations (where present). Site grading, stormwater drainage, streets, access roads, utilities, platted lots, lighting and signage would be provided for each new subdivision. Relocation funds through the Uniform Relocations Act would provide necessary resources for displaced landowners to construct replacement housing at these flood-safe sites. Total costs of the redevelopment sites are estimated to be $270.0M (based upon a per-lot development cost of $45,000 and 6,000 lots).

As described in Plan NSC-1, voluntary floodproofing in all of its forms would be applied across the project area for eligible structures in this plan. First floor elevation up to 15 feet from the ground surface would be used on residential, commercial and institutional structures as determined to be appropriate for the use and available lot space. Those structures that could not be elevated in-place would be either acquired (see acquisitions above) or offered a rebuilt, floodproofed structure on-site. In any case the most cost effective alternative would be offered to the landowner. For those structures that could not be protected by elevation, other techniques such a dry floodproofing (veneer wall, wall sealants, ringwall, ring-levee, etc.) would be considered. Again, the most cost effective option (floodproofing, acquisition, or rebuilt on-site) would be offered to the landowner. Special needs of the household (handicapped occupants or elderly) can be considered in the access design to the elevated first floor. On-site utilities would be modified to service the raised structure and a 300 square foot enclosed area would be constructed beneath the raised first floor for storage and utility chase. Total estimated costs for elevation of eligible structures (25,419) to the BFE are $10.8B. Table 22 shows the numbers and costs of floodproofing by economic reach.

Public buildings that could not be floodproofed in-place because of their location in a high-hazard zone, depth of flooding or other limitations could be replaced through a relocations contract and reconstructed to current day standards. Approximately 7 public buildings, some of which are considered as critical facilities would be eligible for replacement to a flood safe site. The total estimated cost of those replacements would be approximately $51.2M as shown on Table 22.

Modification and updating of current floodplain zoning and floodplain management ordinances would be implemented by the 11 municipalities and three counties to help reduce flood damages to new construction and rehabilitation of damaged structures. Each of the local jurisdictions would adopt the anticipated new DFIRM's and make necessary modifications within their existing floodplain management ordinances to enforce the new floodplain mapping. In addition, all three counties and 10 municipal areas (Pascagoula exempted) would adopt cumulative, storm-related damages (period of accumulation determined by each locality) as the value (along with improvements value) that triggers compliance with NFIP regulations when compared to 50 percent of the structure value. Also, local jurisdictions would adopt the FEMA 550 guidelines for floodproofing on the Gulf Coast as a part of their floodplain management ordinances so that any new construction in flood-prone areas would be using flood resistant materials and reliable construction techniques. Estimated costs for this measure would be $280,000 in the project area.

Local jurisdictions would adopt the newly revised International Building Code (2006) and provide training for their staff and primary users in the community. Enforcement of the updated codes would help to assure that new construction or any rehabilitation of existing structures would be completed in such a manner as to reduce future flood damages. Adoption of the new codes would take place through appropriate administrative procedures with public involvement and comment. Any training or education seminars concerning use of the new codes would be arranged with the IBC Association at minimal cost since the construction permit process collects fees to offset these costs.

The various municipalities and counties would make modifications to their existing zoning ordinances that would change the types and densities of land uses that could be developed in identified flood-hazard areas. This coastal zoning could take one of two pathways: either very low density development in the higher hazard zones along the coast (just short of a taking) or a mixed use (commercial and high-density residential) that crowds the beachfront with high-rise condominiums and commercial business and entertainment. In addition, counties would revise zoning ordinances to allow higher densities of development (especially residential and commercial) in the flood-free zones. Costs to modify the ordinances as well as the supporting comprehensive plans are estimated to be $500,000 in the project area. To thwart development of new land uses in hazard zones, counties and municipalities would revise their subdivisions regulations such that development in high-hazard zones would be accomplished in such a way to reduce flood damages. Also, development impact fees would be instituted for all new subdivisions with individual lots that are subject to flooding. The costs to initiate this fee structure are estimated to be $370,000 within the project area.

To reduce flood damages and the potential for loss of life, the local jurisdictions would initiate activities identified in flood preparedness, emergency evacuations and public education. Activities such as installation of warning sirens and flashing lights at strategic locations within the communities as well as the purchase and distribution of weather radios to citizens would help to warn at-risk occupants of impending hurricane and storm related flooding. In addition, local jurisdictions would disseminate information brochures on potential hurricane threats and emergency measures to schools, chamber of commerce, hotels and motels and all ports of entry (airports, visitor centers) so that both residents and tourists would be better informed of the threats and evacuation procedures. In cooperation with MDOT the counties could install hurricane evacuation route signage and make minor modifications to intersection signaling that would facilitate the movement of evacuees. In addition, the counties could arrange for the emergency usage of county-owned schools and community centers (located outside of the surge inundation zone) as evacuation centers as well as stockpiling supplies at those centers for emergency use. The estimated cost to implement these improvements to the system is approximately $2.9M.

With all components of the plan combined, the estimated total cost of Plan NSC-3 is $19.1B.

Table 22
NCS-3 – Combined Federal/Non-Federal Jurisdiction Plan

Economic Reaches	Permanent Acquisition Parcels	Cost	Flood proofing	Cost	Relocations	Cost	Flood Warning and Emergency Evacuations	Cost	Floodplain Management	Cost	Land Use Zoning	Cost	TDR & PDR	Cost	Development Impact Fees	Cost
1	997	$194,118,218	394	$124,162,500	0	0	2062	$62,540	2062	$6,042	2062	$10,784	718	$38,715	718	$9,549
2	9911	$2,992,128,131	3294	$1,910,805,000	0	0	19363	$587,280	19363	$56,734	19363	$101,268	6248	$336,892	6248	$83,098
3	2202	$668,691,437	376	$333,327,500	0	0	2673	$81,072	2673	$7,832	2673	$13,980	182	$9,813	182	$2,421
4	922	$120,307,917	16	$30,715,000	0	0	901	$27,327	901	$2,640	901	$4,712	6	$324	6	$80
5	2714	$238,388,794	119	$79,272,500	0	0	3109	$94,296	3109	$9,109	3109	$16,260	346	$18,656	346	$4,602
6	567	$107,292,775	590	$311,335,000	1	$8,536,147	1123	$34,061	1123	$3,290	1123	$5,873	10	$539	10	$133
7	450	$33,303,080	232	$186,928,125	0	0	1574	$47,739	1574	$4,612	1574	$8,232	1012	$54,567	1012	$13,460
8	3623	$476,153,333	1730	$691,816,250	4	$25,608,442	8716	$264,356	8716	$25,538	8716	$45,585	4772	$257,306	4772	$63,468
9	44	$16,145,783	16	$16,552,500	0	0	52	$1,577	52	$152	52	$272	16	$863	16	$213
10	1945	$432,607,234	62	$24,201,250	0	0	1727	$52,380	1727	$5,060	1727	$9,032	32	$1,725	32	$426
11	0	0	8	$2,105,000	0	0	44	$1,335	44	$129	44	$230	36	$1,941	36	$479
12	1047	$179,783,825	1136	$438,818,125	0	0	2777	$84,226	2777	$8,137	2777	$14,524	849	$45,778	849	$11,292
13	650	$583,121,543	0	0	0	0	500	$15,165	500	$1,465	500	$2,615	0	0	0	0
14	0	0	0	0	0	0	788	$23,900	788	$2,309	788	$4,121	221	$11,897	221	$2,935
15	85	$44,354,843	9	$28,406,250	0	0	76	$2,305	76	$223	76	$397	1	$54	1	$13
16	78	$16,399,728	121	$38,542,500	0	0	209	$6,339	209	$612	209	$1,093	35	$1,887	35	$466
17	0	0	0	0	0	0	6	$182	6	$18	6	$31	2	$91	2	$22
18	1502	$409,463,532	5	$1,396,250	0	0	1223	$3,7094	1223	$3,583	1223	$6,396	3	$162	3	$40
19	46	$292,728,063	0	0	0	0	22	$667	22	$64	22	$115	0	0	0	0
20	1397	$238,563,082	2050	$853,008,125	1	$8,536,147	3064	$92,931	3064	$8,978	3064	$16,025	592	$31,921	592	$7,874
21	2108	$301,824,272	419	$174,587,500	0	0	1867	$56,626	1867	$5,470	1867	$9,764	497	$26,798	497	$6,610
22	61	$26,330,663	92	$44,933,750	0	0	157	$4,762	157	$460	157	$821	4	$216	4	$53
23	0	0	44	$24,735,000	0	0	65	$1,971	65	$190	65	$340	42	$2,265	42	$559
24	220	$65,229,821	178	$58,153,750	0	0	524	$15,893	524	$1,535	524	$2,741	119	$6,416	119	$1,583
25	0	0	0	0	0	0	327	$9,918	327	$958	327	$1,710	92	$4,937	92	$1,218
26	37	$9,210,336	952	$321,001,875	0	0	1279	$38,792	1279	$3,747	1279	$6,689	289	$15,583	289	$3,844
27	53	$12,880,944	1029	$264,738,125	0	0	2145	$65,058	2145	$6,285	2145	$11,218	1063	$57,317	1063	$14,138
28	961	$90,294,697	122	$59,837,500	0	0	1718	$52,107	1718	$5,034	1718	$8,985	633	$34,131	633	$8,419
29	147	$23,394,829	168	$63,560,625	0	0	546	$16,560	546	$1,600	546	$2,856	231	$12,456	231	$3,072
30	90	$29,459,003	467	$197,030,000	0	0	626	$18,987	626	$1,834	626	$3,274	64	$3,451	64	$851
31	51	$14,959,829	447	$209,015,000	0	0	708	$21,474	708	$2,074	708	$3,703	307	$16,553	307	$4,083
32	0	0	208	$64,368,750	0	0	398	$12,071	398	$1,166	398	$2,082	269	$14,504	269	$3,578
33	0	0	0	0	0	0	77	$2,335	77	$226	77	$403	22	$1,163	22	$287
34	0	0	0	0	0	0	600	$18,198	600	$1,758	600	$3,138	168	$9,059	168	$2,234
35	12	$682,228	1406	$431,113,125	0	0	1599	$48,498	1599	$4,685	1599	$8,363	758	$40,871	758	$10,081
36	32	$3,834,485	2	$6,312,500	0	0	62	$1,880	62	$182	62	$324	51	$2,750	51	$678
37	0	0	0	0	0	0	540	$16,378	540	$1,582	540	$2,824	151	$8,153	151	$2,011
38	50	$21,424,866	78	$19,440,625	0	0	364	$11,040	364	$1,067	364	$1,904	259	$13,965	259	$3,445
39	0	0	6	$1,204,375	0	0	25	$758	25	$73	25	$131	19	$1,024	19	$253
40	0	0	0	0	0	0	7824	$237,302	7824	$22,924	7824	$40,920	2191	$118,124	2191	$29,137
41	0	0	0	0	0	0	536	$16,257	536	$1,570	536	$2,803	150	$8,092	150	$1,996
42	0	0	0	0	0	0	667	$20,230	667	$1,954	667	$3,488	187	$10,070	187	$2,484
43	0	0	1	$206,250	0	0	25	$61	25	$6	25	$10	1	$54	1	$13
44	0	0	0	0	0	0	2587	$78,464	2587	$7,580	2587	$13,350	724	$39,057	724	$9,634
45	0	0	0	0	0	0	2267	$68,758	2267	$6,642	2267	$11,856	635	$34,226	635	$8,442

Economic Reaches	Permanent Acquisition Parcels	Cost	Flood proofing	Cost	Relocations	Cost	Flood Warning and Emergency Evacuations	Cost	Floodplain Management	Cost	Land Use Zoning	Cost	TDR & PDR	Cost	Development Impact Fees	Cost
46	0	0	0	0	0	0	3331	$101,029	3331	$9,760	3331	$17,421	933	$50,290	933	$12,405
47	0	0	0	0	0	0	1303	$39,520	1303	$3,818	1303	$6,815	365	$19,672	365	$4,852
48	0	0	2	$445,000	0	0	1	$61	1	$6	1	$10	0	0	0	0
49	0	0	0	0	0	0	338	$10,252	338	$990	338	$1,768	95	$5,103	95	$1,259
50	495	$89,312,661	848	$263,763,750	0	0	1594	$48,346	1594	$4,670	1594	$8,337	410	$22,107	410	$5,453
51	0	0	786	$299,966,875	0	0	1089	$33,029	1089	$3,191	1089	$5,695	302	$16,284	302	$4,017
52	285	$103,016,211	6838	$2,300,775,000	1	$8,536,147	7628	$231,357	7628	$22,350	7628	$39,894	485	$26,151	485	$6,451
53	399	$113,054,873	360	$256,581,875	0	0	1557	$38,125	1557	$3,683	1557	$6,574	499	$26,906	499	$6,637
54	9	$1,114,862	808	$396,536,875	0	0	1548	$46,951	1548	$4,536	1548	$8,096	726	$39,146	726	$9,656
Subtotals	**33,191***	**$7,928,411,301**	**25,419**	**$10,803,744,154**	**7**	**$51,216,883**	**95,931**	**$2,899,820**	**95,931**	**$280,133**	**95,931**	**$499,852**	**27,822**	**$1,500,025**	**27,822**	**$370,004**
H&CD Sites		Jackson, Harrison and Hancock Counties				6,000 lots in 3 counties at $45,000 per lot								Total Cost for H&CD sites - **$270,000,000**		
Safe harborages		Jackson, Harrison and Hancock Counties				3 safe harborages – $7.7M each								Total Cost of Safe Harborages **- $23,100,000**		
Total Plan Cost														**$19,082,022,338**		

Notes: 1) The numbers of tracts listed under the TDR/PDR and Development Impact Fees measures are estimated vacated tracts within each reach to which the measures would be applied.

2) Building Codes as a measure were omitted from the table due to space limitations in the table. There are no project costs for upgrading and enforcing building codes since the building construction permitting fee system reimburses the administrative costs for this local measure. The parcels affected by the building codes and the $0 cost is shown in Table 23 for Plan NSC-4.

* The total number of parcels eligible for purchase contain approximately 17,100 structures (residential and commercial)

1

Figure 76 – Plan NSC-3 Joint Federal/Non-Federal Jurisdiction Plan (A1)

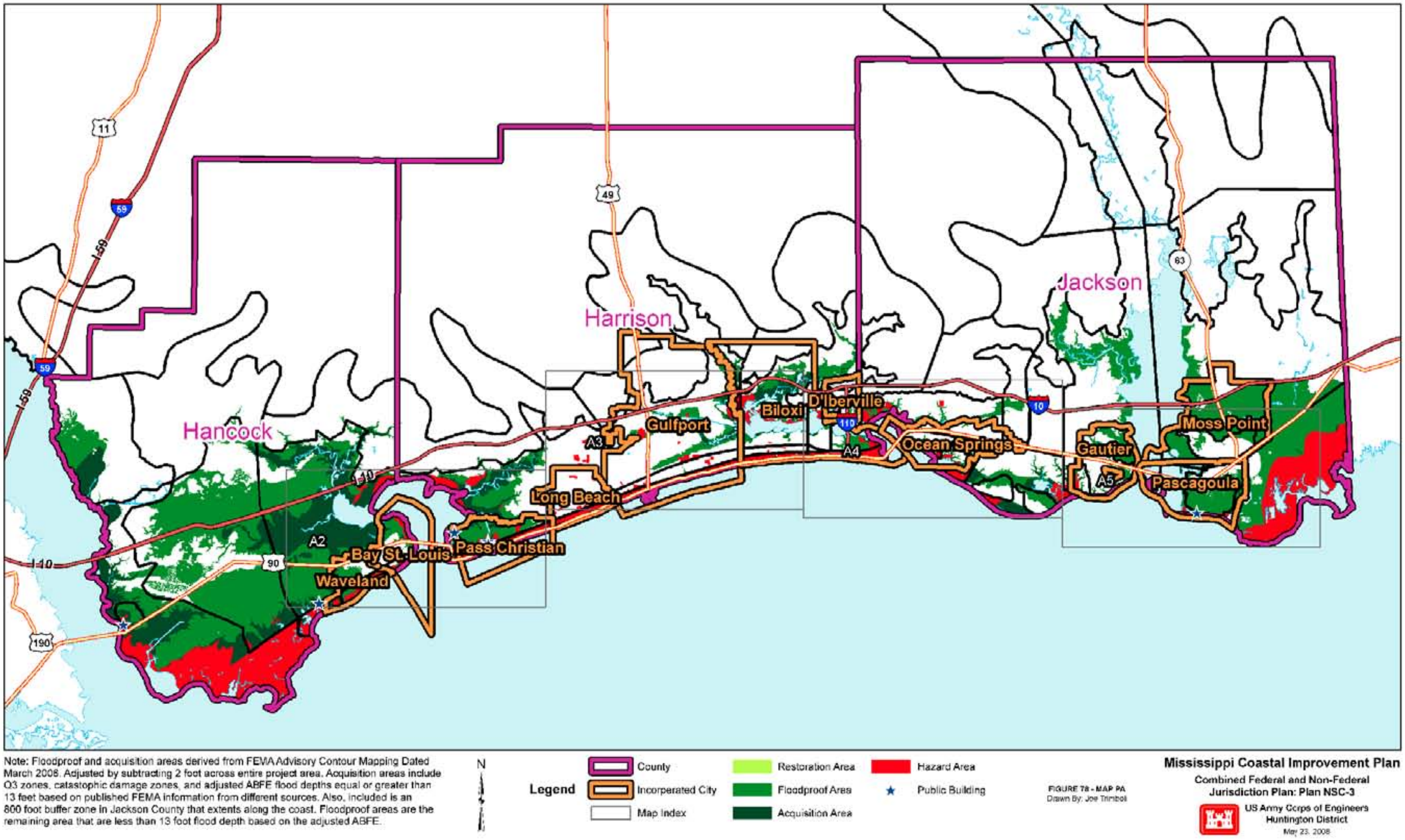


Figure 77 – Plan NSC-3 Joint Federal/Non-Federal Jurisdiction Plan (A2)

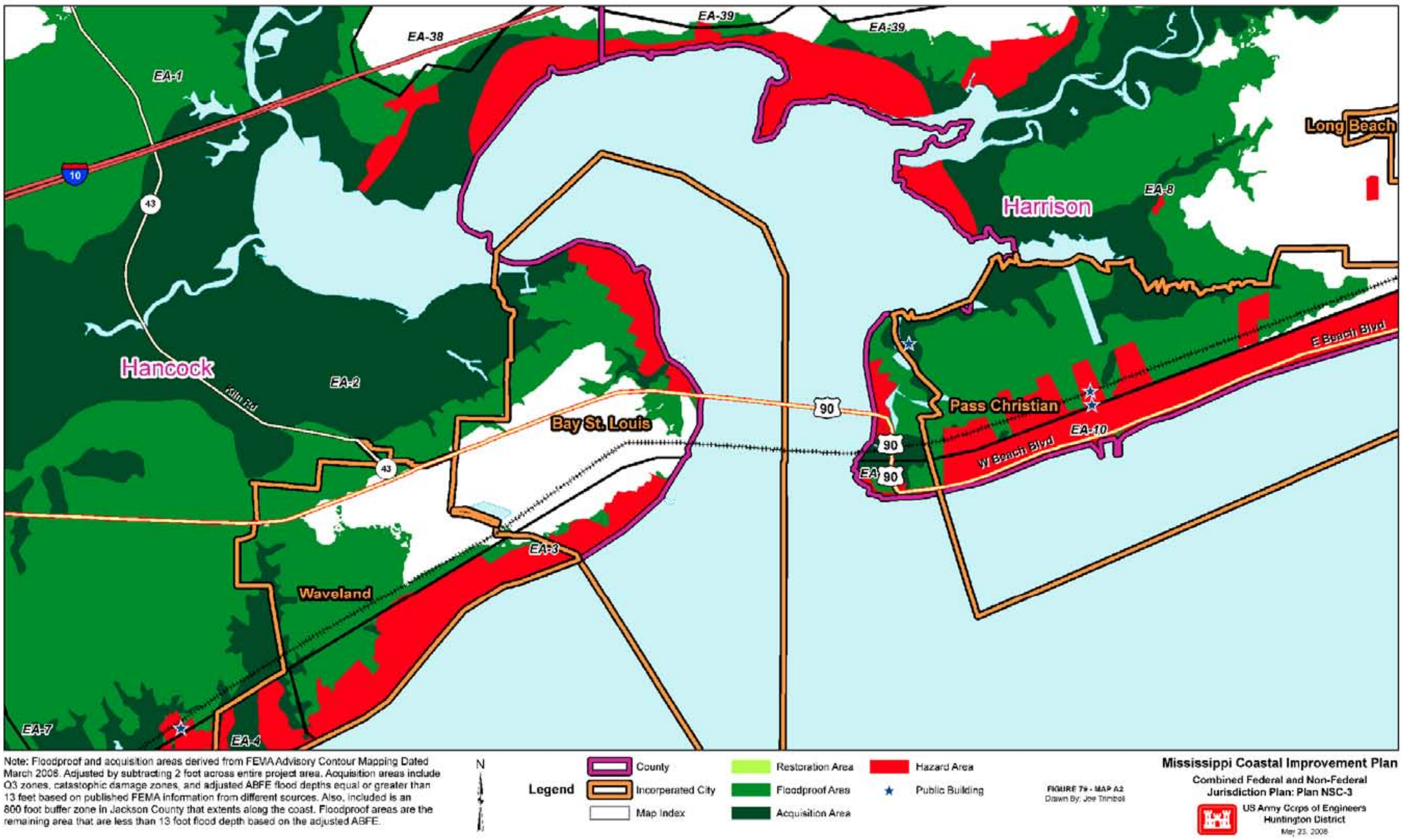


Figure 78 – Plan NSC-3 Joint Federal/Non-Federal Jurisdiction Plan (A3)

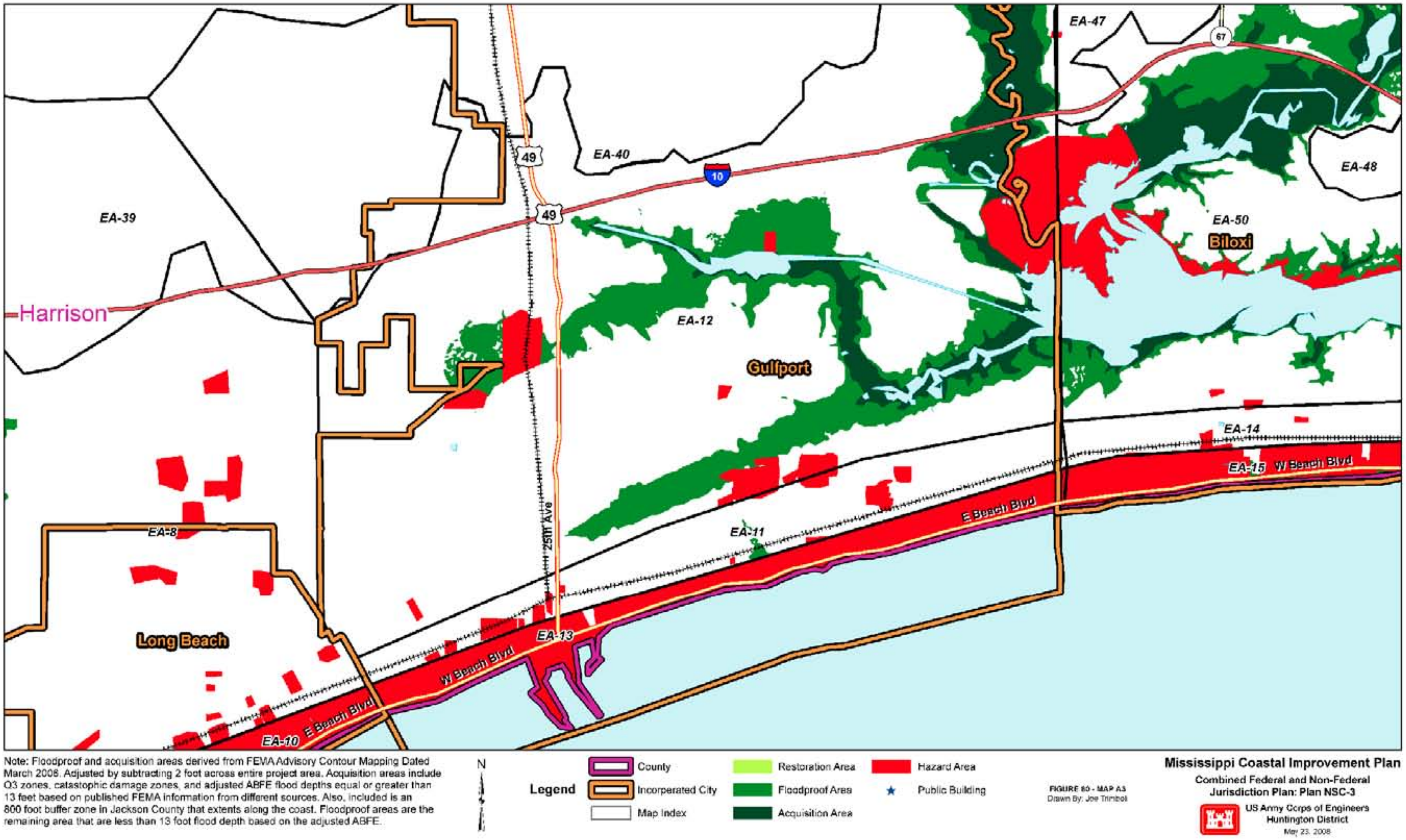


Figure 79 – Plan NSC-3 Joint Federal/Non-Federal Jurisdiction Plan (A4)

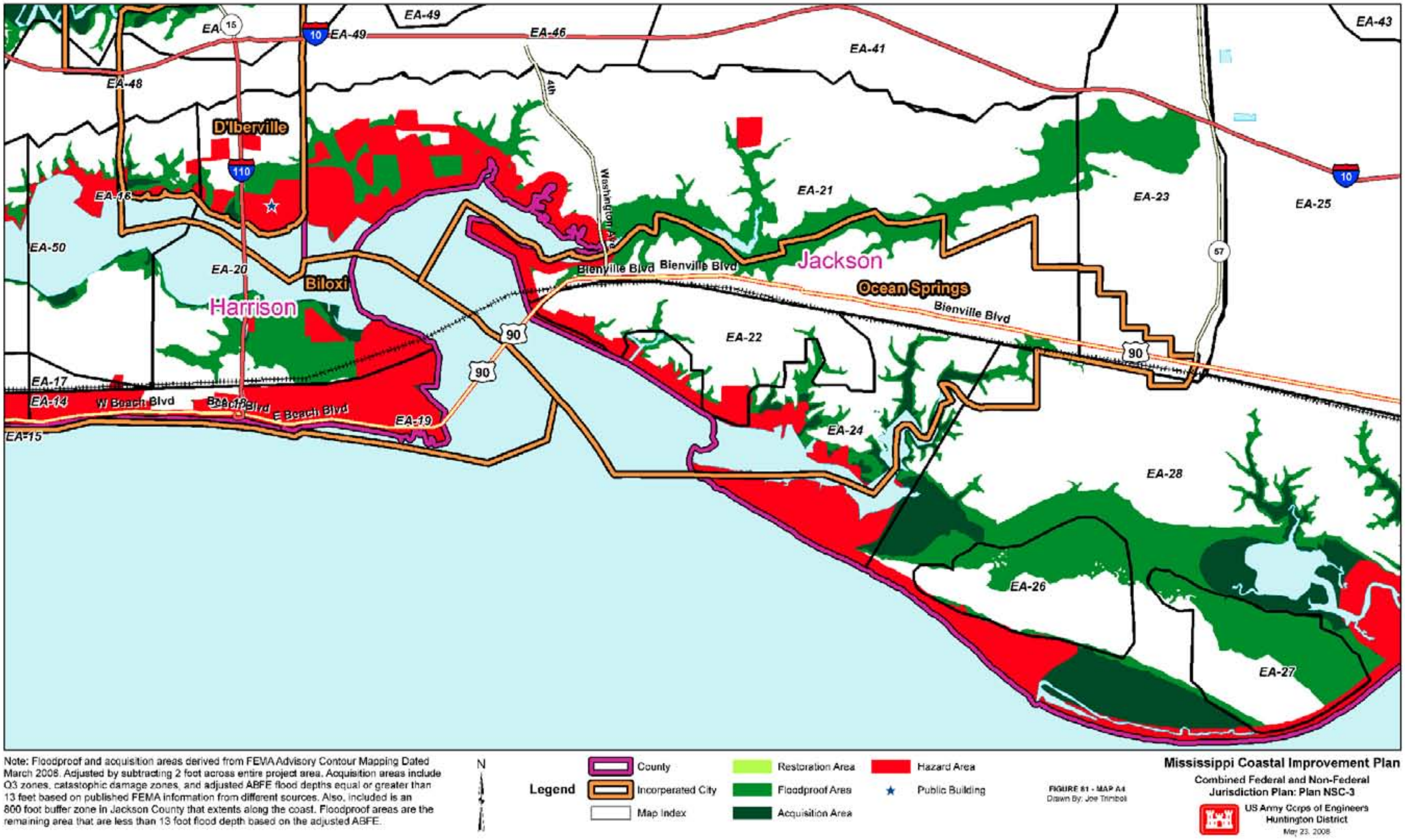
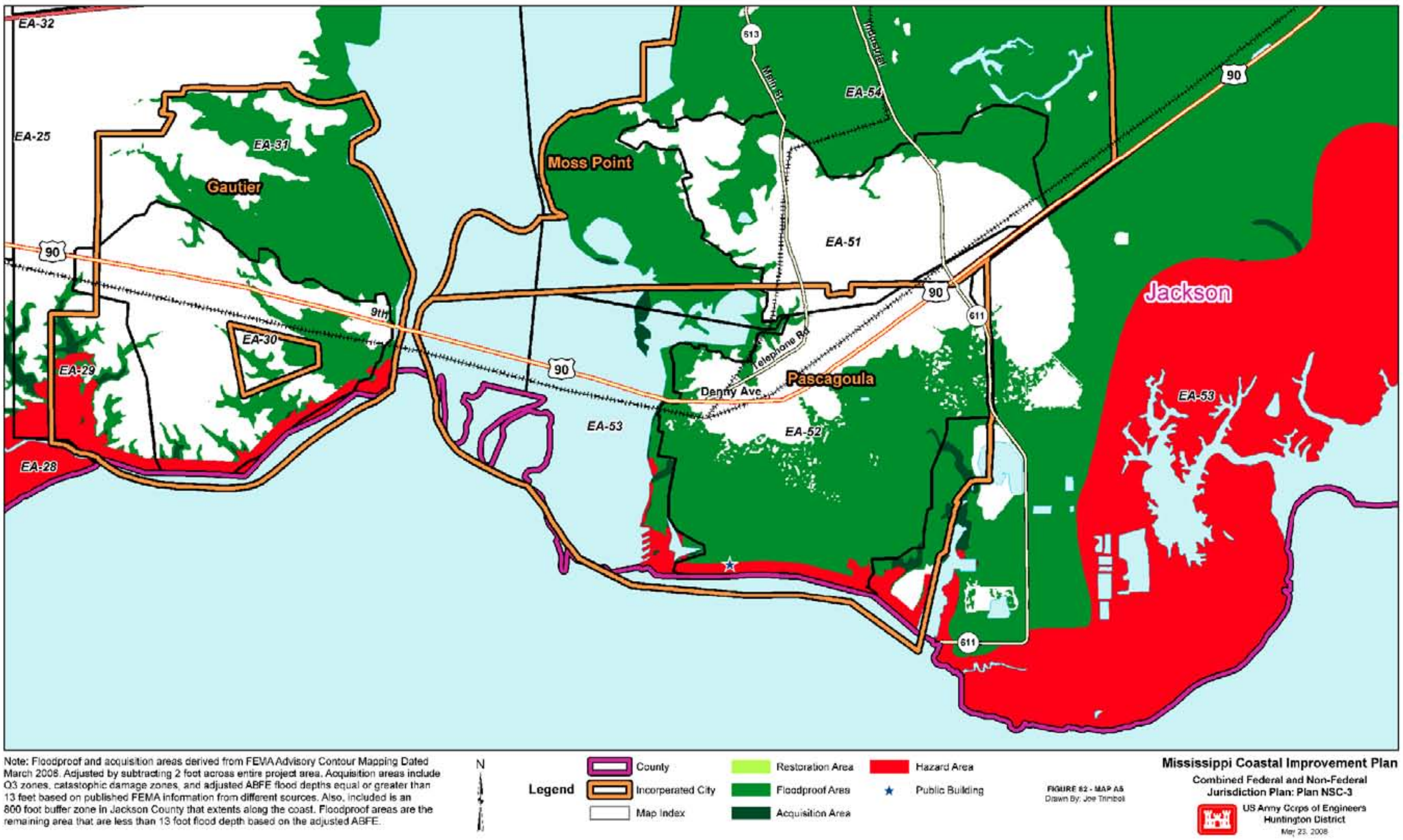


Figure 80 – Plan NSC-3 Joint Federal/Non-Federal Jurisdiction Plan (A5)



In an effort to redirect new development away from high-hazard flooding areas, the local jurisdictions (especially the three counties) would establish either a Transfer of Development Rights or Purchase of Development Rights program within each of the three counties in the project area. Prior to establishing one or more of these programs, the local jurisdictions would have to petition the state legislature through their local representatives to enact enabling legislation that would authorize the three affected counties (and other jurisdictions as may be applicable) within the project area to create the necessary organizations (non-profit) that would administer the TDR and/or PDR programs. Once the enabling legislation is in place, the counties could establish non-profit organizations that would administer the programs and provide start-up funding for administration costs.

Then, in cooperation with the Corps of Engineers, the non-profit organizations would determine the boundaries of the sending (high-hazard zone) and receiving (flood-safe areas) districts for the TDR program or determine only the high-hazard zone from which development rights would be purchased under a PDR program. With property valuation information from the tax assessor's office, the non-profit organization would calculate monetary amounts for the development rights on each property in the sending area. In addition to these programmatic activities, the local jurisdictions would implement a project-wide advertisement and education program informing people of the flood-damage reduction benefits of the TDR/PDR programs and to encourage participation in this voluntary program. In the absence of a Federally-funded permanent acquisition program for the high-hazard zones, the non-profit organization would be unencumbered in their program to either transfer or purchase development rights in those delineated zones. The estimated administrative costs to initiate the TDR and PDR programs are $1.5M ($500,000 for each planning unit). Total acquisition costs for a PDR program may approximate between 60 and 80 percent of the total Federal purchase costs since only the development rights portion of the total land rights package would be acquired. Landowners would retain the land value and continue to operate and maintain the property while assuming a much reduced property tax burden.

6.7.2.4 Plan NSC-4 – Non-Federal Jurisdiction Plan

This plan consists of measures that can be enacted by the local municipalities and counties to reduce flood damages and loss of life. Over 95,000 individual parcels of land in the project area would be affected by these measures enacted by the municipal and county governments. The approximate numbers of parcels that would be affected by these measures and the estimated costs (local and administrative) to implement the measures are shown in Table 23 by economic reach. Figures 81 through 85 show the areas of county and municipal jurisdiction where these measures would be applied.

Implementation of each of these measures is through the police powers granted to individual municipal and county governments by the state and is generally outside the purview of the Federal or state Government. Their implementation would be contingent in part upon the local perception of the flood risks, the political will of the local government leadership and the willingness to invest local funds in the needed changes. The costs of these measures would be largely borne by local jurisdictions (see below for exceptions) and therefore do not generate Federal project costs per se, but there would be flood damage reduction benefits (albeit difficult to quantify) accruing to the project area. The benefits of these locally implemented measures would be found in the incremental inundation damages that would be suffered in the absence of upgrades to the existing control and enforcements systems recommended in this plan.

Some funding for the proposed measures (i.e. Flood Preparedness and Public Education) may be provided by Federal or state agencies (FEMA, MEMA), but generally the administration of the measures would be through local jurisdictions. Although the NFIP is a Federal program administered through FEMA, enforcement of the floodplain ordinances and zoning mapping is clearly the responsibility of local jurisdictions. The ability of the local governments to enact and administer either a TDR or PDR program would be based upon enabling legislation enacted by the state legislature.

Modification and updating of current floodplain zoning and floodplain management ordinances would be implemented by the 11 municipalities and three counties to help reduce flood damages to new construction and rehabilitation of damaged structures. Each of the local jurisdictions would adopt the anticipated new DFIRM's and make necessary modifications within their existing floodplain management ordinances to enforce the new floodplain mapping. In addition, each county and municipality (Pascagoula exempted) would adopt the concept of cumulative storm-related damages as a trigger for determining when a structure must comply with NFIP regulations. Also, local jurisdictions would adopt the FEMA 550 guidelines for floodproofing on the Gulf Coast as a part of their floodplain management ordinances so that any new construction in flood-prone areas would be using flood resistant materials and reliable construction techniques. The estimated administrative and legal costs to update and modify the local ordinances across the project area are $280,000 for the 11 municipalities and 3 counties.

Local jurisdictions would adopt the newly revised International Building Code (circa 2006) and provide training for their staff and primary users in the community. All of the local jurisdictions are using at least the 2003 IBC standards now. Enforcement of the updated codes would help to assure that new construction or any rehabilitation of existing structures would be completed in such a manner as to reduce future flood damages. Adoption of the new codes would take place through appropriate administrative procedures with public involvement and comment. Costs to modify the codes would be offset by building permit fees charged by the municipalities and counties. Any training or education seminars concerning use of the new codes would be arranged with the IBC Association at minimal cost.

The various municipalities and counties would make modifications to their existing zoning ordinances that would change the types and densities of land uses that could be developed in identified flood-hazard areas. This coastal zoning could take one of two pathways: either very low density development in the higher hazard zones along the coast (just short of a taking) or a mixed use (commercial and high-density residential) that crowds the beachfront with high-rise condominiums and commercial business and entertainment. In addition, counties would revise zoning ordinances to allow higher densities of development (especially residential and commercial) in the flood-free zones. To thwart development of new land uses in hazard zones, counties and municipalities would revise their subdivision regulations such that development in high-hazard zones would be accomplished in such a way to reduce flood damages. Also, development impact fees would be instituted for all new subdivisions with individual lots that are subject to flooding at an approximate local cost of $370,000. The estimated cost for modifying the zoning ordinances across the project area is $500,000 and is largely composed of local administrative and legal costs.

To reduce flood damages and the potential for loss of life, the local jurisdictions would initiate activities identified in flood preparedness, emergency evacuations and public education. Activities such as installation of warning sirens and flashing lights at strategic locations within the communities as well as the purchase and distribution of weather radios to citizens would help to warn at-risk occupants of impending hurricane and storm related flooding. In addition, local jurisdictions would disseminate information brochures on potential hurricane threats and emergency measures to schools, chamber of commerce, hotels and motels and all ports of entry (airports, visitor centers) so that both residents and tourists would be better informed of the threats and evacuation procedures. In cooperation with MDOT the counties could install hurricane evacuation route signage and make minor modifications to intersection signaling that would facilitate the movement of evacuees. In addition, the counties could arrange for the emergency usage of county owned schools and community centers as evacuation centers as well as stockpiling supplies at those centers for emergency use. The estimated cost to implement the upgrades to this system is $2.9M.

In an effort to redirect new development away from high-hazard flooding areas, the local jurisdictions (especially the three counties) would establish either a Transfer of Development Rights or Purchase of Development Rights program within each of the three counties in the project area. Prior to establishing one or more of these programs, the local jurisdictions would have to petition the state legislature through their local representatives to enact enabling legislation that would authorize the three affected counties (and other jurisdictions as may be applicable) within the project area to create the necessary organizations (non-profit) that would administer the TDR and/or PDR programs. Once the enabling legislation is in place, the counties would establish non-profit organizations that would administer the programs and provide start-up funding for administration costs. Then, in cooperation with the Corps of Engineers, the non-profit organizations would determine the boundaries of the sending (high-hazard flood-prone) and receiving (flood-safe) districts for the TDR program or determine only the high-hazard areas from which development rights would be purchased under a PDR program. With property valuation information from the tax assessor's office, the non-profit organization would calculate monetary amounts for the development rights on each property in the sending area.

In addition to these programmatic activities, the local jurisdictions would implement a project wide advertisement and education program informing people of the flood-damage reduction benefits of the TDR/PDR programs and to encourage participation in this voluntary program. In the absence of a Federally-funded permanent acquisition program for the high-hazard zones, the non-profit organization would be unencumbered in their program to either transfer or purchase development rights in those delineated zones. The estimated administrative cost to initiate the TDR and PDR programs is $1.5M for the three counties. Annual costs of acquiring development rights under the PDR program would be funded through non-Federal sources (state and local).

Table 23
Plan NSC-4 – Non-Federal Jurisdiction Plan

Economic Reaches	Land Use Zoning	Cost	Floodplain Management	Cost	TDR & PDR	Cost	Flood Warning and Emergency Evacuation	Cost	Building Codes	Cost	Development Impact Fees	Cost
1	2062	$10,784	2062	$6,042	718	$38,715	2062	$62,540	2062	$0	718	$9,549
2	19363	$101,268	19363	$56,734	6248	$336,892	19363	$587,280	19363	$0	6248	$83,098
3	2673	$13,980	2673	$7,832	182	$9,813	2673	$81,072	2673	$0	182	$2,421
4	901	$4,712	901	$2,640	6	$324	901	$27,327	901	$0	6	$80
5	3109	$16,260	3109	$9,109	346	$18,656	3109	$94,296	3109	$0	346	$4,602
6	1123	$5,873	1123	$3,290	10	$539	1123	$34,061	1123	$0	10	$133
7	1574	$8,232	1574	$4,612	1012	$54,567	1574	$47,739	1574	$0	1012	$13,460
8	8716	$45,585	8716	$25,538	4772	$257,306	8716	$264,356	8716	$0	4772	$63,468
9	52	$272	52	$152	16	$863	52	$1,577	52	$0	16	$213
10	1727	$9,032	1727	$5,060	32	$1,725	1727	$52,380	1727	$0	32	$426
11	44	$230	44	$129	36	$1,941	44	$1,335	44	$0	36	$479
12	2777	$14,524	2777	$8,137	849	$45,778	2777	$84,226	2777	$0	849	$11,292
13	500	$2,615	500	$1,465	0	0	500	$15,165	500	$0	0	0
14	788	$4,121	788	$2,309	221	$11,897	788	$23,900	788	$0	221	$2,935
15	76	$397	76	$223	1	$54	76	$2,305	76	$0	1	$13
16	209	$1,093	209	$612	35	$1,887	209	$6,339	209	$0	35	$466
17	6	$31	6	$18	2	$91	6	$182	6	$0	2	$22
18	1223	$6,396	1223	$3,583	3	$162	1223	$3,7094	1223	$0	3	$40
19	22	$115	22	$64	0	0	22	$667	22	$0	0	0
20	3064	$16,025	3064	$8,978	592	$31,921	3064	$92,931	3064	$0	592	$7,874
21	1867	$9,764	1867	$5,470	497	$26,798	1867	$56,626	1867	$0	497	$6,610
22	157	$821	157	$460	4	$216	157	$4,762	157	$0	4	$53
23	65	$340	65	$190	42	$2,265	65	$1,971	65	$0	42	$559
24	524	$2,741	524	$1,535	119	$6,416	524	$15,893	524	$0	119	$1,583
25	327	$1,710	327	$958	92	$4,937	327	$9,918	327	$0	92	$1,218
26	1279	$6,689	1279	$3,747	289	$15,583	1279	$38,792	1279	$0	289	$3,844
27	2145	$11,218	2145	$6,285	1063	$57,317	2145	$65,058	2145	$0	1063	$14,138
28	1718	$8,985	1718	$5,034	633	$34,131	1718	$52,107	1718	$0	633	$8,419
29	546	$2,856	546	$1,600	231	$12,456	546	$16,560	546	$0	231	$3,072
30	626	$3,274	626	$1,834	64	$3,451	626	$18,987	626	$0	64	$851
31	708	$3,703	708	$2,074	307	$16,553	708	$21,474	708	$0	307	$4,083
32	398	$2,082	398	$1,166	269	$14,504	398	$12,071	398	$0	269	$3,578
33	77	$403	77	$226	22	$1,163	77	$2,335	77	$0	22	$287
34	600	$3,138	600	$1,758	168	$9,059	600	$18,198	600	$0	168	$2,234
35	1599	$8,363	1599	$4,685	758	$40,871	1599	$48,498	1599	$0	758	$10,081
36	62	$324	62	$182	51	$2,750	62	$1,880	62	$0	51	$678
37	540	$2,824	540	$1,582	151	$8,153	540	$16,378	540	$0	151	$2,011
38	364	$1,904	364	$1,067	259	$13,965	364	$11,040	364	$0	259	$3,445
39	25	$131	25	$73	19	$1,024	25	$758	25	$0	19	$253
40	7824	$40,920	7824	$22,924	2191	$118,124	7824	$237,302	7824	$0	2191	$29,137

Economic Reaches	Land Use Zoning	Cost	Floodplain Management	Cost	TDR & PDR	Cost	Flood Warning and Emergency Evacuation	Cost	Building Codes	Cost	Development Impact Fees	Cost
41	536	$2,803	536	$1,570	150	$8,092	536	$16,257	536	$0	150	$1,996
42	667	$3,488	667	$1,954	187	$10,070	667	$20,230	667	$0	187	$2,484
43	25	$10	25	$6	1	$54	25	$61	25	$0	1	$13
44	2587	$13,350	2587	$7,580	724	$39,057	2587	$78,464	2587	$0	724	$9,634
45	2267	$11,856	2267	$6,642	635	$34,226	2267	$68,758	2267	$0	635	$8,442
46	3331	$17,421	3331	$9,760	933	$50,290	3331	$101,029	3331	$0	933	$12,405
47	1303	$6,815	1303	$3,818	365	$19,672	1303	$39,520	1303	$0	365	$4,852
48	1	$10	1	$6	0	0	1	$61	1	$0	0	0
49	338	$1,768	338	$990	95	$5,103	338	$10,252	338	$0	95	$1,259
50	1594	$8,337	1594	$4,670	410	$22,107	1594	$48,346	1594	$0	410	$5,453
51	1089	$5,695	1089	$3,191	302	$16,284	1089	$33,029	1089	$0	302	$4,017
52	7628	$39,894	7628	$22,350	485	$26,151	7628	$231,357	7628	$0	485	$6,451
53	1557	$6,574	1557	$3,683	499	$26,906	1557	$38,125	1557	$0	499	$6,637
54	1548	$8,096	1548	$4,536	726	$39,146	1548	$46,951	1548	$0	726	$9,656
Subtotals	**95931**	**$499,852**	**95931**	**$280,133**	**27822**	**$1,500,025**	**95931**	**$2,899,820**	**95931**	**$0**	**27822**	**$370,004**
Total cost	**Total Nonstructural Parcels in Plan – 95,931**											**$5,550,000**

Note: Building codes are self sufficient through assessed fees for construction permits, therefore the cost to implement and maintain them is $0.00

Figure 81 – Plan NSC-4 Non-Federal Jurisdiction Plan (A1)

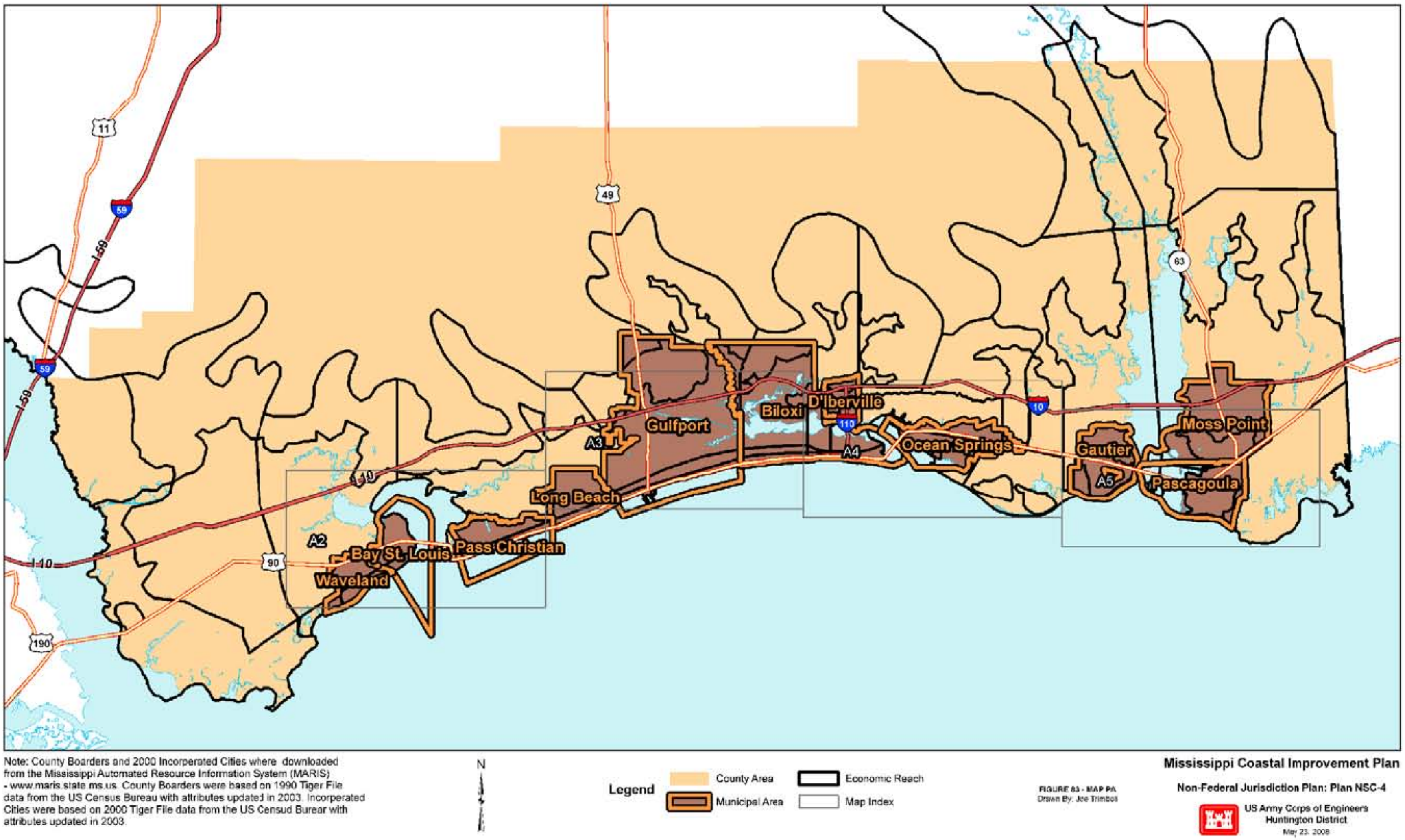


Figure 82 – Plan NSC-4 Non-Federal Jurisdiction Plan (A2)

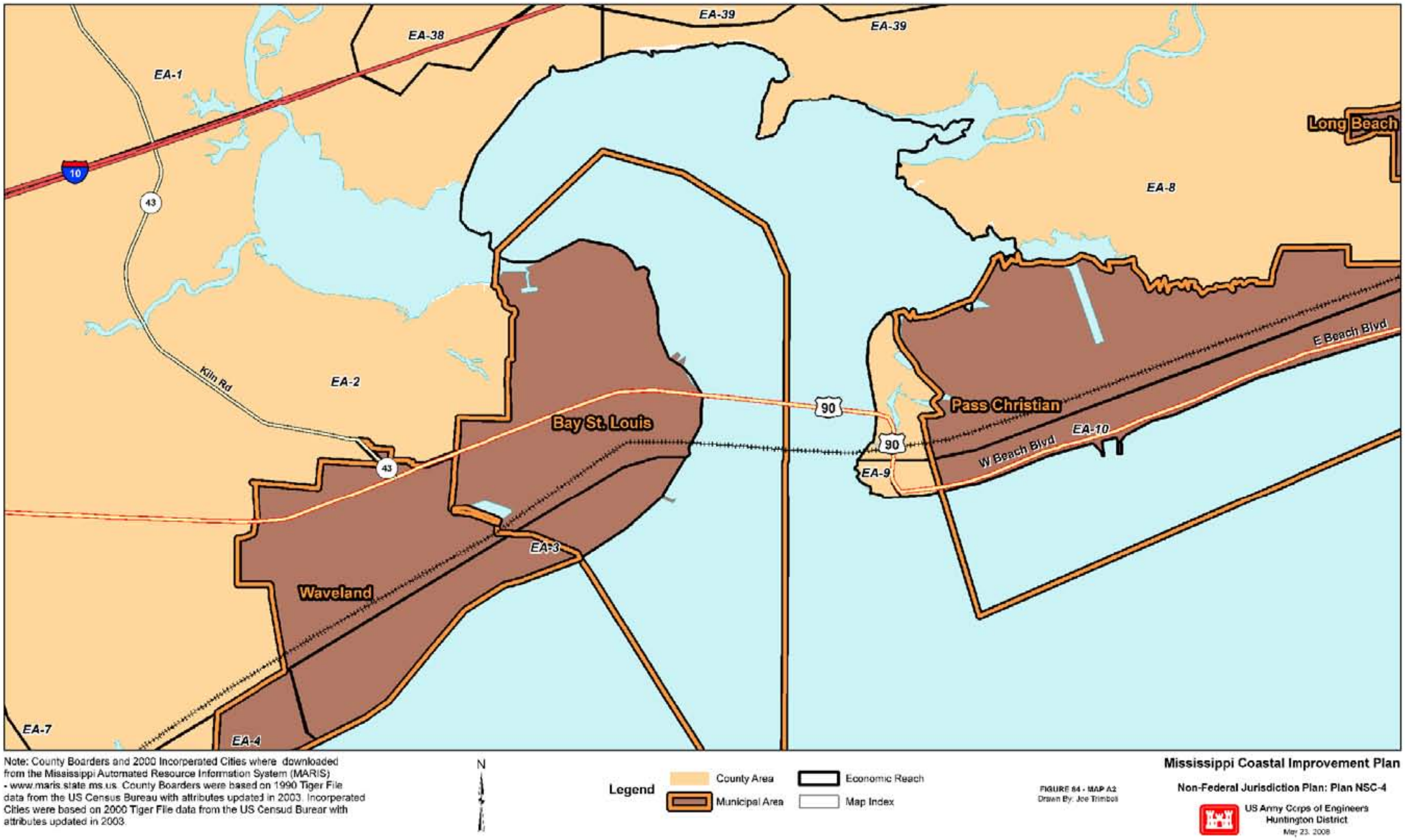


Figure 83 – Plan NSC-4 Non-Federal Jurisdiction Plan (A3)

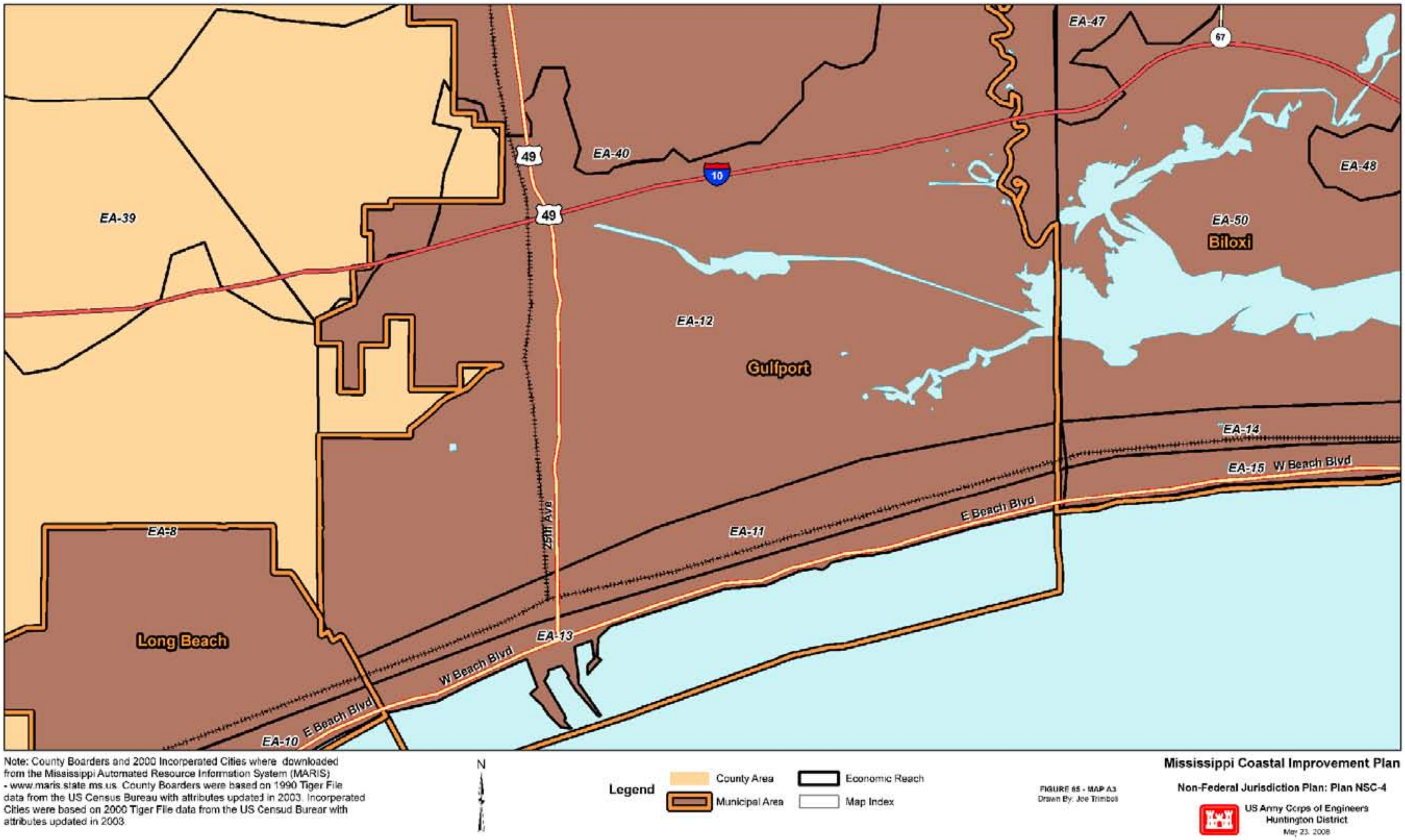


Figure 84 – Plan NSC-4 Non-Federal Jurisdiction Plan (A4)

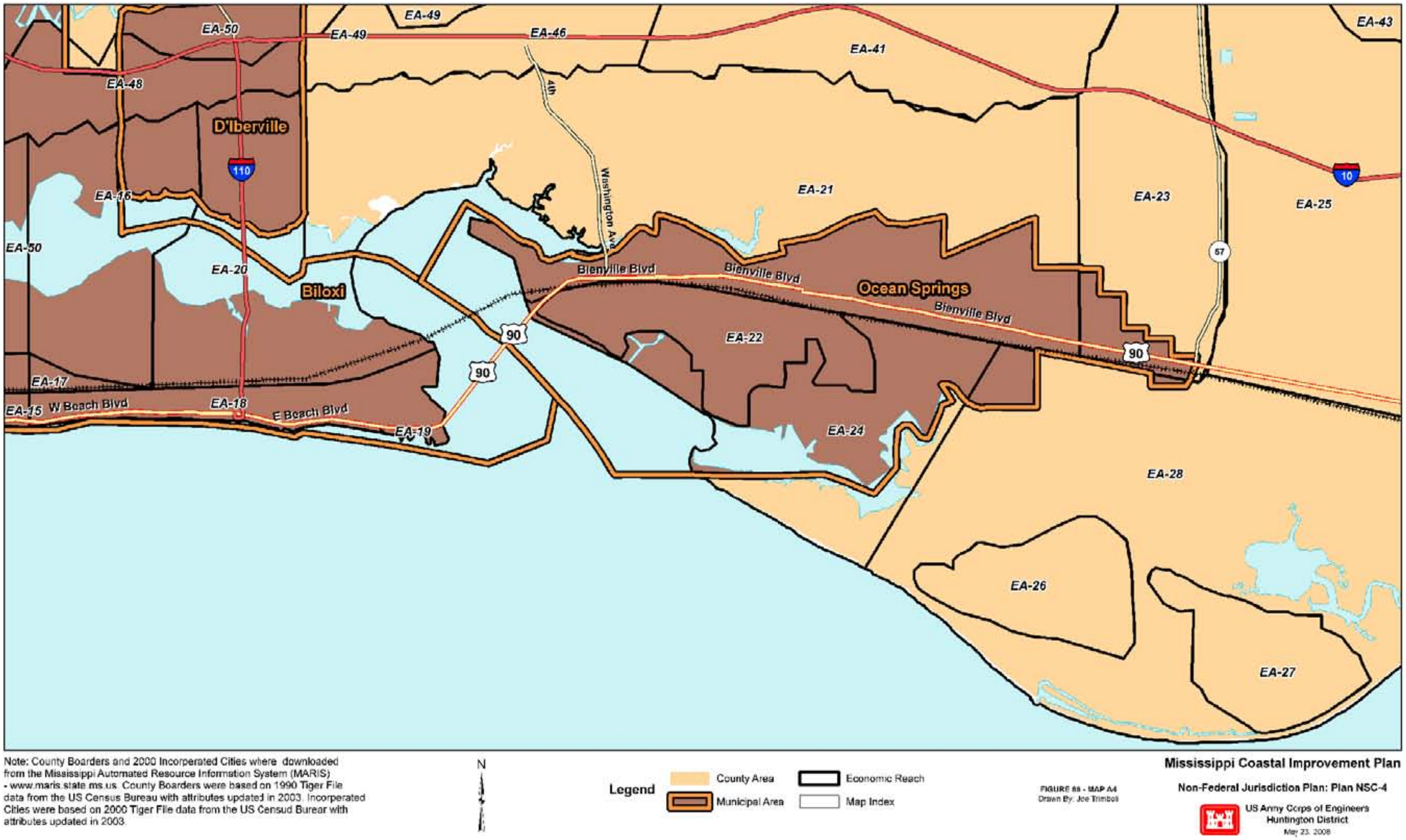
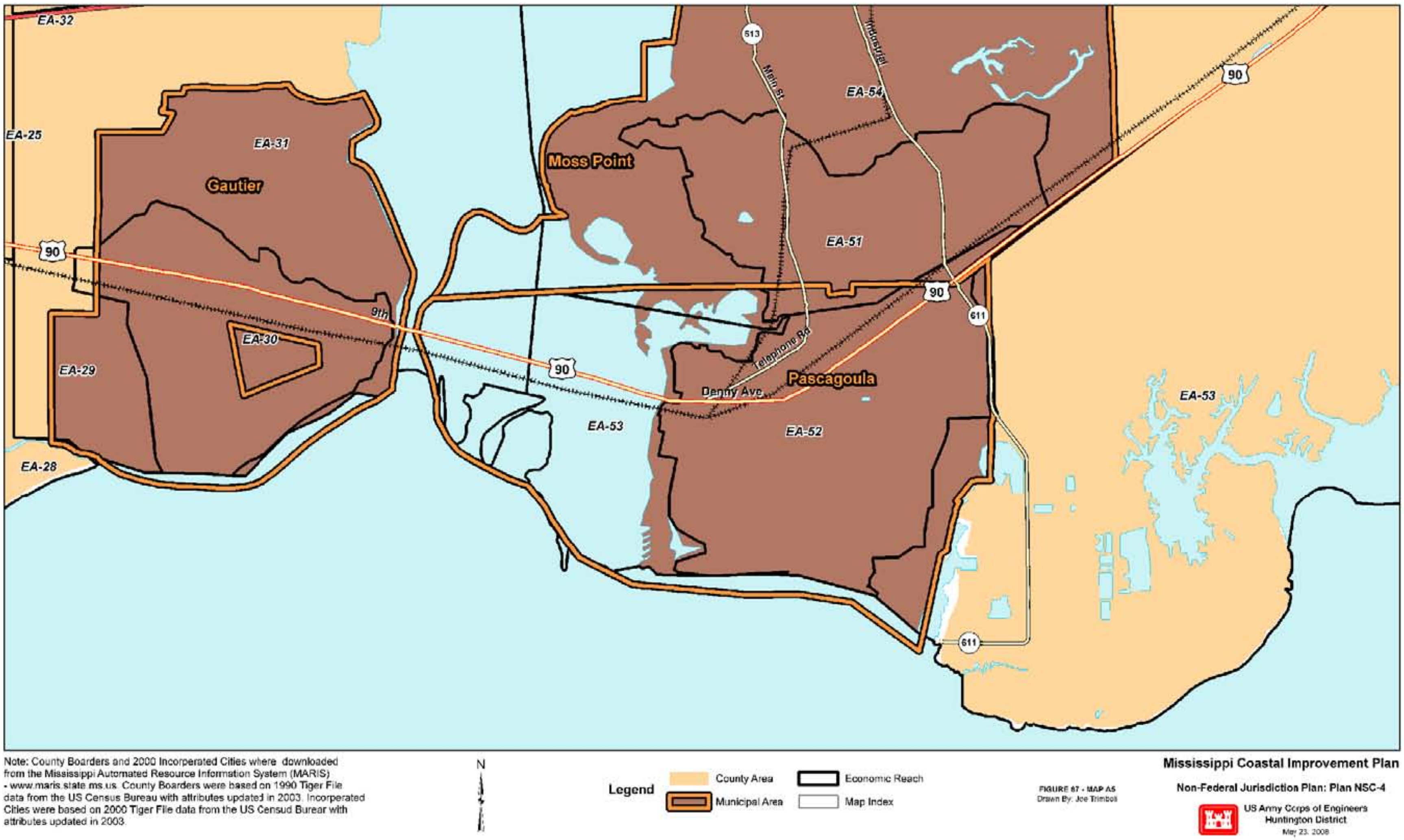


Figure 85 – Plan NSC-4 Non-Federal Jurisdiction Plan (A5)



6.7.2.5 Plan NSC-5 – Loss of Life Reduction Plan

This plan is a mixture of Federal and local measures that specifically address project objectives for reducing losses of life in high and moderate-hazard zones. The approximate number of structures that would be affected by these measures and the estimated costs are shown in Table 24. Figures 88 through 92 show the application of these measures. The Plan relies on three primary measures: 1) Permanent acquisition of parcels, structures and facilities in the high-hazard zones, 2) Flood Preparedness and Emergency Evacuation and 3) Replacement of Public Buildings.

Floodproofing is not included as a measure in this plan since its primary purpose is protection of structures and their contents in-place. A floodproofed structure is not considered to be a reliable shelter for its occupants during a hurricane. Too many uncertainties exist in determining the elevation of the first floor, supporting foundation design and construction to condone using elevated structures as human shelters that may be surrounded by surge inundation and buffeted by hurricane force winds.

Real property and structures and facilities (with some exceptions previously noted) in the high hazard zone identified in the permanent acquisition measure (the HHZ composed of the V-zone, catastrophic damages zone and the 800 foot buffer zone) would be acquired through the Corps' authorized program. That total number of acquisitions is estimated to be 14,997 parcels within the high hazard zone. Current estimates are that approximately 7,500 structures remain in this area and would be purchased during this process. Relocation benefits under the Uniform Relocations Act would be offered to assure that relocatees would have sufficient financial resources to acquire DSS replacement housing. As in other plans featuring permanent acquisitions in the high-hazard zone this plan assumes that the parcels made vacant by Katrina would be redeveloped by the time this plan would be authorized and funded as was described in the future without-project condition. The costs for permanent acquisition include structure and land purchase, relocations assistance and structure demolition.

In addition to the cost of the real estate acquisition, relocations assistance and structure demolition associated with this alternative, the large number of displaced households would probably trigger the need for replacement DSS housing over and above what normal market resources could provide. Based upon current housing construction capacity in the project area, as much as 40 percent of the need may be unmet by the market area. In view of this anticipated shortage of suitable DSS housing, the plan would include several redevelopment sites (at least one in each county) that would hold approximately 3,000 residential lots. Lot sizes would vary within the redevelopment sites but would be no less than quarter-acre in size. At an average cost of $45,000 per lot for site acquisition, site development, infrastructure and site amenities, the total cost of these redevelopment sites would be approximately $135.0M

The total cost for this measure including the redevelopment sites is estimated to be $6.1B and is shown in Table 24 by economic reach. The extent of the permanent acquisitions in the high-hazard zone is shown in Figures 86 through 90.

The second measure in the Plan will be the full application of all components of the flood preparedness and emergency evacuation measure including installation of additional reporting buoys in the Gulf, installation of sirens and flashing strobe lights within communities, acquisition and distribution of weather emergency radios, training and education seminars on appropriate actions following a warning for the public and emergency personnel, dissemination of emergency procedures information brochures and pamphlets to area residents and visitors alike, adjustment of hurricane warning times from 24 to 36 hours for hurricanes greater than Category 3, and development of emergency evacuation plans for those structures and facilities that cannot be moved from the waterfront. In addition to these components, there would be improvements to the evacuation routes themselves including new signage designating evacuation routes, messaging boards that provide needed information to evacuees, and procedures for reverse flow or contraflow routing during emergency evacuation situations.

Also, improvements would be made to all modal crossings that can potentially impede traffic flow, correction of undersized culverts and other stream crossing infrastructure that could endanger evacuees, and improvements to intersections (turning lanes, signaling, etc.). Additional improvements would include enroute emergency resources (fuel, food, emergency services, etc.) along evacuation routes and pre-arranged, safe sheltering with emergency supplies located away from the coast. The estimated cost to implement the improvements to the flood preparedness and emergency evacuation system is approximately $2.9M.

Replacing public buildings would remove several public buildings within the permanent acquisition zones described above that may be filled with residents that have special needs (medical, incarcerated, elderly, children, etc.) for evacuation in advance of a approaching hurricane. A total of 7 structures and facilities determined at this level of planning to be publicly-owned would be eligible for replacement to reduce flood damages. This number would include some schools that would serve as emergency evacuation centers. The total cost of these replacements is estimated to be $51.2M. Replacing those facilities at a flood-safe location in a new building constructed to current standards would significantly reduce the chances for loss of life due to flooding during a hurricane or during the evacuation that would precede such an event. Table 24 shows the total number of units by economic reach and the total estimated cost.

Table 24
NSC-5 Loss of Life Reduction Plan

Economic Reaches	Permanent Acquisition Parcels*	Cost	Public Buildings Relocations	Cost	Flood Warning and Emergency Evacuation	Cost
1	0	0	0	0	2062	$62,540
2	1056	$459,548,812	0	0	19363	$587,280
3	2099	$851,631,850	0	0	2673	$81,072
4	823	$202,919,893	0	0	901	$27,327
5	971	$107,653,678	0	0	3109	$94,296
6	210	$114,862,969	1	$8,536,147	1123	$34,061
7	125	$9,562,216	0	0	1574	$47,739
8	1565	$431,782,512	4	$25,608,442	8716	$264,356
9	4	$6,652,740	0	0	52	$1,577
10	1695	$736,216,496	0	0	1727	$52,380
11	0	0	0	0	44	$1,335
12	450	$138,318,777	0	0	2777	$84,226
13	595	$821,785,431	0	0	500	$15,165
14	0	0	0		788	$23,900
15	66	$88,566,796	0	0	76	$2,305
16	36	$14,594,008	0	0	209	$6,339
17	0	0	0	0	6	$182
18	285	$608,152,730	0	0	1223	$3,7094
19	12	$17,246,403	0	0	22	$667
20	1150	$316,031,090	1	$8,536,147	3064	$92,931

Economic Reaches	Permanent Acquisition Parcels*	Cost	Public Buildings Relocations	Cost	Flood Warning and Emergency Evacuation	Cost
21	2082	$695,355,710	0	0	1867	$56,626
22	62	$39,368,916	0	0	157	$4,762
23	0	0	0	0	65	$1,971
24	138	$45,373,108	0	0	524	$15,893
25	0	0	0	0	327	$9,918
26	31	$11,221,913	0	0	1279	$38,792
27	37	$5,996,209	0	0	2145	$65,058
28	583	$10,167,976	0	0	1718	$52,107
29	132	$14,287,454	0	0	546	$16,560
30	81	$24,818,841	0	0	626	$18,987
31	37	$9,281,900	0	0	708	$21,474
32	0	0	0	0	398	$12,071
33	0	0	0	0	77	$2,335
34	0	0	0	0	600	$18,198
35	0	0	0	0	1599	$48,498
36	0	0	0	0	62	$1,880
37	0	0	0	0	540	$16,378
38	0	0	0	0	364	$11,040
39	0	0	0	0	25	$758
40	0	0	0	0	7824	$237,302
41	0	0	0	0	536	$16,257
42	0	0	0	0	667	$20,230
43	0	0	0	0	25	$61
44	0	0	0	0	2587	$78,464
45	0	0	0	0	2267	$68,758
46	0	0	0	0	3331	$101,029
47	0	0	0	0	1303	$39,520
48	0	0	0	0	1	$61
49	0	0	0	0	338	$10,252
50	96	$24,190,783	0	0	1594	$48,346
51	0	0	0	0	1089	$33,029
52	275	$68,789,089	1	$8,536,147	7628	$231,357
53	300	$46,723,811	0	0	1557	$38,125
54	0	0	0	0	1548	$46,951
Subtotals	**14,997**	**$5,921,102,111**	**7**	**$51,216,883**	**95931**	**$2,899,820**
H&CD Sites		Jackson, Harrison and Hancock		3,000 lots at $45,000 each		**$135,000,000**
Total Plan Cost						**$6,110,218,814**

Notes: The Flood Warning and Emergency Evacuation improvements may be accomplished by other Federal Agencies (FEMA and NOAA) but would be supported by the Corps.

* The total parcel count for acquisition within the high-hazard zone includes approximately 7,500 existing structures (residential and commercial).

Figure 86 – Plan NSC-5 Loss of Life Reduction Plan (A1)

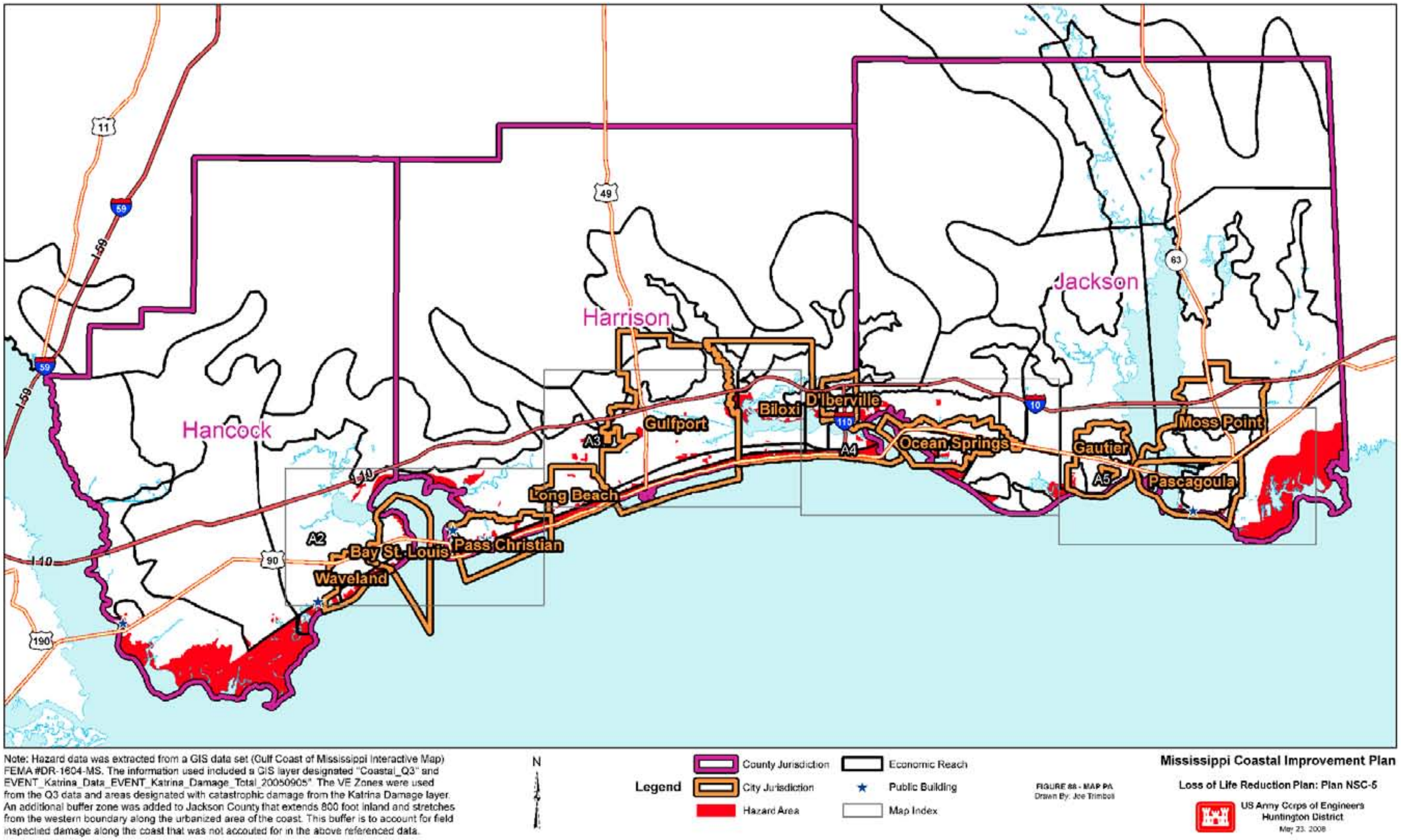


Figure 87 – Plan NSC-5 Loss of Life Reduction Plan (A2)

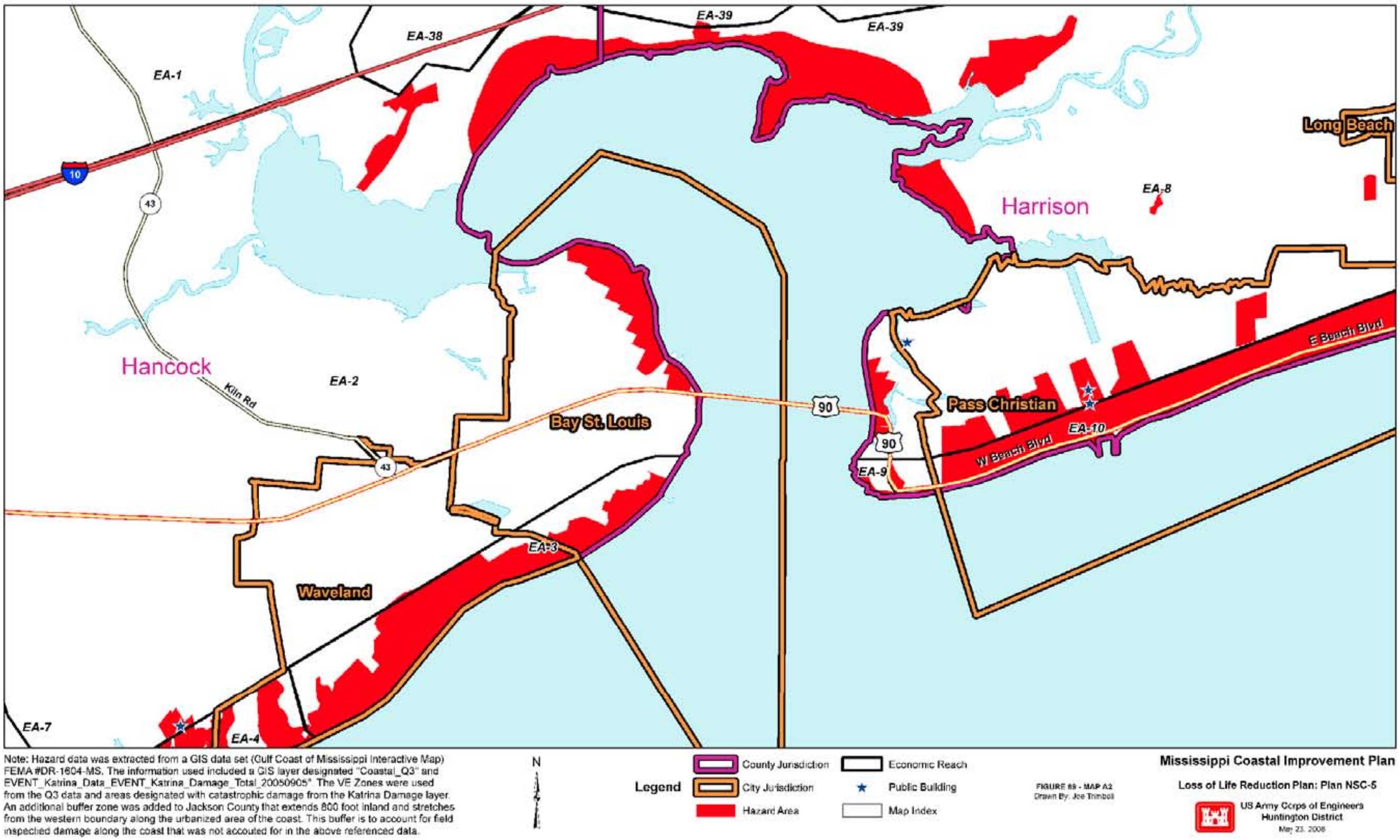


Figure 88 – Plan NSC-5 Loss of Life Reduction Plan (A3)

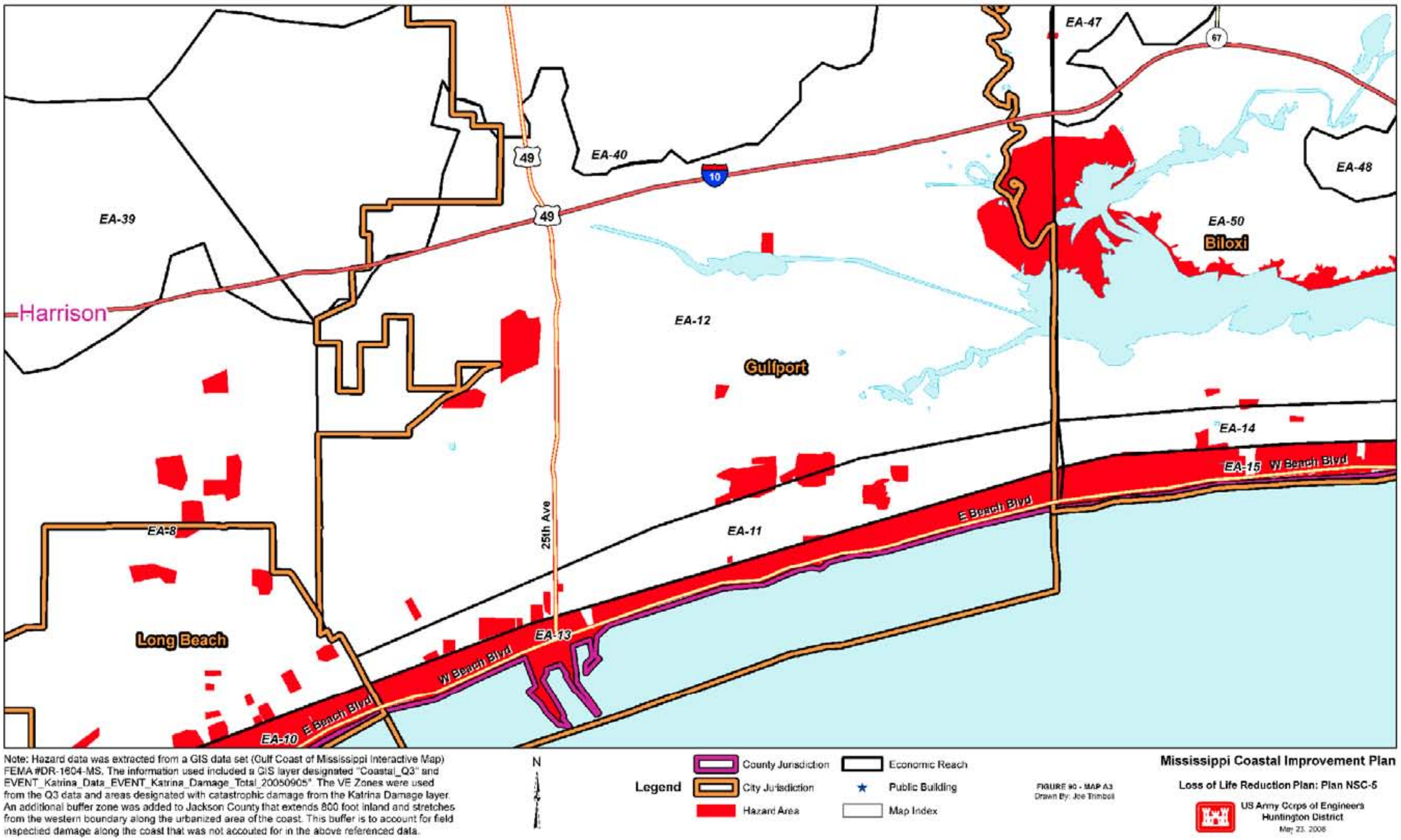


Figure 89 – Plan NSC-5 Loss of Life Reduction Plan (A4)

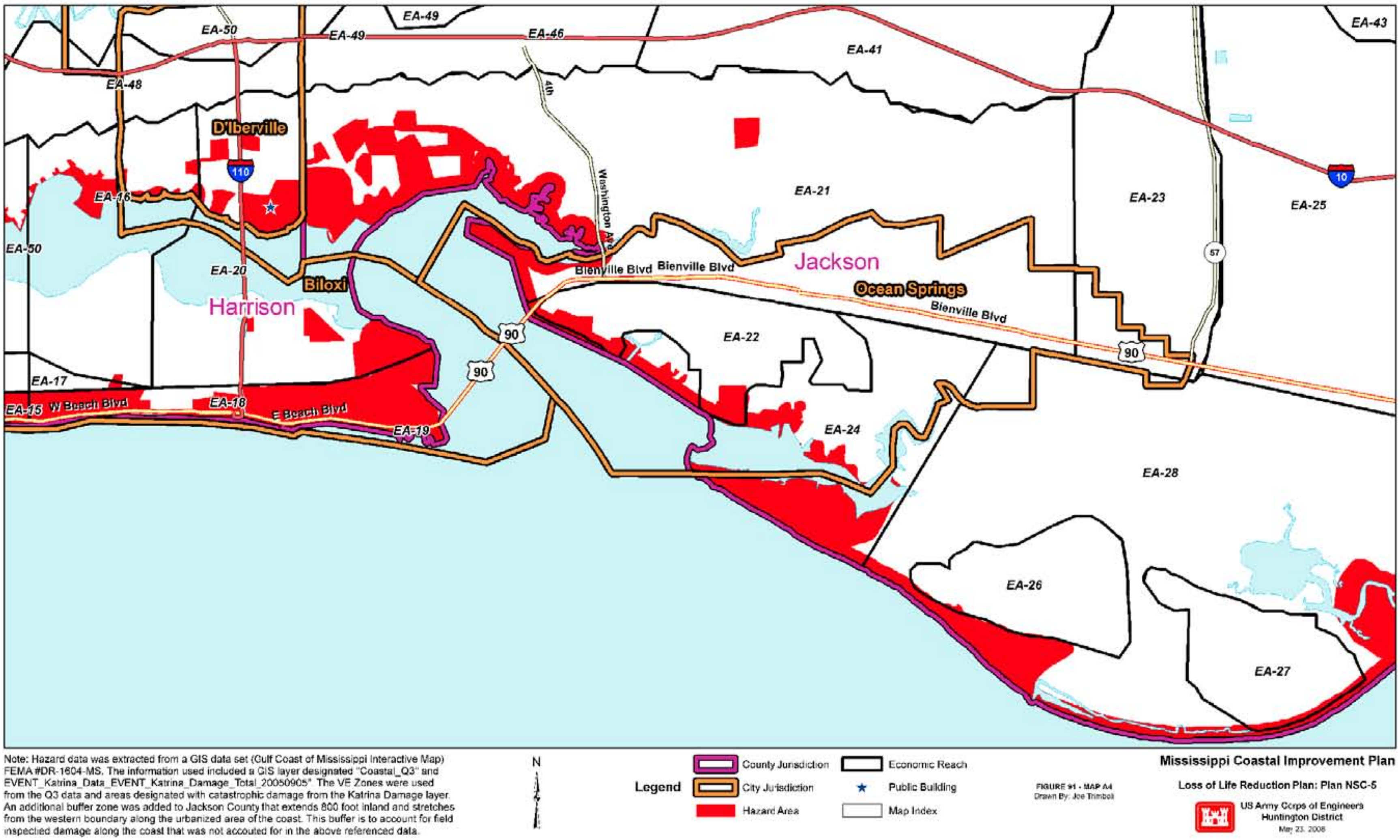
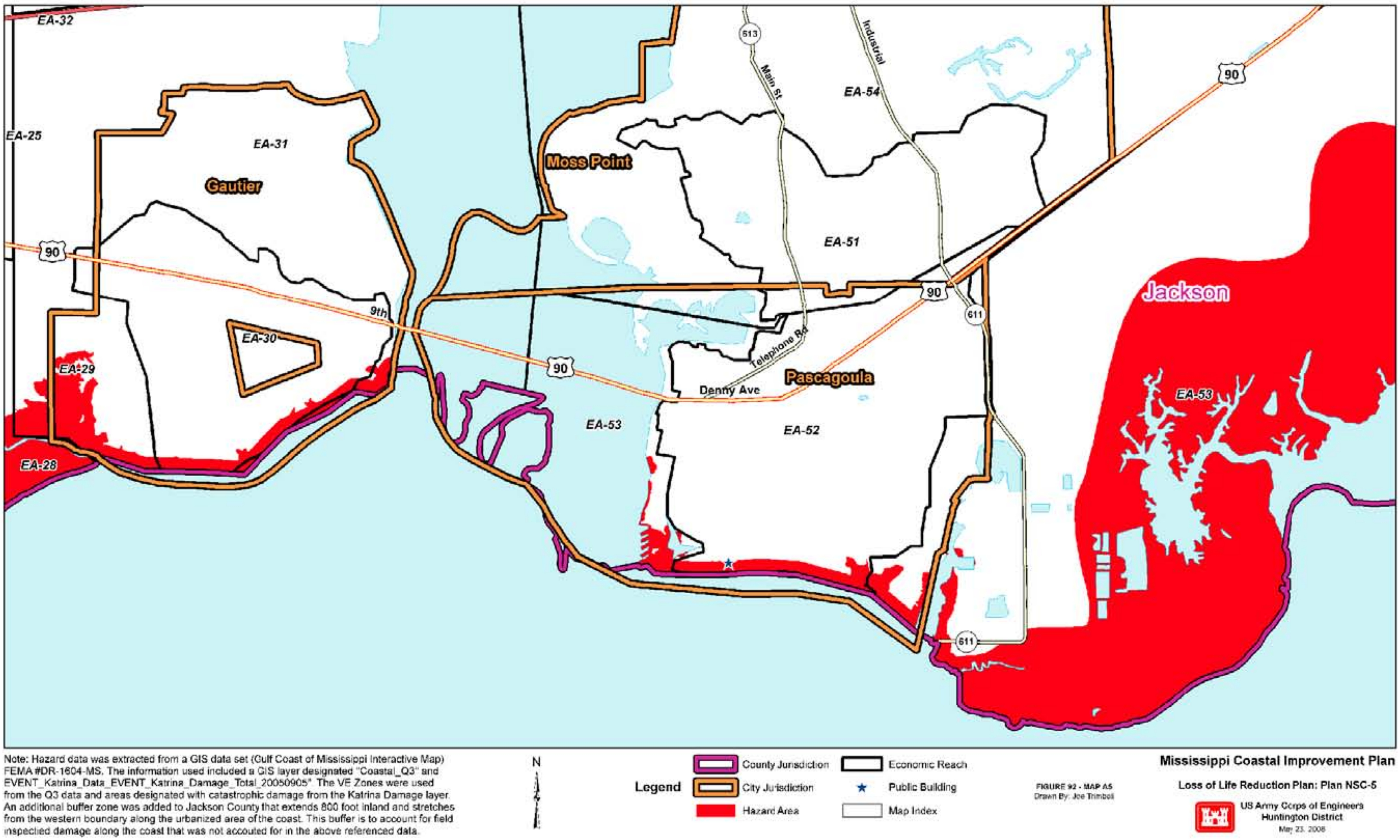


Figure 90 – Plan NSC-5 Loss of Life Reduction Plan (A5)



6.7.2.6. Plan NSC-6 – Combined Structural/Nonstructural Plan

This Plan would consist of nonstructural measures applied to structures and facilities that would be located outside the protection limits of structural projects described in the comprehensive plan. Line of Defense 4 (LOD 4) and various ringwalls or ring-levees that protect portions of named communities in the project area or any combination of the structural protection schemes are included in these plans. The number of structures that would be affected by these measures and the estimated costs are shown in Tables 26 through 33. The costs for nonstructural measures (primarily permanent acquisition outside the line of protection) that support structural projects are shown for each proposed structural alternative in the tables. These “buffer zones” or areas located outside the line of protection provided by the structural components would be addressed in the nonstructural program using the same procedures already described for other nonstructural alternatives.

Since the protection features of each structural plan are designed with cost effectiveness in mind, there would be many structures and facilities located outside the limits of structural protection. Case in point would be the many structures remaining outside the lines of protection provided by ring levees designed around high-density urban areas in the project area such as Gautier, Pascagoula, Ocean Springs, and Moss Point. In many cases the structural feature alignment was influenced by the ground elevations of the site and in several cases the alignment was adjusted to avoid impacts to wetlands or other environmentally sensitive ecosystems. Likewise the LOD 4 structural component would not provide protection for structures or facilities located between the Gulf and the levee alignment along the CSX railway right-of-way.

The nonstructural plans described in the tables represent the measures that would be available for all of those structures and facilities not protected by the lines of protection provided by structural measures at the various levels of protection. The two primary structural measures considered in the tables are the various ringwalls and ring-levees formulated for individual municipal or communities (i.e. Pascagoula, Moss Point, Gulf Park Estates, Pearlington, Belle Fontaine, and Gautier) and LOD 4 (trackside levee and surge gates at the inlets) with various levels of protection (20 feet, 30 feet and 40 feet of surge inundation). The nonstructural measures applied to these unprotected areas would be the suite of measures described in NSC-1 above with one exception. That exception would be the costs for relocating municipal structures that would be affected by surge inundation at the 20 foot, 30 foot and 40 foot levels of inundation. Numbers of public structures to be relocated and their costs were determined for the ABFE-2 feet inundation level, but time constraints and database constraints (FEMA HAZUS does not calculate surge profiles for 20, 30 and 40 feet of inundation) did not permit determinations of the numbers or costs of public building replacements at the higher levels of inundation. In those higher inundation scenarios, the public buildings were considered to be standard acquisition items and included in the Real Estate permanent acquisition category. Therefore, those costs may be slightly understated at this level of study.

The appropriate nonstructural measures applied to those structures and facilities would be in keeping with the basic parameters of other nonstructural plans regarding potential location in a high-hazard zone, depth of flooding at the structure, condition and use of the structure, and whether the structure or facility is publicly or privately owned. In addition, interspersed vacant property would be either acquired (permanent acquisition), or the development rights secured through either a locally administered TDR or PDR program. Structures and facilities located adjacent to structural protection works may experience slightly greater inundation due to hydraulic effects of surge and waves against the protection works, but those effects can be compensated for in the nonstructural measures’ design.

The estimated numbers of structures to be protected by nonstructural measures lying outside the structural alignments for each economic reach are shown in Tables 26 through 33. Figures 91 through 138 show the locations of the proposed nonstructural measures that would be implemented in combination with structural measures.

Of note is the progressively greater number of parcels being included in the nonstructural program as the level of surge inundation increases from the ABFE-2 feet (a minimum level of protection in accordance with local floodplain management ordinances) to the 20 foot, 30 foot and 40 foot levels of inundation. At the ABFE-2 feet level of inundation only 44,098 parcels are included in the program. At the 20 foot level of inundation that total parcel number increases to 77,523 and at the 30 and 40 foot levels that number tops out at 85,447 parcels. There is no difference in total parcels between the 30 foot and 40 foot levels of inundation because the 30 foot level captures all of the eligible parcels.

Also of note is the progression of parcels moving from the floodproofing category to the permanent acquisition category of nonstructural measures. Initially at the 20 foot level the number of parcels eligible for floodproofing increases above that shown for the ABFE-2 level, but at the 30 foot and 40 foot levels that number decreases dramatically. This migration is due to the ever-deepening surge inundation levels that exceed the 13 feet water depth permitted for elevating structures in this program. Table 25 shows the relationship of total parcels and both acquisition and floodproofing parcels among the scales of the NSC-6 plan. As discussed for Plan NSC-1 at the greater levels of inundation (20, 30 and 40 feet of surge), plan costs do not increase in direct proportion to the increase in numbers of structures becoming eligible for the project (exempting the lot costs for displaced landowners). Since permanent acquisition costs per parcel used in the plan are on average slightly less that floodproofing costs per parcel, the migration of parcels from the floodproofing measure to the permanent acquisition measure (due to increased water depths) actually results in lower plan costs. Plan costs at the 30 and 40 foot levels do rise only because of the need for more redevelopment lots for a greater number of displaced owners.

Table 25
Plan NSC-6 - Comparison of Eligible Parcels in Acquisitions and Floodproofing

Plan Designation	Total Parcels	Acquisition Parcels	Potential Lives Protected	Floodproofing Parcels	Potential Lives Protected
NSC-6 ABFE w/ring-levees	44,088	29,445	76,557	14,620	38,012
NSC-6a 20 feet w/ring-levees	77,523	36,559	95,053	40,964	106,506
NSC-6b 30 feet w/ring-levees	85,447	71,448	185,765	13,999	36,397
NSC-6c 40 feet w/ring-levees	85,447	85,447	222,162	0	0
NSC-6d ABFE w/LOD-4 **	30,508	20,156	52,406	10,347	26,902
NSC-6e 20 feet w/LOD-4**	46,315	19,556	50,846	26,759	69,573
NSC-6f 30 feet w/LOD-4**	51,935	40,125	104,325	11,810	30,706
MSC-6g 40 feet w/LOD-4**	51,935	51,935	135,031	0	0

** (See discussion of the status of the LOD 4 structural alternative in the Executive Summary)

Table 26
NSC-6 – Combined Structural and Nonstructural – ABFE w/Ring-Levees

Reaches	Acquisition Parcels	Acquisitions Cost	Public Relocations	Public Relocations Cost	Public Floodproofing	Public Floodproofing Cost	Public Buildings Costs	Floodproofing Parcels	Floodproofing Costs	Subtotal Nonstructural Costs
1	997	$194,118,217.88	0	$0.00	0	$0.00	$0.00	394	$101,229,150.00	$295,347,367.88
2	9911	$2,990,789,131.25	1	$392,586.21	5	$23,778,209.33	$24,170,795.55	3289	$1,543,195,389.00	$4,558,155,315.80
3	2202	$668,691,436.88	0	$0.00	0	$0.00	$0.00	376	$269,175,578.00	$937,867,014.88
4	922	$120,307,916.63	0	$0.00	0	$0.00	$0.00	16	$24,642,670.00	$144,950,586.63
7	450	$33,210,173.75	0	$0.00	0	$0.00	$0.00	232	$149,936,910.00	$183,147,083.75
8	3623	$476,088,332.50	3	$25,478,083.02	1	$3,815,128.75	$29,293,211.77	1729	$569,574,546.00	$1,074,956,090.27
9	44	$16,132,782.50	0	$0.00	0	$0.00	$0.00	16	$13,361,448.00	$29,494,230.50
10	1945	$432,581,233.50	0	$0.00	0	$0.00	$0.00	62	$20,028,706.00	$452,609,939.50
11	0	$0.00	0	$0.00	0	$0.00	$0.00	8	$1,727,008.00	$1,727,008.00
12	1047	$179,614,825.00	0	$0.00	1	$3,815,128.75	$3,815,128.75	1135	$358,050,524.00	$541,480,477.75
13	650	$583,121,543.00	0	$0.00	0	$0.00	$0.00	0	$0.00	$583,121,543.00
15	85	$44,354,843.00	0	$0.00	0	$0.00	$0.00	9	$22,725,000.00	$67,079,843.00
16	78	$16,399,728.00	0	$0.00	0	$0.00	$0.00	121	$31,715,348.00	$48,115,076.00
18	1502	$409,411,532.00	0	$0.00	0	$0.00	$0.00	5	$1,138,504.00	$410,550,036.00
19	46	$292,728,063.00	0	$0.00	0	$0.00	$0.00	0	$0.00	$292,728,063.00
20	1397	$238,433,082.00	1	$8,492,694.34	5	$19,075,643.74	$27,568,338.08	2045	$692,997,655.00	$958,999,075.08
21	2108	$301,798,271.81	0	$0.00	4	$15,260,514.99	$15,260,514.99	415	$142,103,926.00	$459,162,712.81
22	61	$26,330,662.50	0	$0.00	0	$0.00	$0.00	92	$36,587,106.00	$62,917,768.50
23	0	$0.00	0	$0.00	0	$0.00	$0.00	44	$19,986,176.00	$19,986,176.00
24	220	$65,229,820.63	0	$0.00	0	$0.00	$0.00	178	$47,664,846.00	$112,894,666.63
28	961	$90,294,696.75	0	$0.00	0	$0.00	$0.00	122	$47,989,150.00	$138,283,846.75
29	147	$23,394,828.50	0	$0.00	0	$0.00	$0.00	168	$51,396,802.00	$74,791,630.50
31	51	$14,946,829.31	0	$0.00	0	$0.00	$0.00	447	$168,990,104.00	$183,936,933.31
32	1	$216,228.13	0	$0.00	0	$0.00	$0.00	208	$51,710,800.00	$51,927,028.13
35	12	$682,228.13	0	$0.00	0	$0.00	$0.00	1406	$350,816,536.00	$351,498,764.13
36	32	$3,834,485.38	0	$0.00	0	$0.00	$0.00	2	$5,050,000.00	$8,884,485.38
38	50	$21,424,866.13	0	$0.00	0	$0.00	$0.00	78	$15,883,024.00	$37,307,890.13
39	0	$0.00	0	$0.00	0	$0.00	$0.00	6	$991,302.00	$991,302.00
43	0	$0.00	0	$0.00	0	$0.00	$0.00	1	$170,304.00	$170,304.00
48	0	$0.00	0	$0.00	0	$0.00	$0.00	2	$366,298.00	$366,298.00
50	495	$89,247,660.50	0	$0.00	0	$0.00	$0.00	848	$215,363,629.00	$304,611,289.50
53	399	$113,015,334.56	0	$0.00	0	$0.00	$0.00	360	$204,582,670.00	$317,598,004.56
54	9	$1,114,862.06	0	$0.00	2	$7,630,257.50	$7,630,257.50	806	$319,497,144.00	$328,242,263.56
Subtotals	29445	$7,447,513,615	5	$34,363,363	18	$73,374,883	$107,738,246	14620	$5,478,648,253	$13,033,900,114
	H&CD sites	Hancock, Harrison and Jackson Counties				Approx 10,300 lots at $45,000 per lot				$464,000,000
Total Cost	Total Nonstructural Parcels – 44,088									$ 13,497,627,949

Table 27
NSC-6a – Combined Structural and Nonstructural Plan w/20 Feet inundation and Ring-Levees

Reaches	Acquisition Parcels	Acquisitions Cost	Floodproofing Parcels	Floodproofing Costs	Nonstructural Total Costs by Reach
1	795	$242,760,352.63	1068	$111,644,220	$354,404,572.63
2	6119	$1,982,505,118.75	12206	$2,270,306,077	$4,252,811,195.75
3	2029	$869,599,919.38	502	$261,603,614	$1,131,203,533.38
4	769	$137,140,841.63	55	$41,048,722	$178,189,563.63
7	343	$28,183,289.75	1092	$123,833,026	$152,016,315.75
8	6585	$721,036,617.25	2761	$268,481,369	$989,517,986.25
9	23	$10,006,258.75	15	$4,155,724	$14,161,982.75
10	3052	$687,523,634.50	36	$9,985,596	$697,509,230.50
11	45	$13,955,967.50	882	$131,996,005	$145,951,972.50
12	1617	$398,388,336.75	2184	$925,803,107	$1,324,191,443.75
13	2284	$1,059,037,972.50	1	$275,000	$1,059,312,972.50
14	10	$3,531,145.00	3	$0	$3,531,145.00
15	407	$321,467,398.75	5	$195,994	$321,663,392.75
16	178	$45,986,843.00	420	$89,816,180	$135,803,023.00
18	1650	$531,842,684.50	29	$7,968,172	$539,810,856.50
19	15	$238,143,653.50	0	$0	$238,143,653.50
20	1046	$197,002,707.50	1756	$491,997,409	$689,000,116.50
21	2142	$698,779,207.38	1688	$518,126,016	$1,216,905,223.38
22	314	$142,425,847.38	1921	$475,539,586	$617,965,433.38
23	59	$18,831,864.50	104	$23,208,676	$42,040,540.50
24	301	$134,113,558.00	854	$131,106,828	$265,220,386.00
25	0	$0.00	27	$3,700,964	$3,700,964.00
28	1318	$162,484,163.75	444	$40,032,082	$202,516,245.75
29	491	$115,704,667.88	1081	$180,905,804	$296,610,471.88
31	472	$150,421,617.50	810	$206,865,030	$357,286,647.50
32	236	$44,686,667.38	461	$71,960,724	$116,647,391.38
35	630	$92,739,948.25	1277	$453,335,528	$546,075,476.25
36	0	$0.00	29	0	$0.00
37	0	$0.00	5	0	$0.00
38	33	$23,256,254.25	304	$16,587,864	$39,844,118.25
39	8	$1,627,170.00	287	$16,374,482	$18,001,652.00
40	1	$100,211.25	4	0	$100,211.25
43	0	$0.00	4	$366,298	$366,298.00
46	0	$0.00	3	$114,092	$114,092.00
47	0	$0.00	5	$587,982	$587,982.00
48	1	$1,457,777.50	5	$587,982	$2,045,759.50
49	0	$0.00	63	$2318648	$2,318,648.00
52	1840	$535,059,176.25	7305	$4,108,479,076	$4,643,538,252.25
53	646	$134,435,107.63	613	$207,158,892	$341,593,999.63
54	1100	$276,596,580.13	655	$219,619,572	$496,216,152.13
Subtotals	**36559**	**$10,020,832,560**	**40964**	**$ 11,416,086,341**	**$21,436,918,901**
H&CD Sites	Hancock, Harrison & Jackson Co		Approx 12,700 Lots at $45,000/lot		**$572,000,000**
	Total Plan Costs	**Total Nonstructural Parcels – 77,523**			**$22,008,918,901**

Table 28
NSC-6b – Combined Structural and Nonstructural Plan w/30 feet inundation and Ring-Levees

Reaches	Acquisition Parcels	Acquisitions Costs	Floodproofing Parcels	Floodproofing Costs	Nonstructural Total Costs by Reach
1	1591	$470,268,503.50	511	$ 80,353,606.00	$550,622,109.50
2	15864	$3,364,937,903.75	6331	$ 2,006,692,184.00	$5,371,630,087.75
3	2565	$1,036,199,788.88	557	$ 239,155,950.00	$1,275,355,738.88
4	823	$143,859,191.50	1	$ 195,994.00	$144,055,185.50
7	1222	$127,404,692.38	267	$ 18,389,310.00	$145,794,002.38
8	8591	$913,966,937.50	755	$ 201,679,104.00	$1,115,646,041.50
9	38	$12,583,953.75	0	$ -	$12,583,953.75
10	3088	$696,444,472.00	0	$ -	$696,444,472.00
11	79	$17,236,421.25	848	$ 315,371,358.00	$332,607,779.25
12	3801	$1,250,095,756.75	0	$ -	$1,250,095,756.75
13	2284	$1,059,037,972.50	1	$ 2,525,000.00	$1,061,562,972.50
14	10	$3,531,145.00	3	$ -	$3,531,145.00
15	412	$326,617,775.00	0	$ -	$326,617,775.00
16	598	$173,917,626.75	0	$ -	$173,917,626.75
18	1655	$533,199,240.00	24	$ 11,739,556.00	$544,938,796.00
19	15	$238,143,653.50	0	$ -	$238,143,653.50
20	2144	$416,967,996.50	1802	$ 861,061,816.00	$1,278,029,812.50
21	3830	$1,483,891,217.50	0	$ -	$1,483,891,217.50
22	2235	$872,740,336.25	0	$ -	$872,740,336.25
23	163	$57,221,763.88	0	$ -	$57,221,763.88
24	539	$264,338,265.75	616	$ 110,725,374.00	$375,063,639.75
25	27	$11,661,813.00	0	$ -	$11,661,813.00
28	1687	$241,776,845.63	1742	$ 249,531,974.00	$491,308,819.63
29	1572	$359,722,100.25	0	$ -	$359,722,100.25
31	1282	$415,121,092.13	0	$ -	$415,121,092.13
32	697	$173,934,340.75	0	$ -	$173,934,340.75
35	1907	$416,542,564.88	0	$ -	$416,542,564.88
36	15	$2,306,708.13	36	$ -	$2,306,708.13
37	1	$340,434.38	4	$ -	$340,434.38
38	198	$59,672,860.88	452	$ 74,116,316.00	$133,789,176.88
39	295	$34,977,357.00	0	$ -	$34,977,357.00
40	5	$417,288.75	0	$ -	$417,288.75
43	4	$1,269,975.00	0	$ -	$1,269,975.00
46	3	$322,862.50	0	$ -	$322,862.50
47	5	$1,720,815.00	0	$ -	$1,720,815.00
48	6	$5,485,907.50	0	$ -	$5,485,907.50
49	63	$8,814,550.50	0	$ -	$8,814,550.50
52	9145	$3,199,336,671.63	0	$ -	$3,199,336,671.63
53	1234	$464,412,757.75	49	$ 26,056,898.00	$490,469,655.75
54	1755	$541,259,959.00	0	$ -	$541,259,959.00
Subtotals	**71448**	**$19,401,701,518**	**13999**	**$4,197,594,440**	**$23,599,295,958**
H&CD Sites	**Hancock, Harrison & Jackson Co**		**Approx. 25,000 lots at $45,000/lot**		**$ 1,125,000,000**
Total Cost	**Total Nonstructural Parcels – 85,447**				**$24,724,295,958**

Table 29

NSC-6c – Combined Structural and Nonstructural w/40 inundation and Ring-Levees

Reaches	Acquisition Parcels	Acquisitions Cost	Floodproofing Parcels	Floodproofing Costs	Nonstructural Costs by Reach
1	2102	$632,549,786.38	0	0	$632,549,786.38
2	22195	$5,686,835,321.25	0	0	$5,686,835,321.25
3	3122	$1,266,472,734.00	0	0	$1,266,472,734.00
4	824	$144,644,086.50	0	0	$144,644,086.50
7	1489	$159,349,868.63	0	0	$159,349,868.63
8	9346	$1,119,589,307.50	0	0	$1,119,589,307.50
9	38	$12,583,953.75	0	0	$12,583,953.75
10	3088	$696,444,472.00	0	0	$696,444,472.00
11	927	$238,310,263.50	0	0	$238,310,263.50
12	3801	$1,250,095,756.75	0	0	$1,250,095,756.75
13	2285	$1,059,287,941.25	0	0	$1,059,287,941.25
14	13	$5,321,020.00	0	0	$5,321,020.00
15	412	$326,617,775.00	0	0	$326,617,775.00
16	598	$173,917,626.75	0	0	$173,917,626.75
18	1679	$542,567,877.25	0	0	$542,567,877.25
19	15	$238,143,653.50	0	0	$238,143,653.50
20	3946	$829,880,446.50	0	0	$829,880,446.50
21	3830	$1,483,891,217.50	0	0	$1,483,891,217.50
22	2235	$872,740,336.25	0	0	$872,740,336.25
23	163	$57,221,763.88	0	0	$57,221,763.88
24	1155	$598,237,712.00	0	0	$598,237,712.00
25	27	$11,661,813.00	0	0	$11,661,813.00
28	3429	$714,783,499.38	0	0	$714,783,499.38
29	1572	$359,722,100.25	0	0	$359,722,100.25
31	1282	$415,121,092.13	0	0	$415,121,092.13
32	697	$173,934,340.75	0	0	$173,934,340.75
35	1907	$416,542,564.88	0	0	$416,542,564.88
36	51	$6,438,158.75	0	0	$6,438,158.75
37	5	$1,911,196.25	0	0	$1,911,196.25
38	650	$214,970,390.38	0	0	$214,970,390.38
39	295	$34,977,357.00	0	0	$34,977,357.00
40	5	$417,288.75	0	0	$417,288.75
43	4	$1,269,975.00	0	0	$1,269,975.00
46	3	$322,862.50	0	0	$322,862.50
47	5	$1,720,815.00	0	0	$1,720,815.00
48	6	$5,485,907.50	0	0	$5,485,907.50
49	63	$8,814,550.50	0	0	$8,814,550.50
52	9145	$3,199,336,671.63	0	0	$3,199,336,671.63
53	1283	$496,107,037.25	0	0	$496,107,037.25
54	1755	$541,259,959.00	0	0	$541,259,959.00
Subtotals	**85447**	**$23,999,500,500**	**0**	**0**	**$23,999,500,500**
H&CD Sites	Hancock, Harrison & Jackson C.		Approx. 29,900 lots at $45,000/lot		$ 1,345,500,000
Total Cost	**Total Nonstructural Parcels – 85,447**				**$25,345,000,500**

Table 30

NSC-6d – Combined Structural and Nonstructural - ABFE w/LOD4 **

Reaches	Acquisition Parcels	Acquisition Parcels Cost	Public Relocations	Public Relocations Cost	Public Floodproofing	Public Floodproofing Costs	Public Buildings Costs	Floodproofing parcels	Floodproofing Costs	Total Nonstructural Costs by Reach
1	997	$194,118,217.88	0	$0.00	0	$0.00	$0.00	394	$101,229,150.00	$295,347,367.88
2	9911	$2,990,789,131.25	1	$392,586.21	5	$23,778,209.33	$24,170,795.55	3289	$1,543,195,389.00	$4,558,155,315.80
7	450	$33,210,173.75	0	$0.00	0	$0.00	$0.00	232	$149,936,910.00	$183,147,083.75
8	3623	$476,088,332.50	3	$25,478,083.02	1	$3,815,128.75	$29,293,211.77	1729	$569,574,546.00	$1,074,956,090.27
11	0	$0.00	0	$0.00	0	$0.00	$0.00	8	$1,727,008.00	$1,727,008.00
12	1047	$179,614,825.00	0	$0.00	1	$3,815,128.75	$3,815,128.75	1135	$358,050,524.00	$541,480,477.75
16	78	$16,399,728.00	0	$0.00	0	$0.00	$0.00	121	$31,715,348.00	$48,115,076.00
20	1397	$238,433,082.00	1	$8,492,694.34	5	$19,075,643.74	$27,568,338.08	2045	$692,997,655.00	$958,999,075.08
21	2108	$301,798,271.81	0	$0.00	4	$15,260,514.99	$15,260,514.99	415	$142,103,926.00	$459,162,712.81
23	0	$0.00	0	$0.00	0	$0.00	$0.00	44	$19,986,176.00	$19,986,176.00
38	50	$21,424,866.13	0	$0.00	0	$0.00	$0.00	78	$15,883,024.00	$37,307,890.13
39	0	$0.00	0	$0.00	0	$0.00	$0.00	6	$991,302.00	$991,302.00
43	0	$0.00	0	$0.00	0	$0.00	$0.00	1	$170,304.00	$170,304.00
48	0	$0.00	0	$0.00	0	$0.00	$0.00	2	$366,298.00	$366,298.00
50	495	$89,247,660.50	0	$0.00	0	$0.00	$0.00	848	$215,363,629.00	$304,611,289.50
Subtotals	**20156**	**$4,541,124,288**	**5**	**$34,363,363**				**10347**	**$3,843,291,189**	**$8,484,523,466**
H&CD Sites	**Hancock, Harrison & Jackson Counties**			**Approx. 7,000 lots at $45,000 per lot**						**$315,000,000**
Totals	**Total Parcels in Nonstructural Plan – 30,508**									**$8,799,523,466**

** (See discussion of the LOD 4 structural alternative in the Executive Summary)

Table 31
NSC-6e – Combined Structural and Nonstructural 20 Feet Inundation w/LOD4 **

Reaches	Acquisition Parcels	Acquisitions Cost	Floodproofing Parcels	Floodproofing Costs	Total Nonstructural Costs by Reach
1	795	$242,760,352.63	1068	$ 111,644,220.00	$354,404,572.63
2	6119	$1,982,505,118.75	12206	$2,270,306,077.00	$4,252,811,195.75
7	343	$28,183,289.75	1092	$ 123,833,026.00	$152,016,315.75
8	6585	$721,036,617.25	2761	$ 268,481,369.00	$989,517,986.25
11	45	$13,955,967.50	882	$ 131,996,005.00	$145,951,972.50
12	1617	$398,388,336.75	2184	$ 925,803,107.00	$1,324,191,443.75
14	10	$3,531,145.00	3	$	$3,531,145.00
16	178	$45,986,843.00	420	$ 89,816,180.00	$135,803,023.00
20	1046	$197,002,707.50	1756	$ 491,997,409.00	$689,000,116.50
21	2142	$698,779,207.38	1688	$ 518,126,016.00	$1,216,905,223.38
23	59	$18,831,864.50	104	$ 23,208,676.00	$42,040,540.50
37	0	$0.00	5	$ -	$0.00
38	33	$23,256,254.25	304	$ 16,587,864.00	$39,844,118.25
39	8	$1,627,170.00	287	$ 16,374,482.00	$18,001,652.00
40	1	$100,211.25	4	$	$100,211.25
43	0	$0.00	4	$ 366,298.00	$366,298.00
46	0	$0.00	3	$ 114,092.00	$114,092.00
47	0	$0.00	5	$ 587,982.00	$587,982.00
48	1	$1,457,777.50	5	$ 587,982.00	$2,045,759.50
49	0	$0.00	63	$ 2,318,648.00	$2,318,648.00
50	574	$204,376,584.50	1915	$ 363,408,582.00	$567,785,166.50
Subtotals	**19556**	**$4,581,779,447**	**26759**	**$5,355,558,015**	**$9,937,337,462**
H&CD Sites	Hancock, Harrison &Jackson		Approx. 6,800 lots at $45,000/lot		**$306,000,000**
Totals	**Total Nonstructural Parcels – 46,315**				**$10,243,337,462**

** (See discussion of the LOD 4 structural alternative in the Executive Summary)

Table 32

NSC-6f – Combined Structural and Nonstructural 30 Feet Inundation w/LOD4 **

Reaches	Acquisition Parcels	Acquisition Costs	Floodproofing Parcels	Floodproofing Costs	Total Nonstructural Costs by Reach
1	1591	$470,268,503.50	511	$ 80,353,606.00	$550,622,109.50
2	15864	$3,364,937,903.75	6331	$ 2,006,692,184.00	$5,371,630,087.75
7	1222	$127,404,692.38	267	$ 18,389,310.00	$145,794,002.38
8	8591	$913,966,937.50	755	$ 201,679,104.00	$1,115,646,041.50
11	79	$17,236,421.25	848	$ 315,371,358.00	$332,607,779.25
12	3801	$1,250,095,756.75	0	$ -	$1,250,095,756.75
14	10	$3,531,145.00	3	$ -	$3,531,145.00
16	598	$173,917,626.75	0	$ -	$173,917,626.75
20	2144	$416,967,996.50	1802	$ 861,061,816.00	$1,278,029,812.50
21	3830	$1,483,891,217.50	0	$ -	$1,483,891,217.50
23	163	$57,221,763.88	0	$ -	$57,221,763.88
37	1	$340,434.38	4	$ -	$340,434.38
38	198	$59,672,860.88	452	$ 74,116,316.00	$133,789,176.88
39	295	$34,977,357.00	0	$ -	$34,977,357.00
40	5	$417,288.75	0	$ -	$417,288.75
43	4	$1,269,975.00	0	$ -	$1,269,975.00
46	3	$322,862.50	0	$ -	$322,862.50
47	5	$1,720,815.00	0	$ -	$1,720,815.00
48	6	$5,485,907.50	0	$ -	$5,485,907.50
49	63	$8,814,550.50	0	$ -	$8,814,550.50
50	1652	$665,887,180.75	837	$ 176,952,378.00	$842,839,558.75
Subtotals	**40125**	**$9,058,349,197**	**11810**	**$ 3,734,616,072**	**$12,792,965,269**
H&CD Sites	Hancock, Harrison & Jackson		Approx 14,000 lots at $45,000/lot		**$630,000,000**
Totals	**Total Nonstructural Parcels – 51,935**				**$13,422,965,269**

** (See discussion of the LOD 4 structural alternative in the Executive Summary)

Table 33

NSC-6g – Combined Structural and Nonstructural 40 Feet Inundation with LOD4 **

Reaches	Acquisition Parcels	Acquisition Costs	Floodproofing Parcels	Floodproofing Costs	Total Nonstructural Costs by Reach
1	2102	$632,549,786.38	0	0	$632,549,786.38
2	22195	$5,686,835,321.25	0	0	$5,686,835,321.25
7	1489	$159,349,868.63	0	0	$159,349,868.63
8	9346	$1,119,589,307.50	0	0	$1,119,589,307.50
11	927	$238,310,263.50	0	0	$238,310,263.50
12	3801	$1,250,095,756.75	0	0	$1,250,095,756.75
14	13	$5,321,020.00	0	0	$5,321,020.00
16	598	$173,917,626.75	0	0	$173,917,626.75
20	3946	$829,880,446.50	0	0	$829,880,446.50
21	3830	$1,483,891,217.50	0	0	$1,483,891,217.50
23	163	$57,221,763.88	0	0	$57,221,763.88
37	5	$1,911,196.25	0	0	$1,911,196.25
38	650	$214,970,390.38	0	0	$214,970,390.38
39	295	$34,977,357.00	0	0	$34,977,357.00
40	5	$417,288.75	0	0	$417,288.75
43	4	$1,269,975.00	0	0	$1,269,975.00
46	3	$322,862.50	0	0	$322,862.50
47	5	$1,720,815.00	0	0	$1,720,815.00
48	6	$5,485,907.50	0	0	$5,485,907.50
49	63	$8,814,550.50	0	0	$8,814,550.50
50	2489	$1,063,036,000.75	0	0	$1,063,036,000.75
Subtotals	**51935**	**$12,969,888,722**	**0**	**0**	**$12,969,888,722**
H&CD Sites	Hancock, Harrison & Jackson Counties		Approx. 18,200 Lots at $45,000/lot		**$819,000,000**
Totals	**Total Nonstructural Parcels in Plan – 51,935**				**$13,788,888,722**

** (See discussion of the LOD 4 structural alternative in the Executive Summary)

Figure 91 – Plan NSC-6 Combined Nonstructural and Structural Plan (A1)

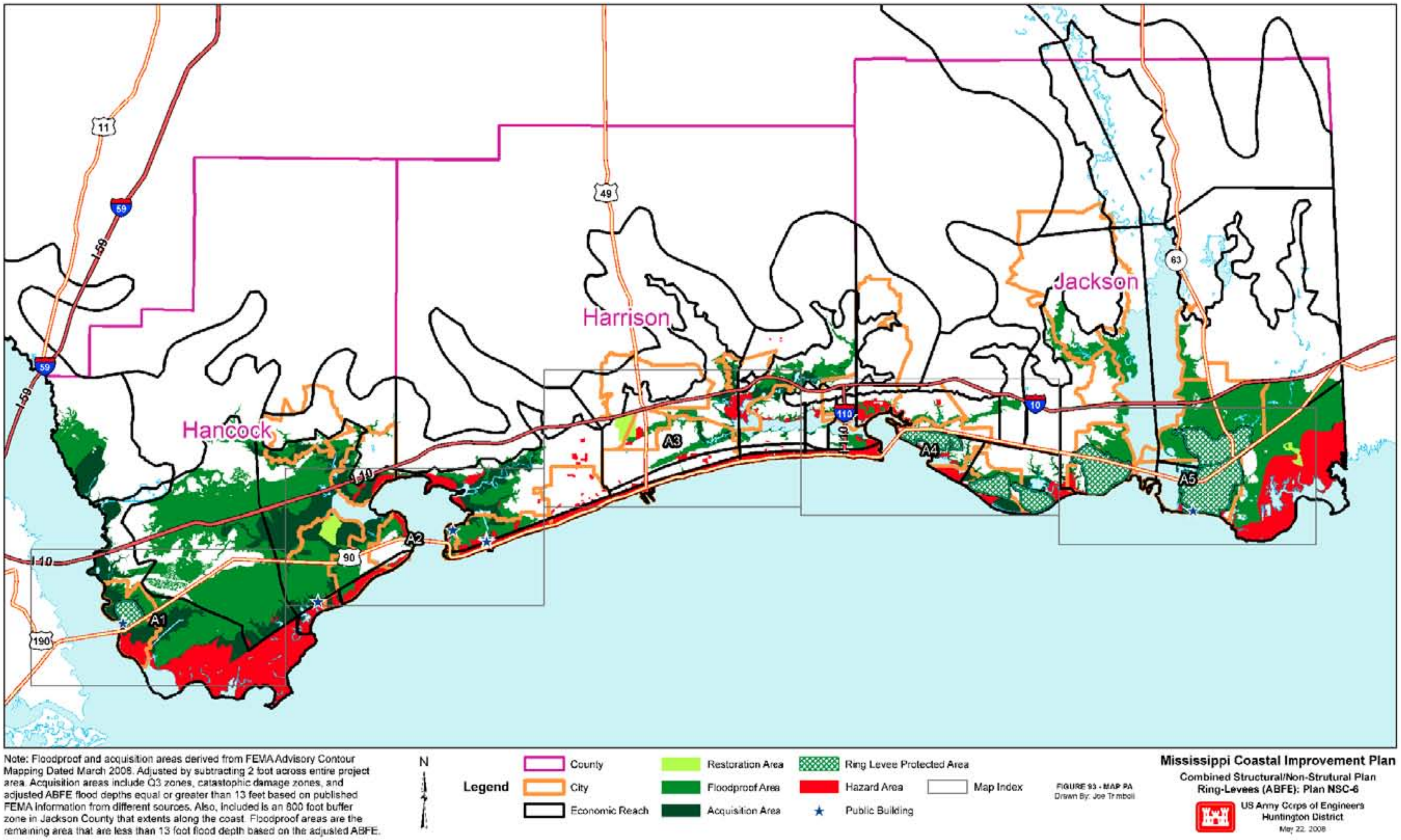


Figure 92 – Plan NSC-6 Combined Nonstructural and Structural Plan (A2)

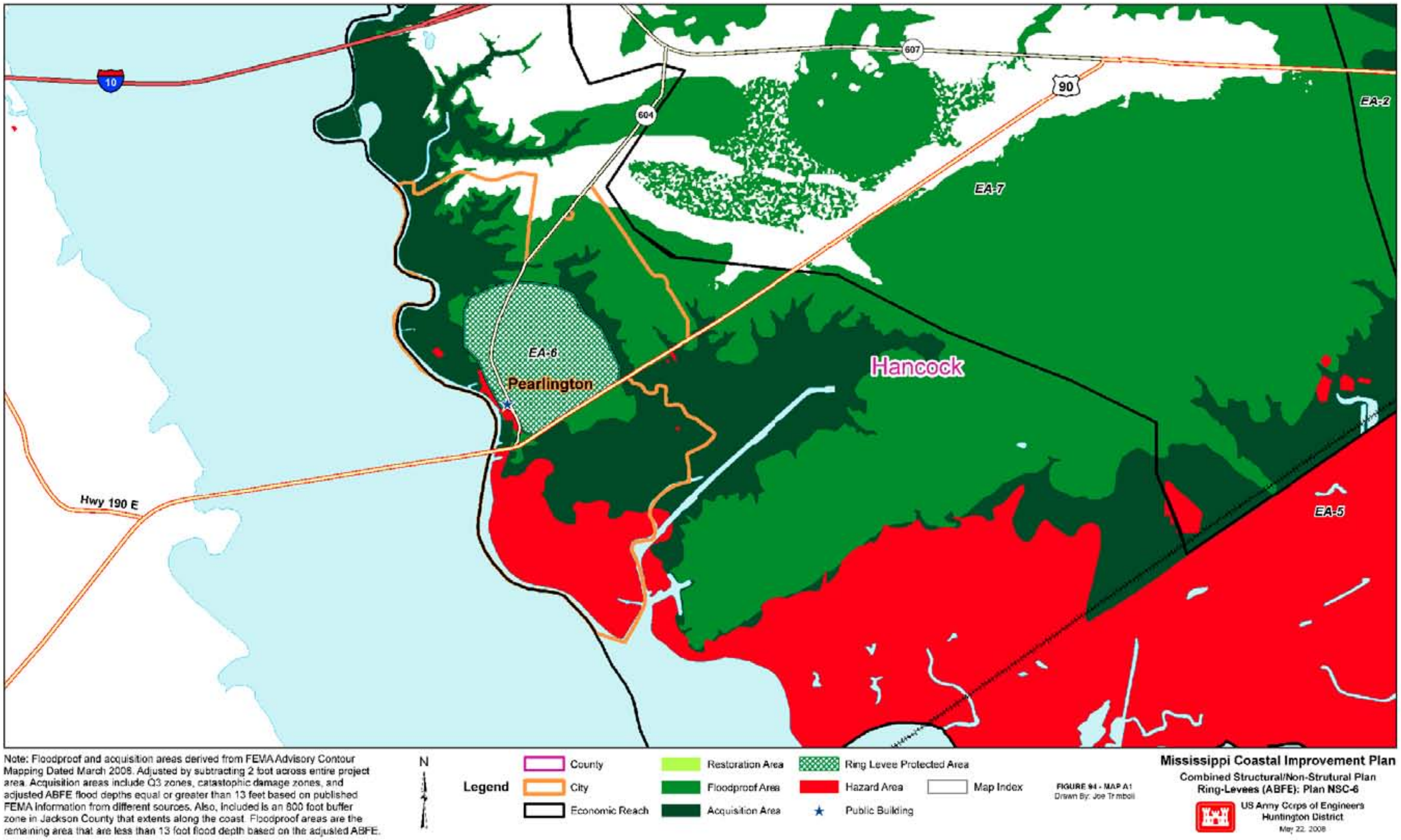


Figure 93 – Plan NSC-6 Combined Nonstructural and Structural Plan (A3)

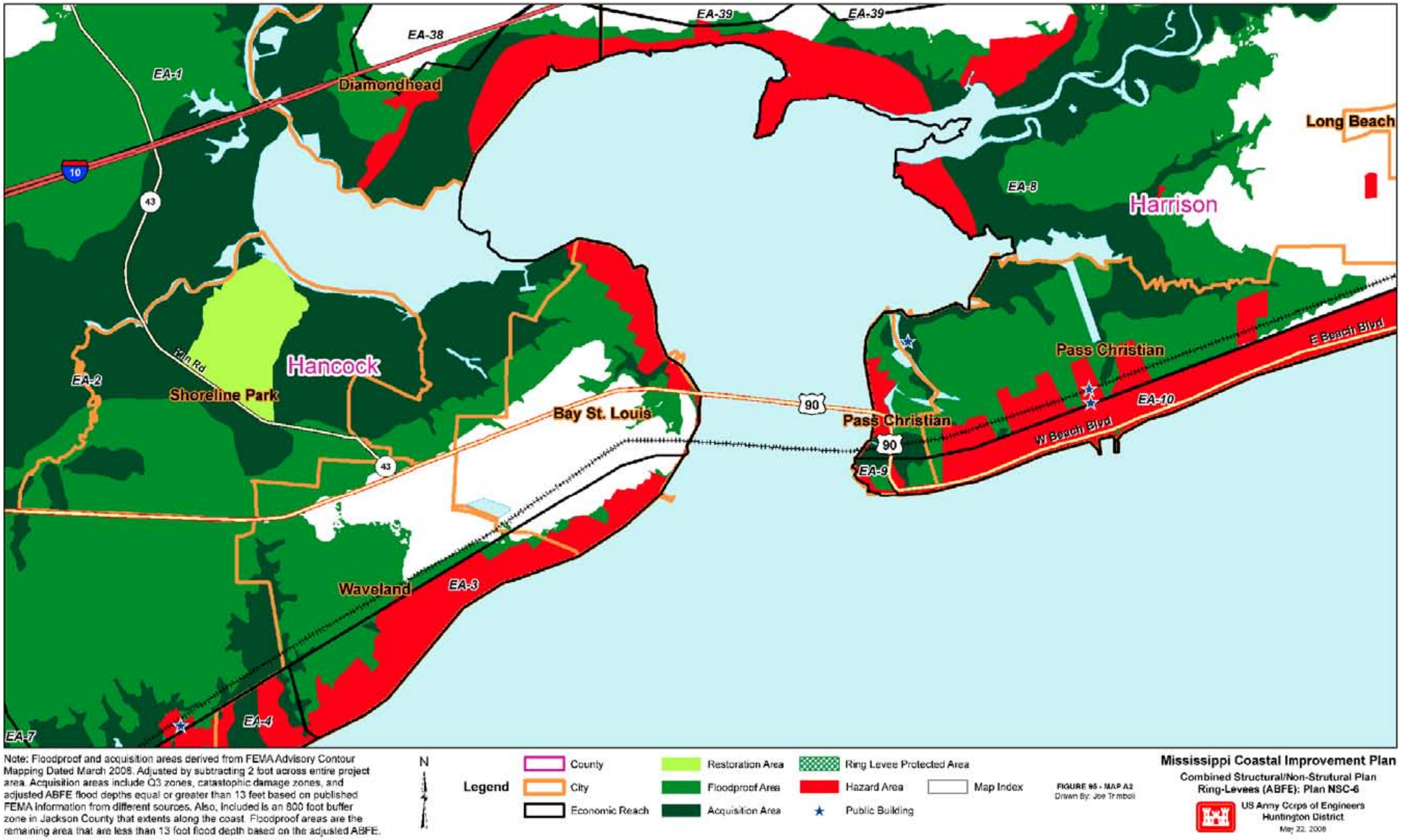


Figure 94 – Plan NSC-6 Combined Nonstructural and Structural Plan (A4)

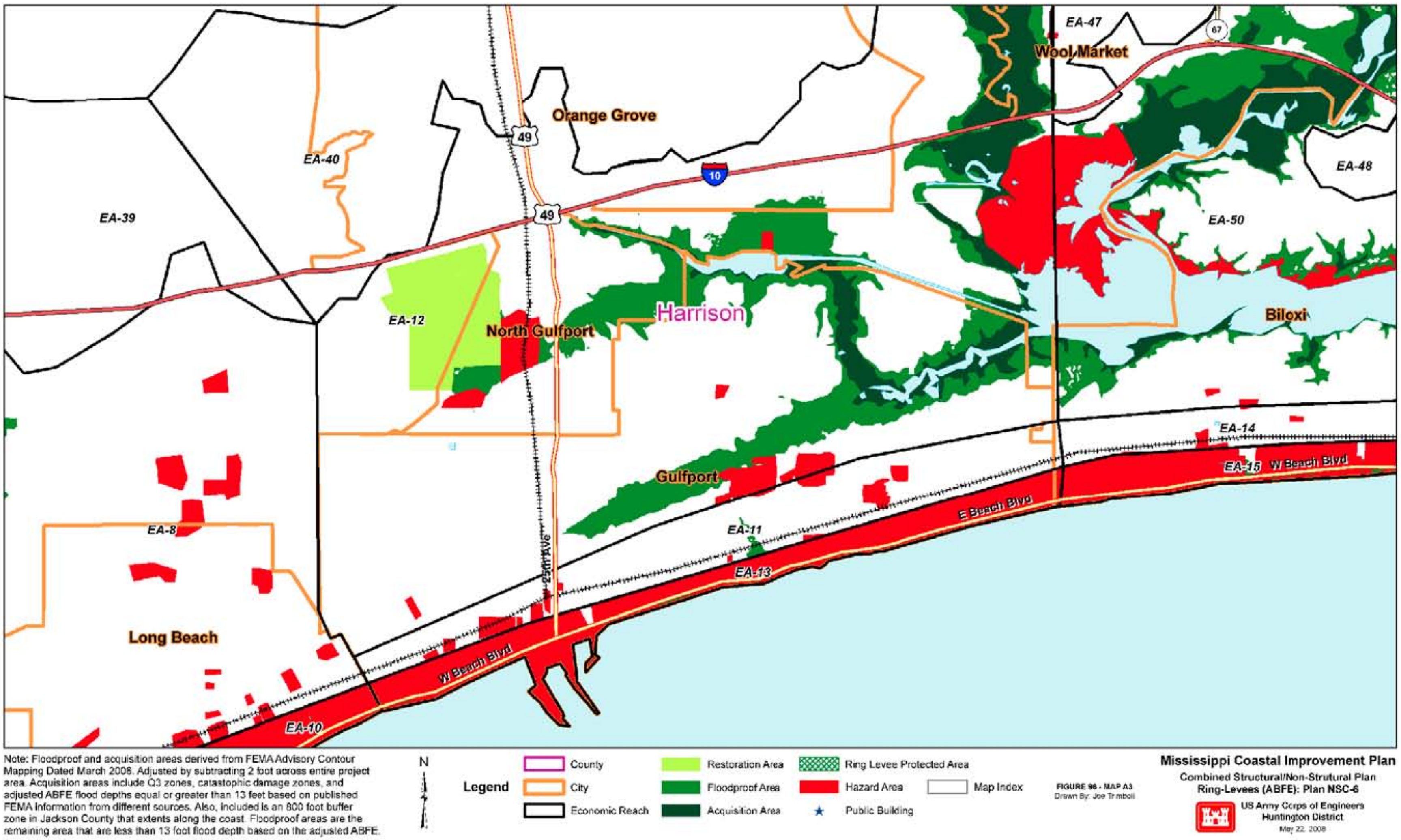


Figure 95 – Plan NSC-6 Combined Nonstructural and Structural Plan (A5)

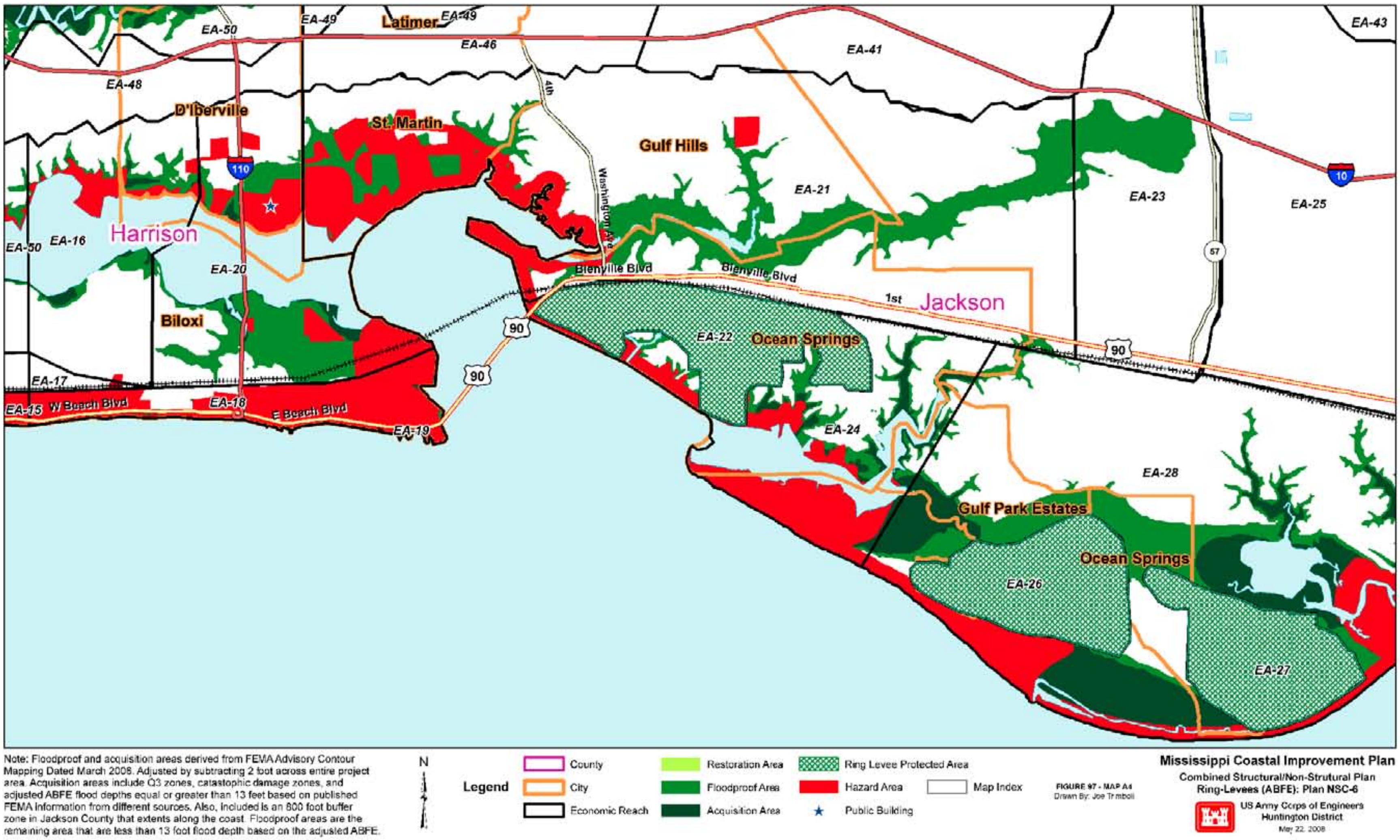


Figure 96 – Plan NSC-6 Combined Nonstructural and Structural Plan (A6)

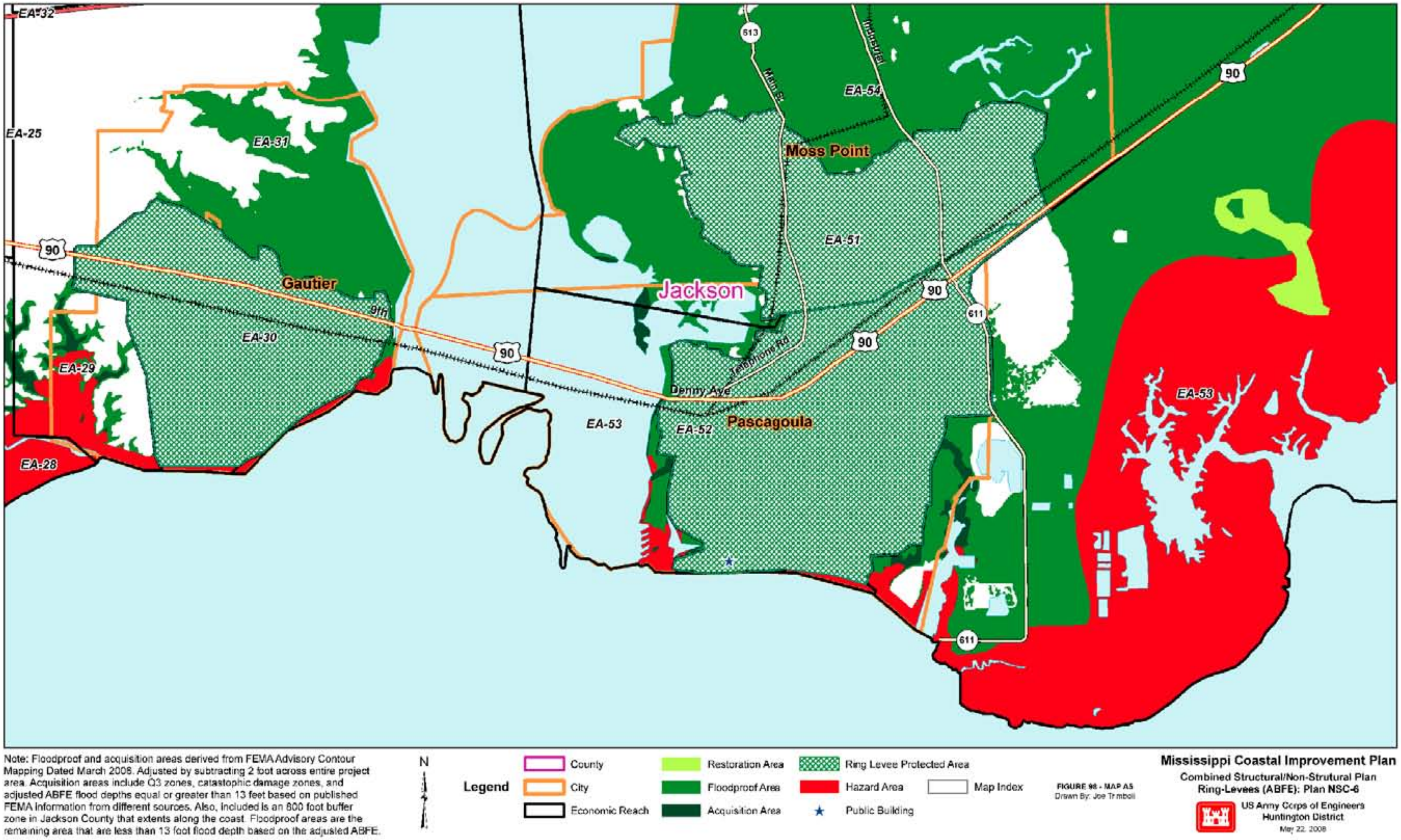


Figure 97 - Plan NSC-6a Combined Nonstructural and Structural Plan (A1)

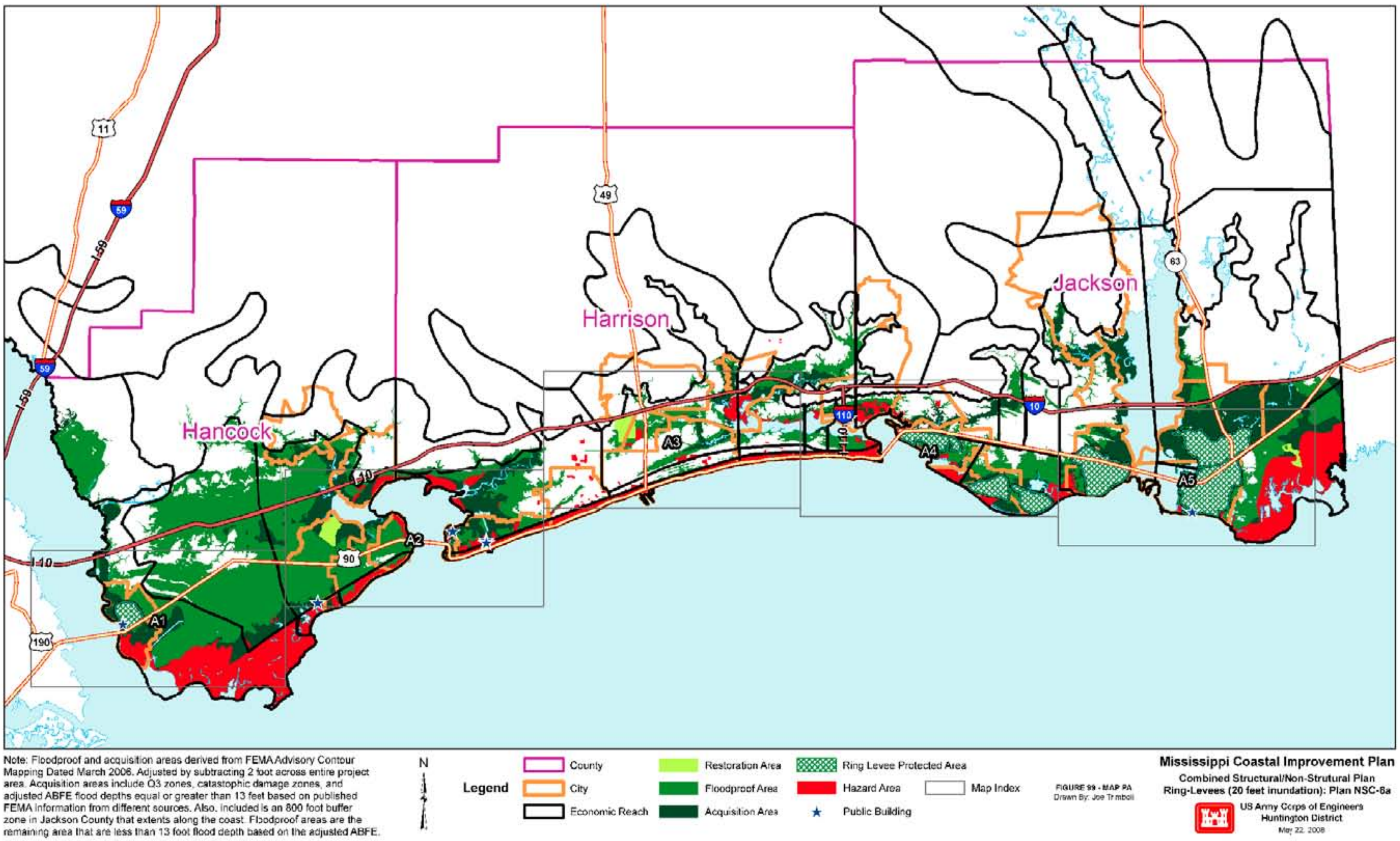


Figure 98 - Plan NSC-6a Combined Nonstructural and Structural Plan (A2)

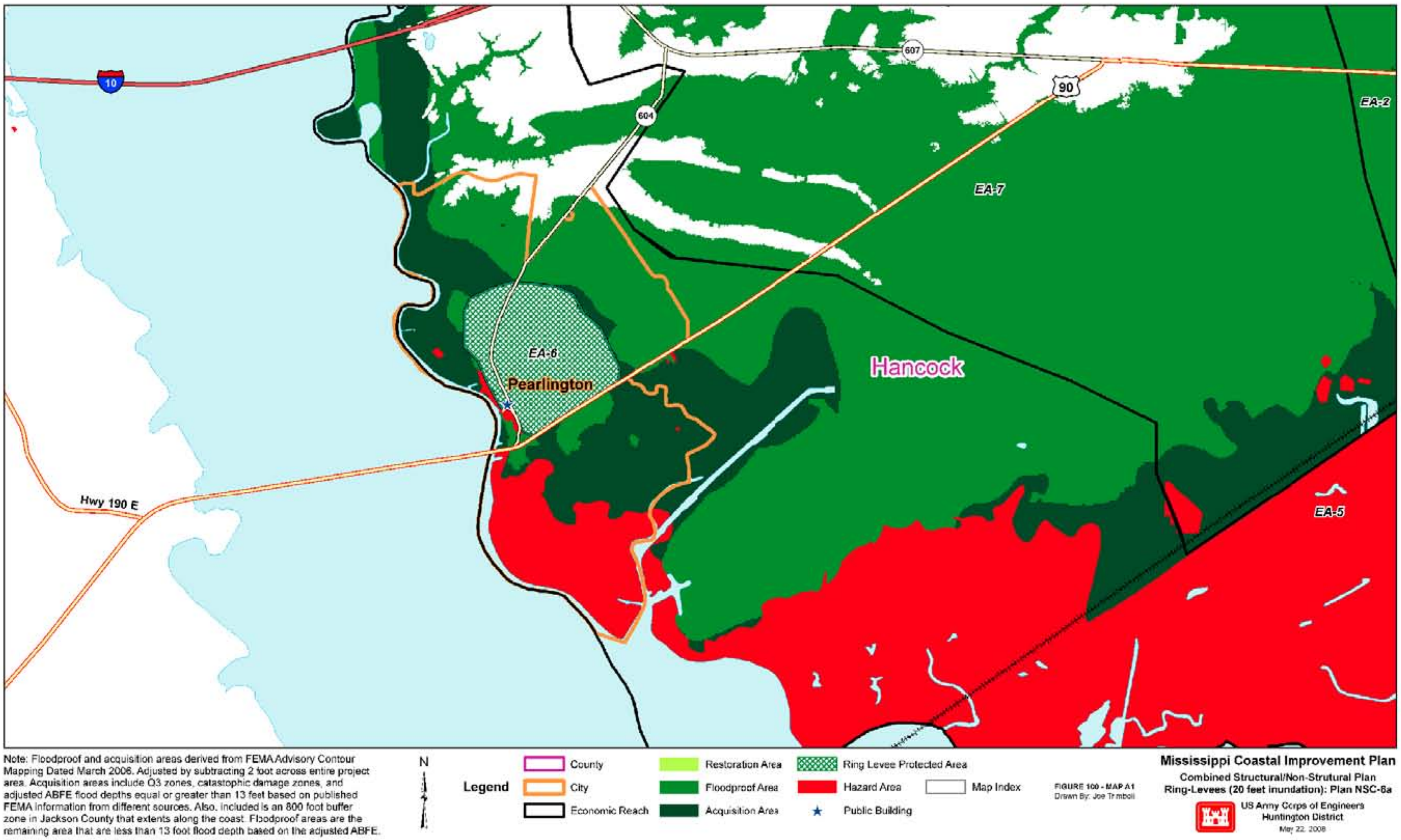


Figure 99 - Plan NSC-6a Combined Nonstructural and Structural Plan (A3)

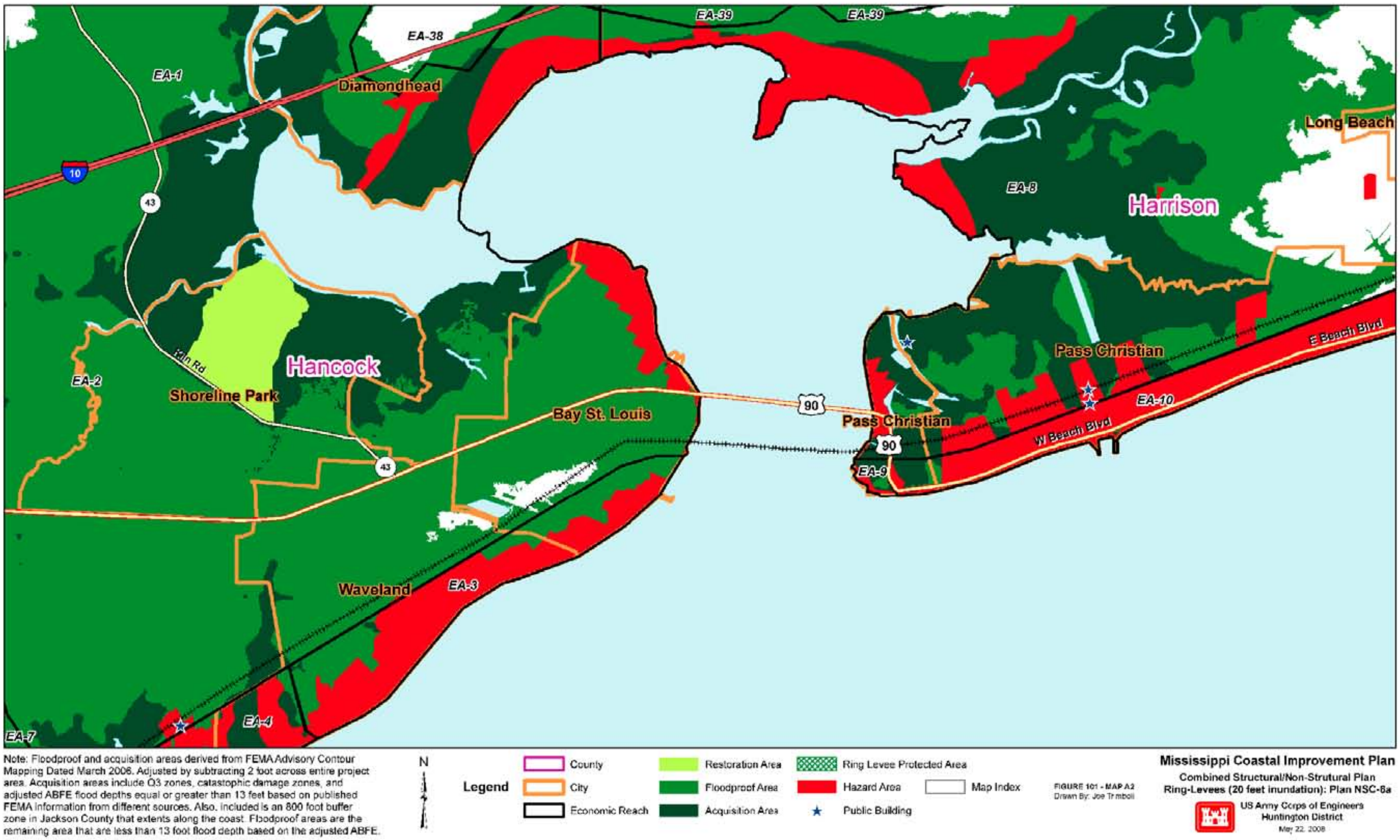


Figure 100 - Plan NSC-6a Combined Nonstructural and Structural Plan (A4)

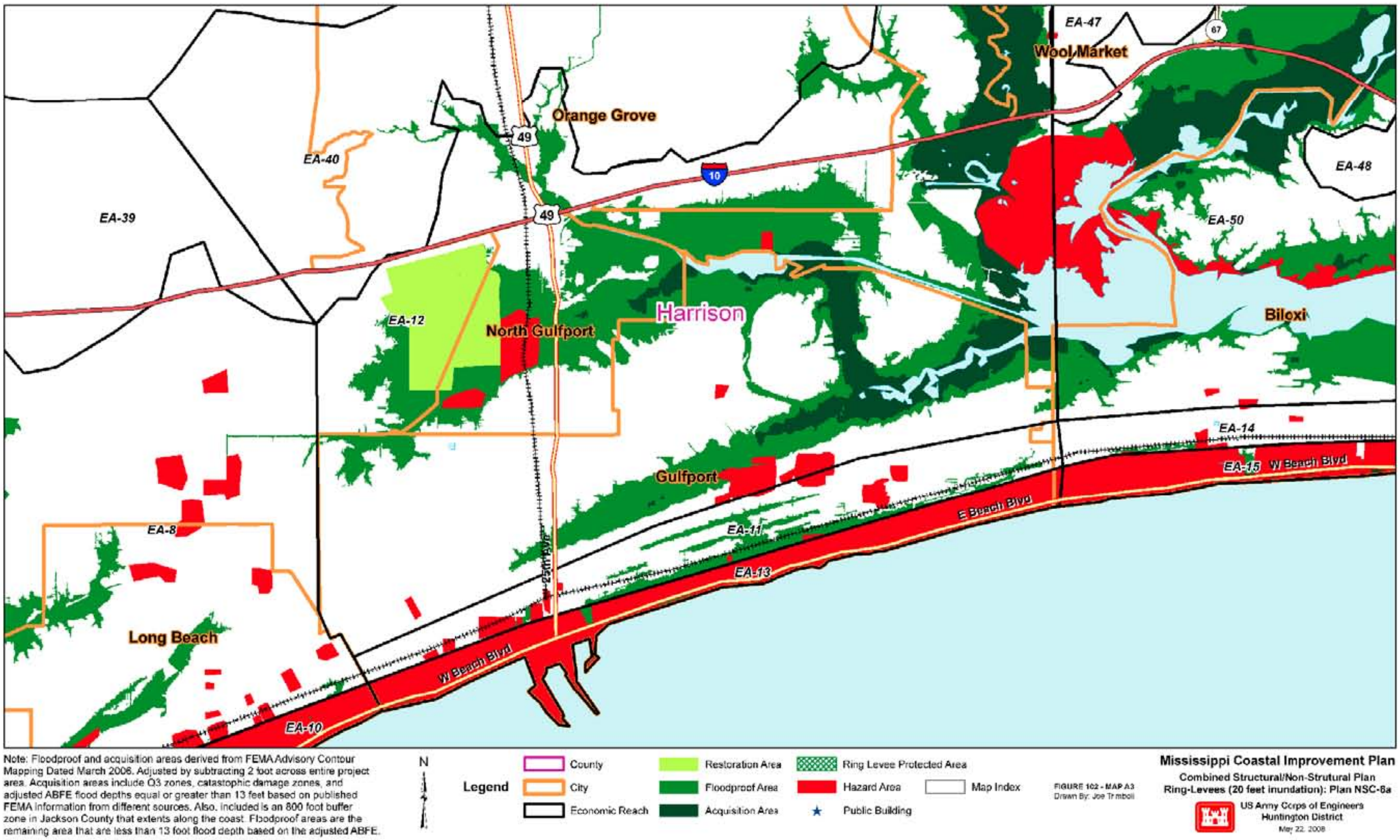


Figure 101 - Plan NSC-6a Combined Nonstructural and Structural Plan (A5)

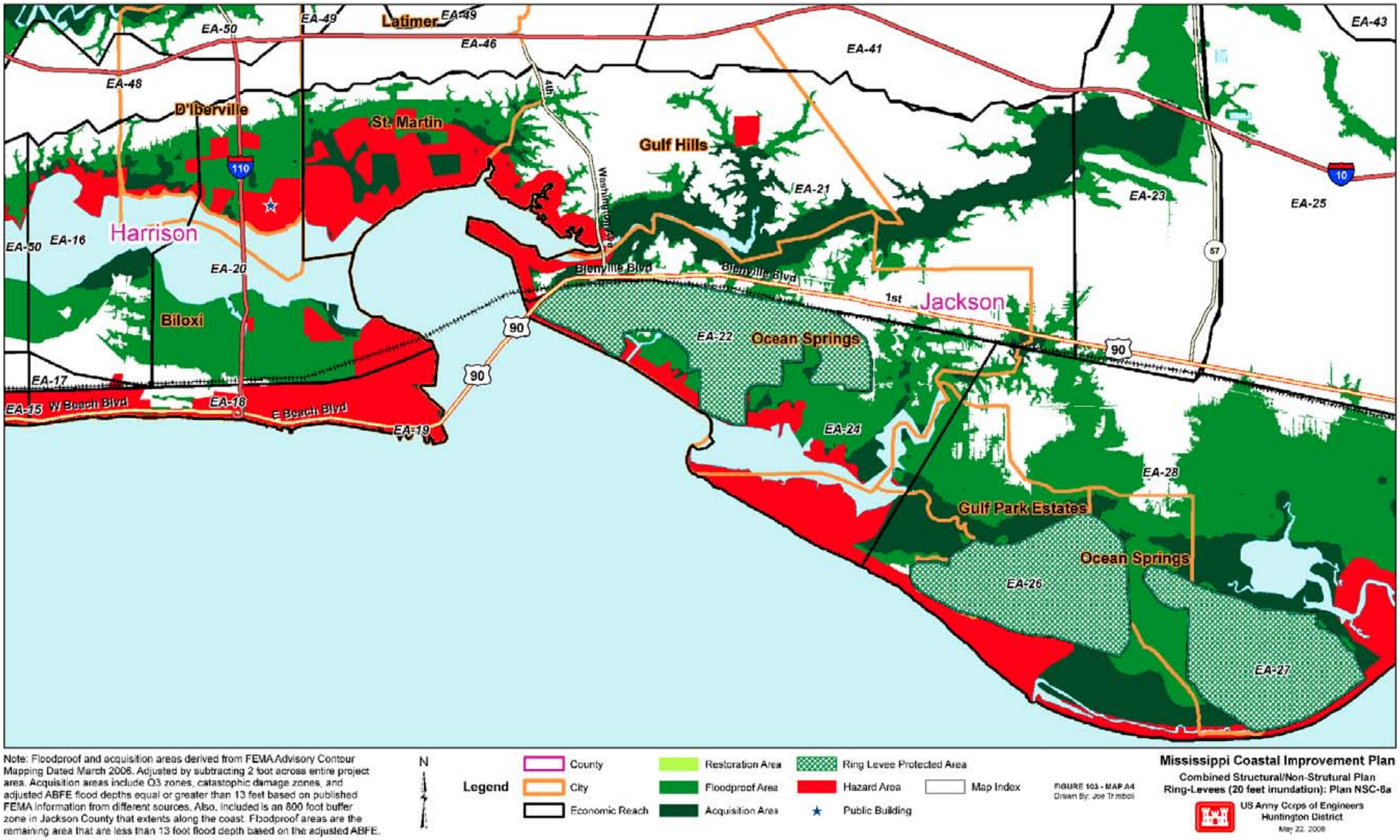


Figure 102 - Plan NSC-6a Combined Nonstructural and Structural Plan (A6)

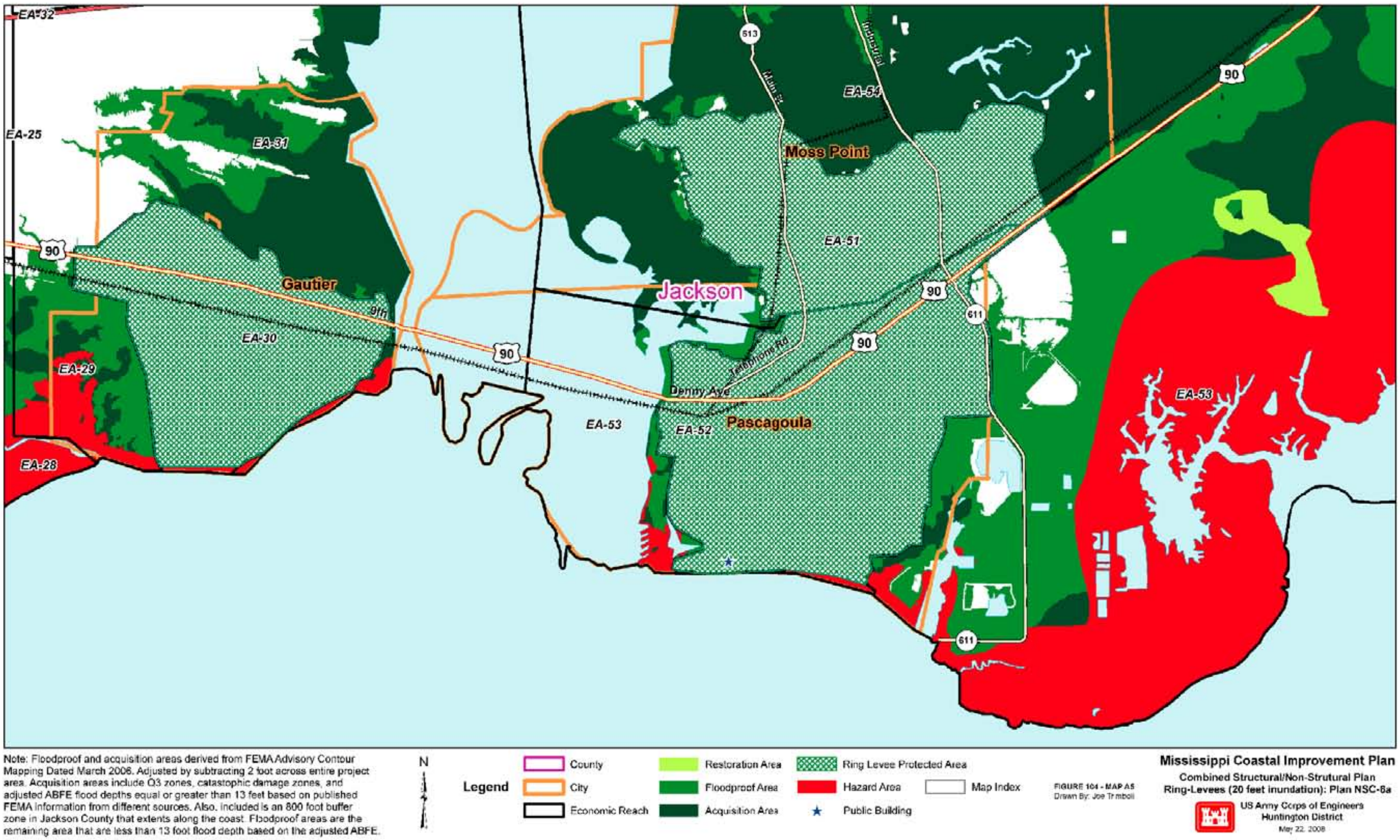


Figure 103 - Plan NSC-6b Combined Nonstructural and Structural Plan (A1)

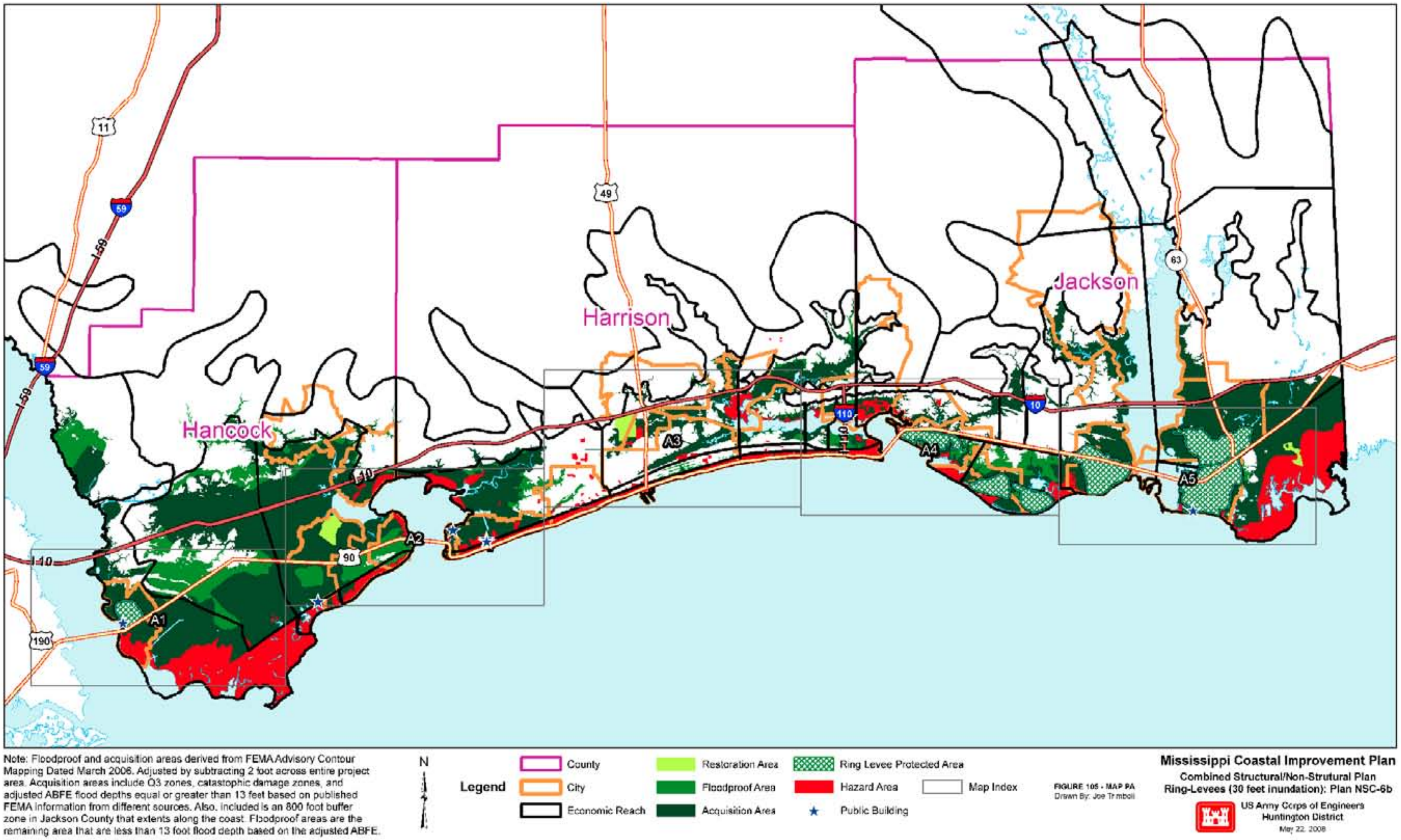


Figure 104 - Plan NSC-6b Combined Nonstructural and Structural Plan (A2)

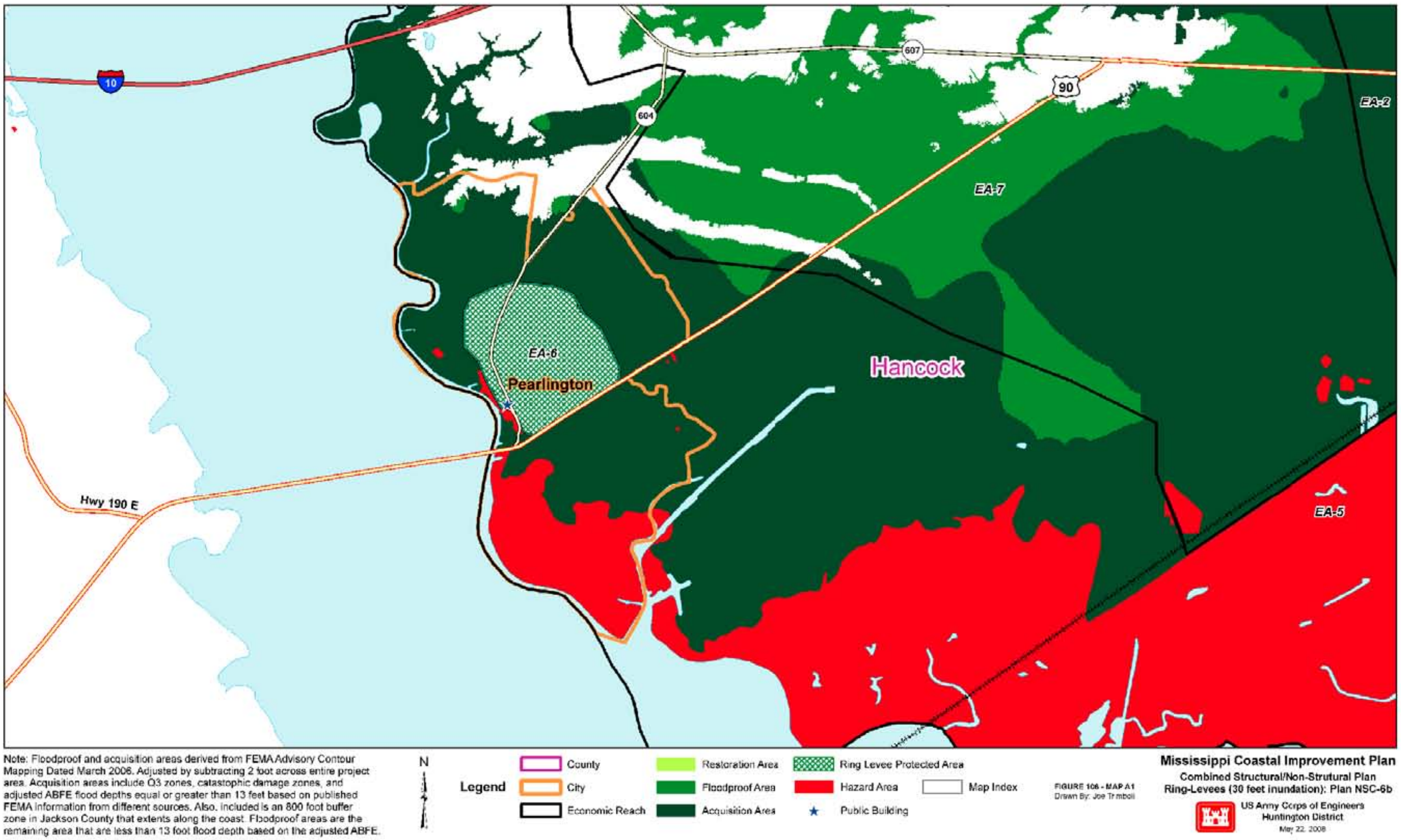


Figure 105 - Plan NSC-6b Combined Nonstructural and Structural Plan (A3)

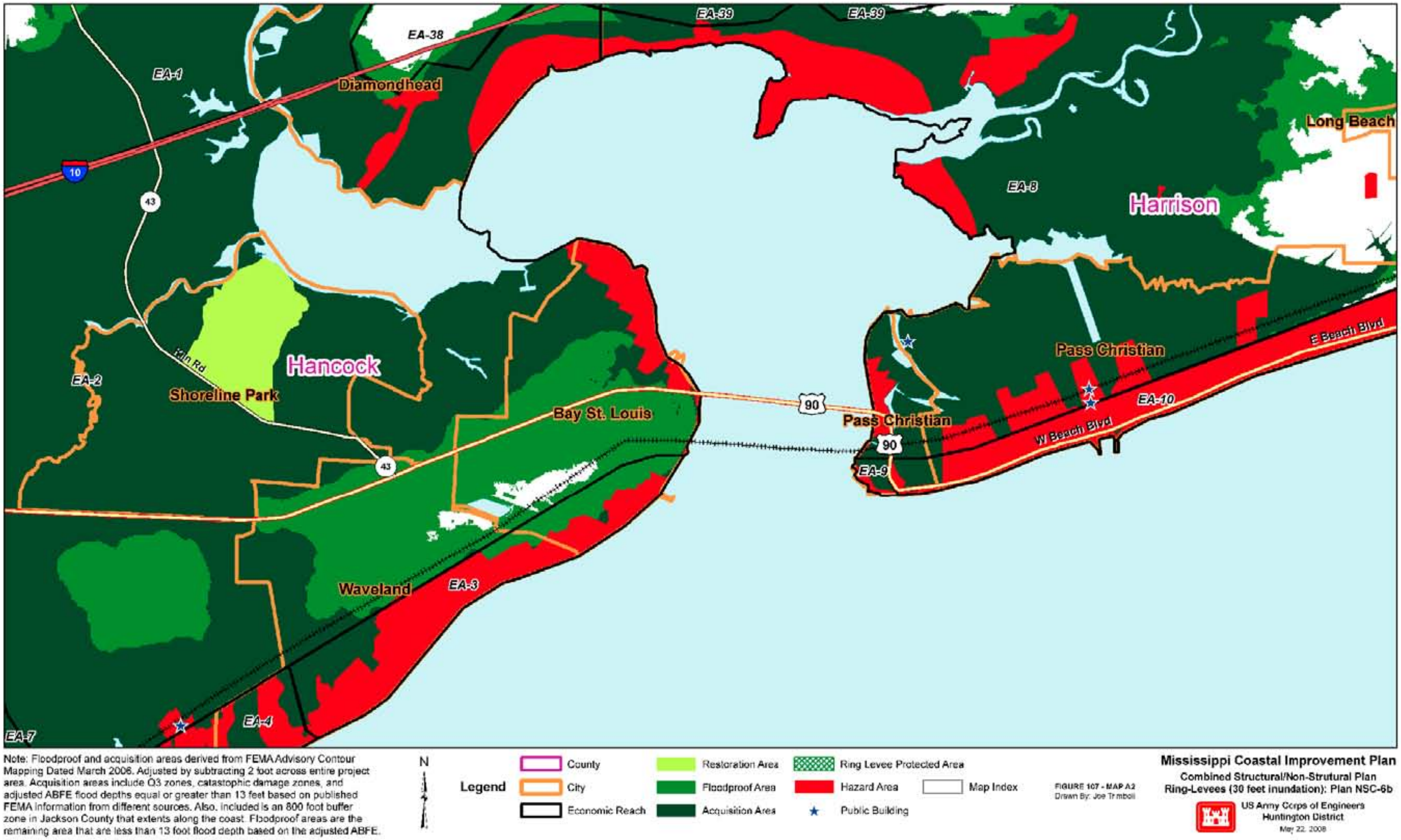


Figure 106 - Plan NSC-6b Combined Nonstructural and Structural Plan (A4)

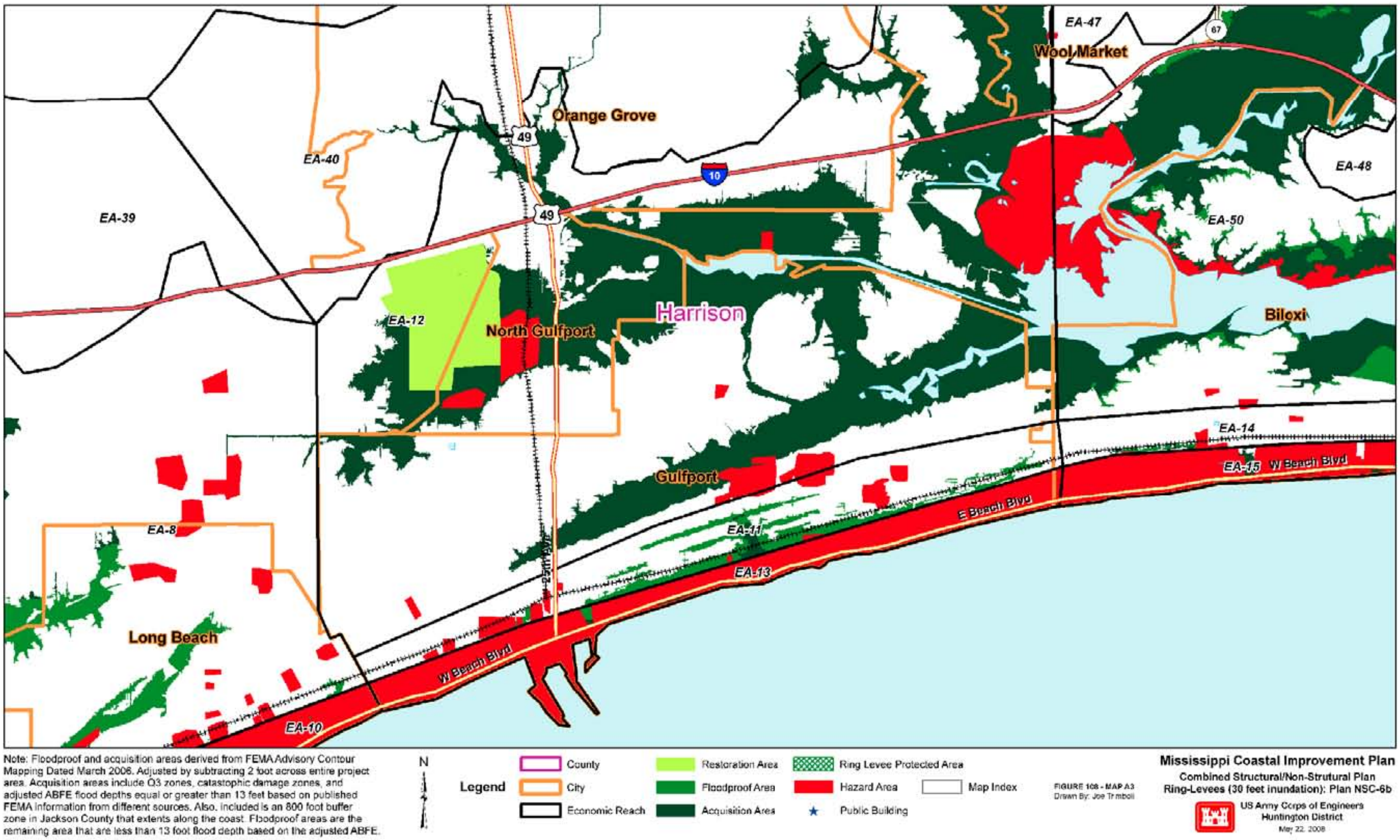


Figure 107 - Plan NSC-6b Combined Nonstructural and Structural Plan (A5)

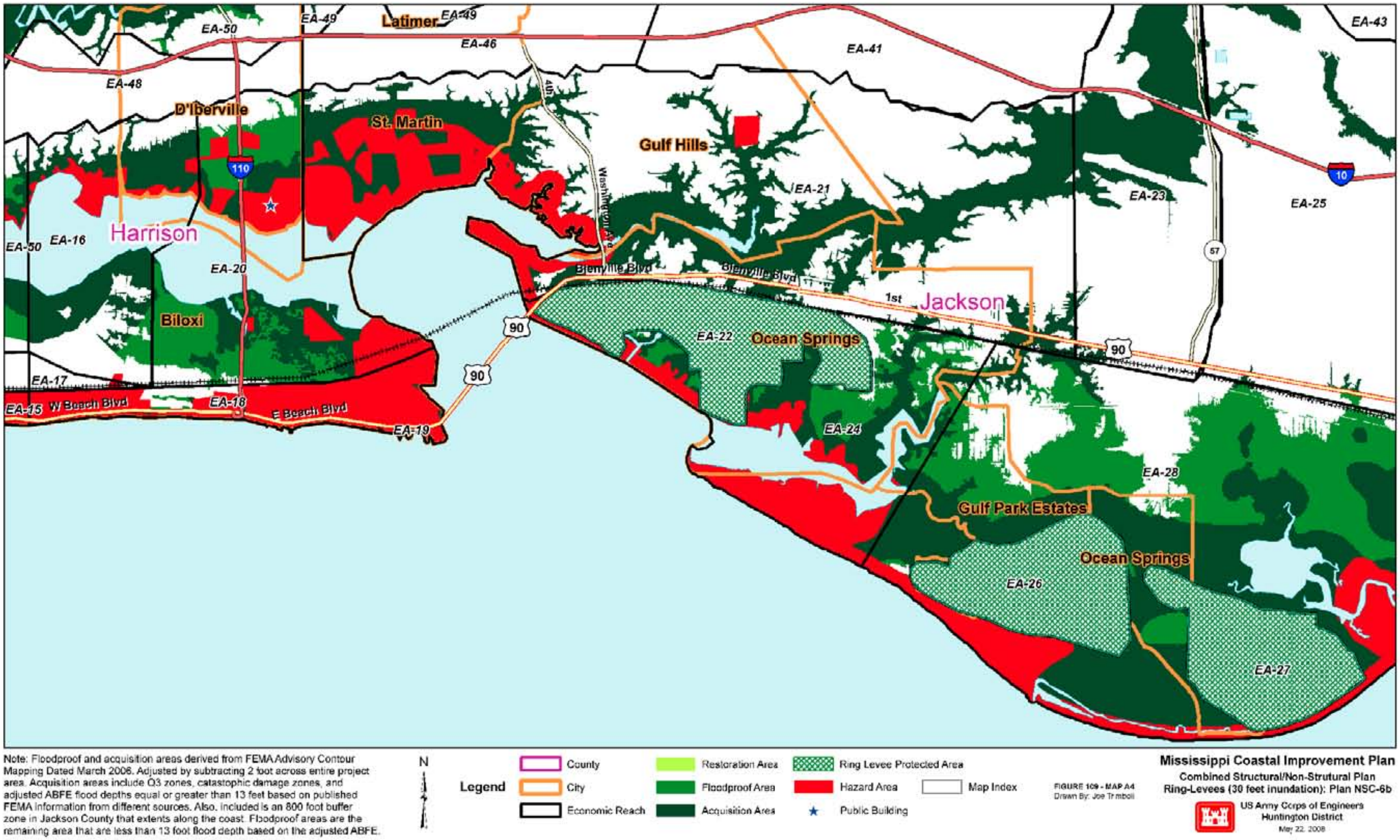


Figure 108 - Plan NSC-6b Combined Nonstructural and Structural Plan (A6)

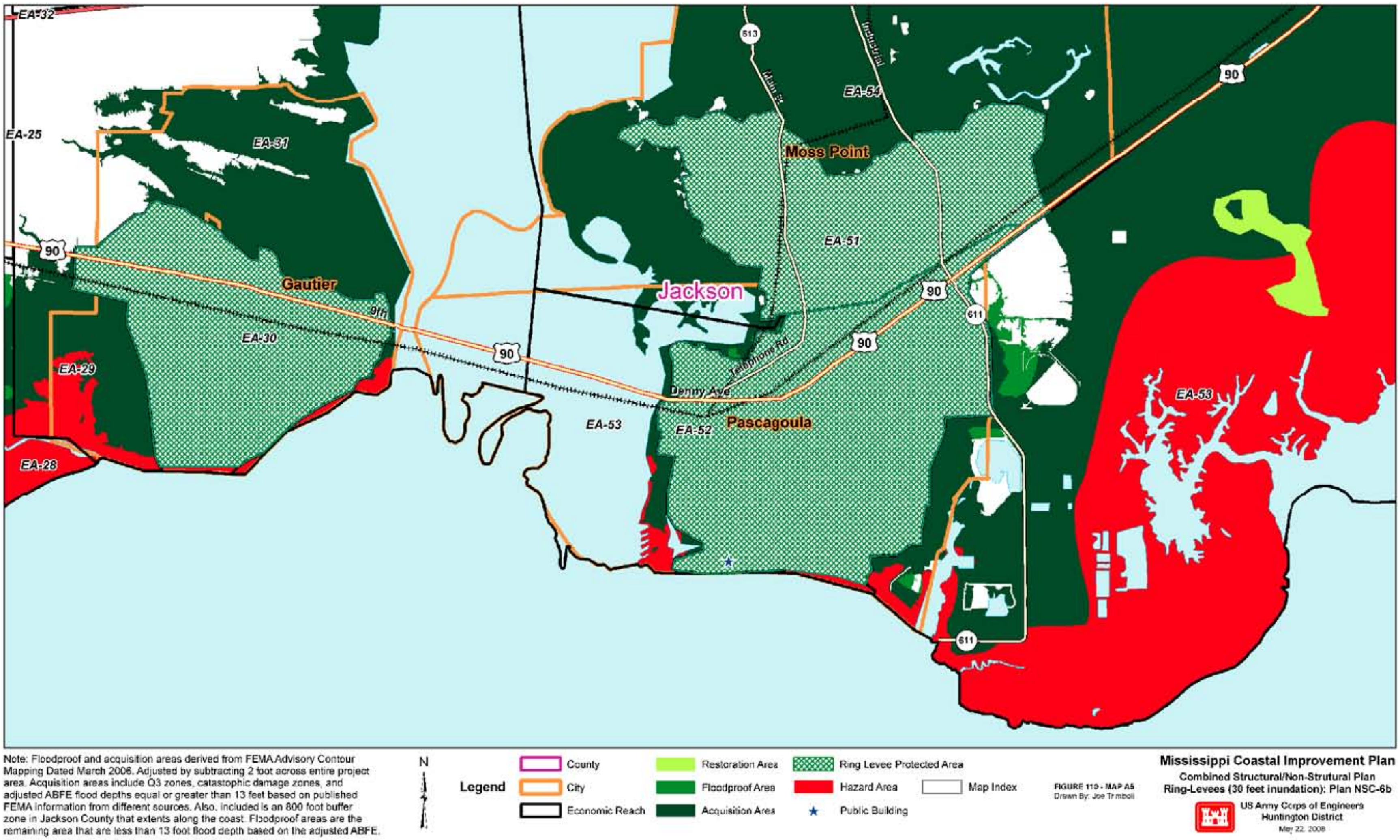


Figure 109 - Plan NSC-6c Combined Nonstructural and Structural Plan (A1)

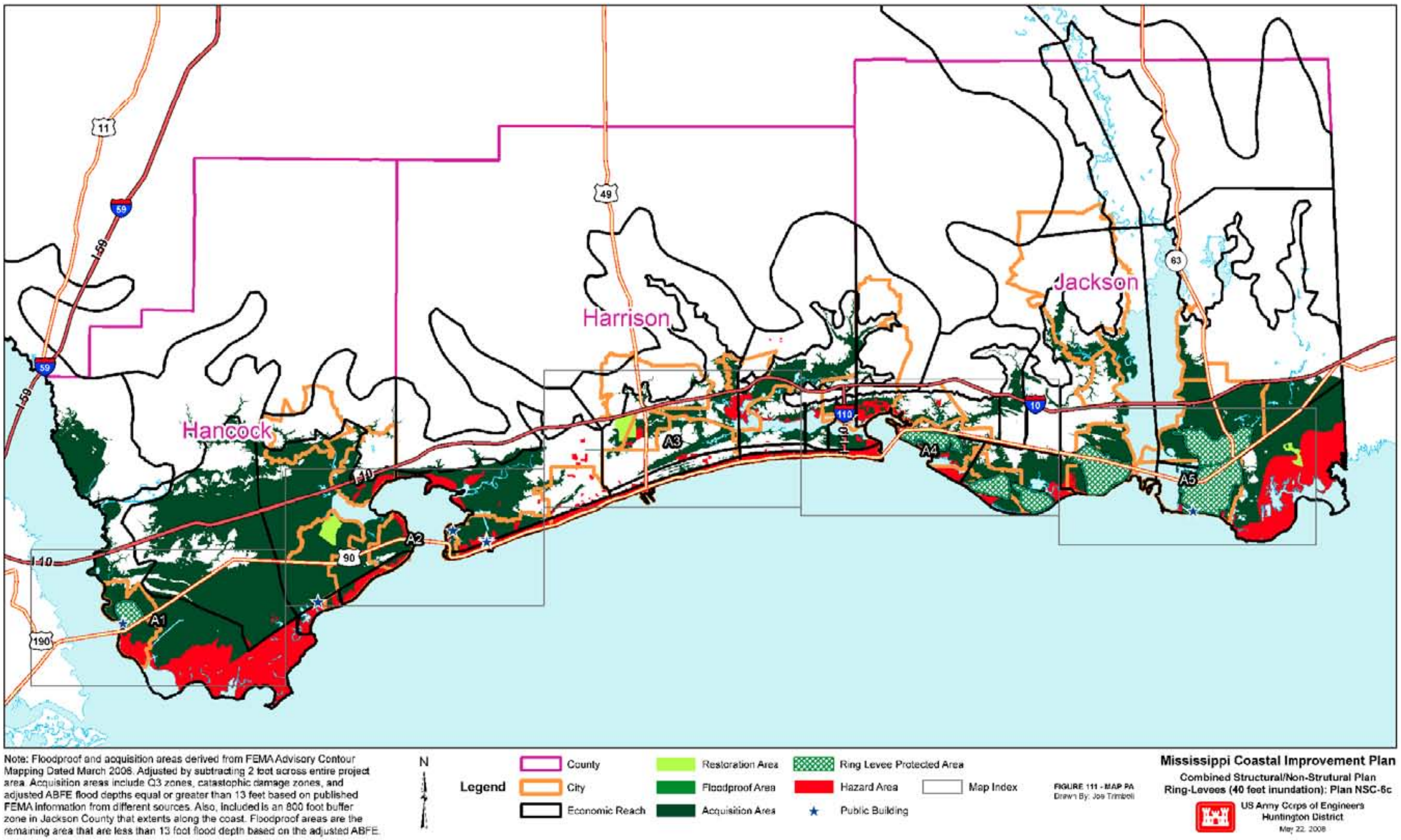


Figure 110 - Plan NSC-6c Combined Nonstructural and Structural Plan (A2)

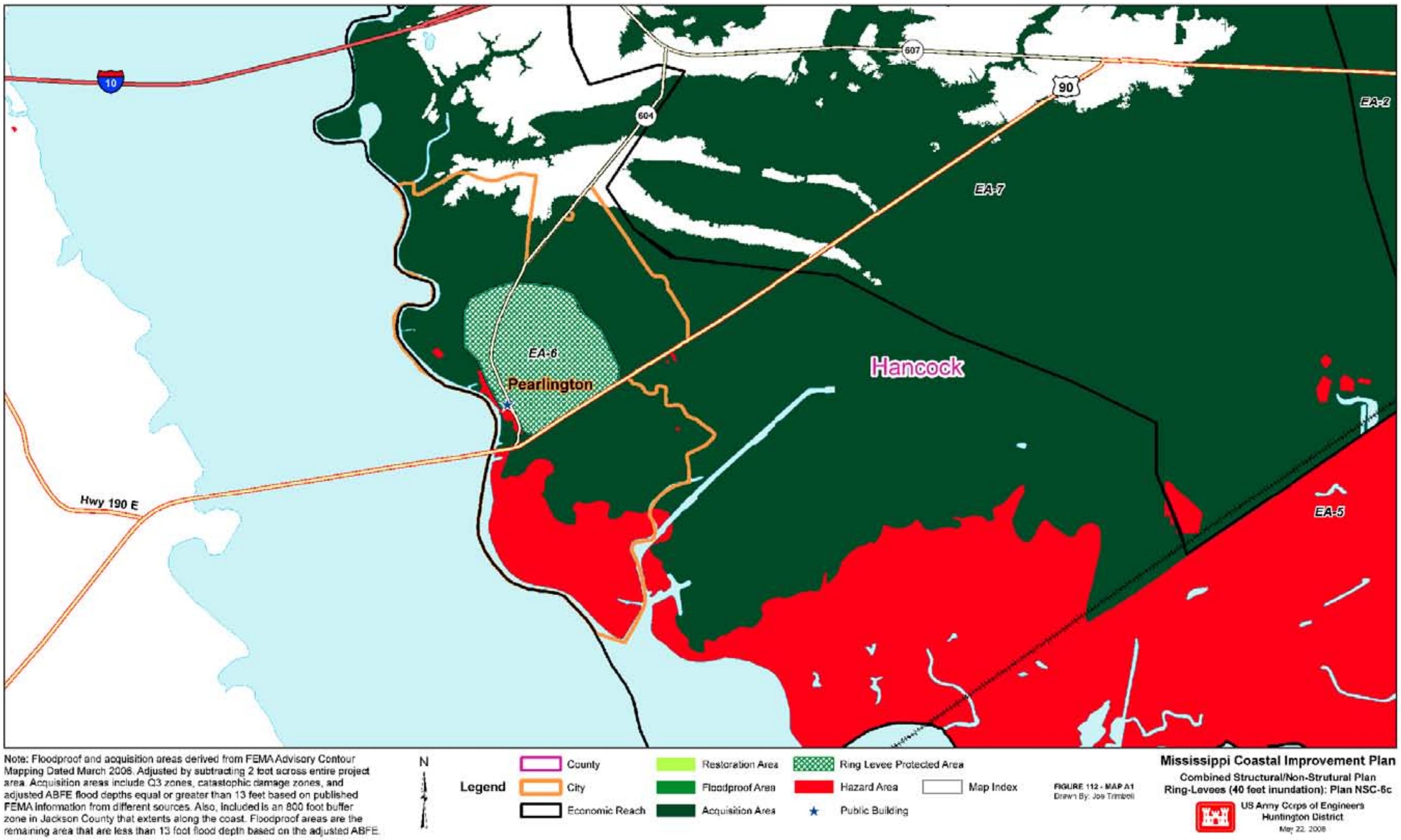


Figure 111 - Plan NSC-6c Combined Nonstructural and Structural Plan (A3)

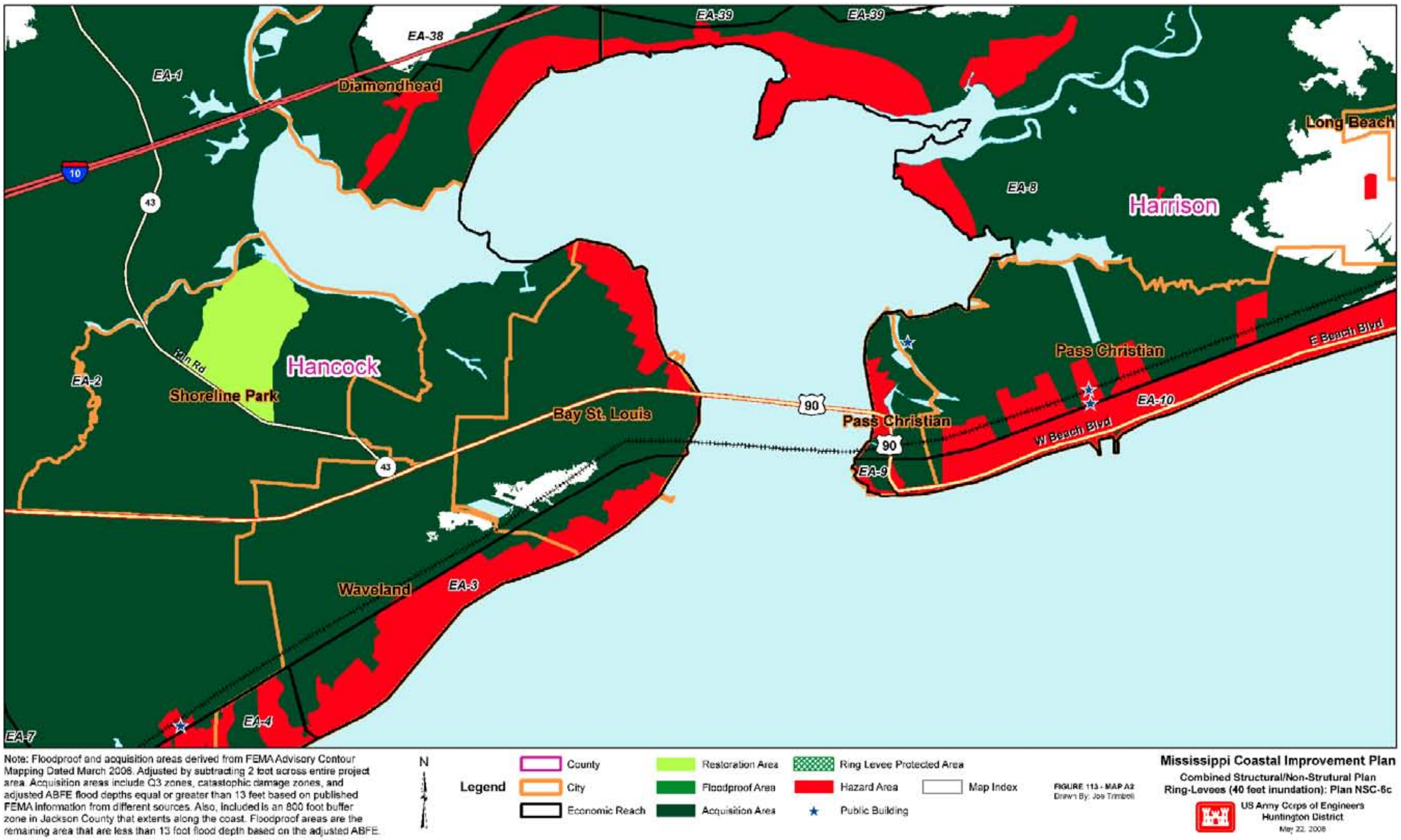


Figure 112 - Plan NSC-6c Combined Nonstructural and Structural Plan (A4)

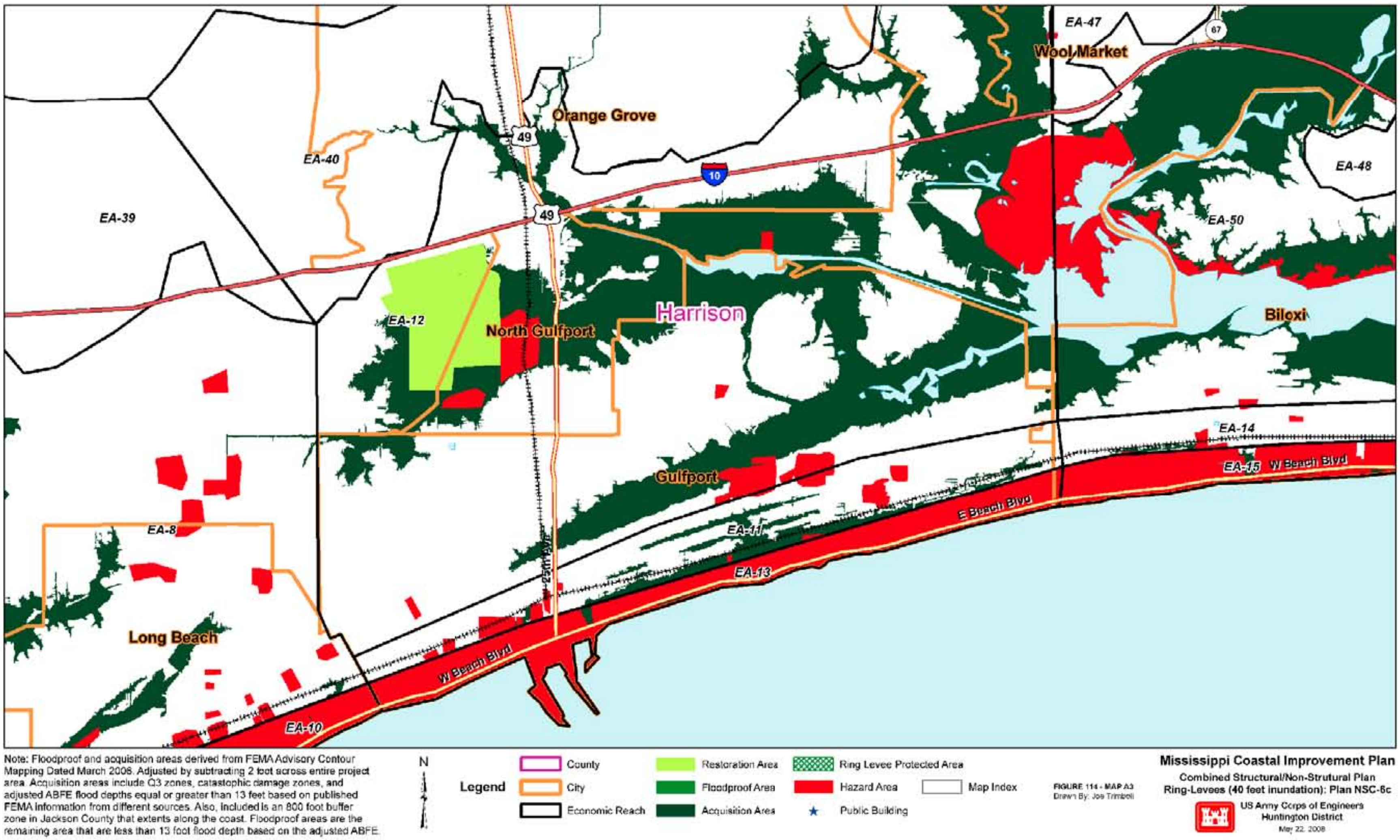


Figure 113 - Plan NSC-6c Combined Nonstructural and Structural Plan (A5)

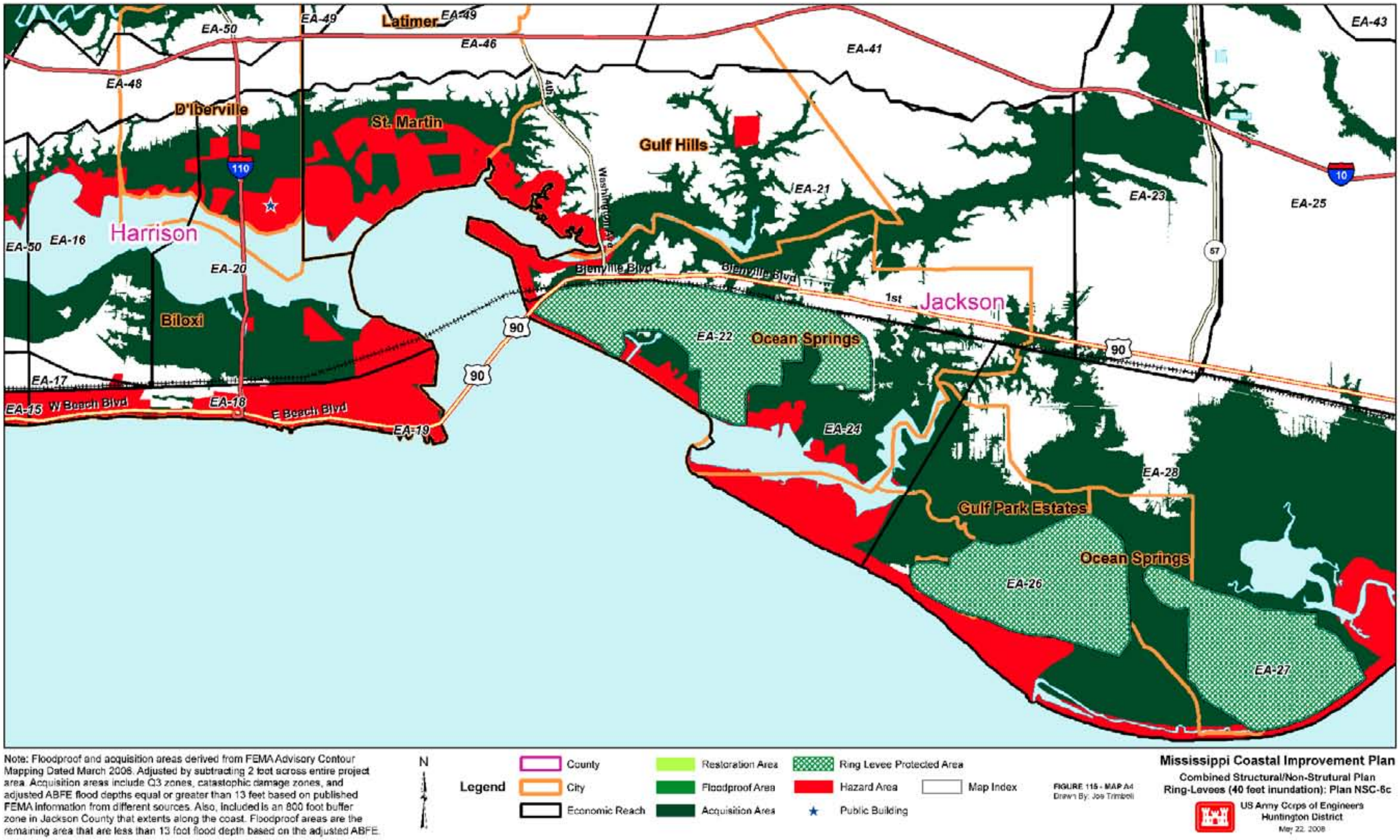


Figure 114 - Plan NSC-6c Combined Nonstructural and Structural Plan (A6)

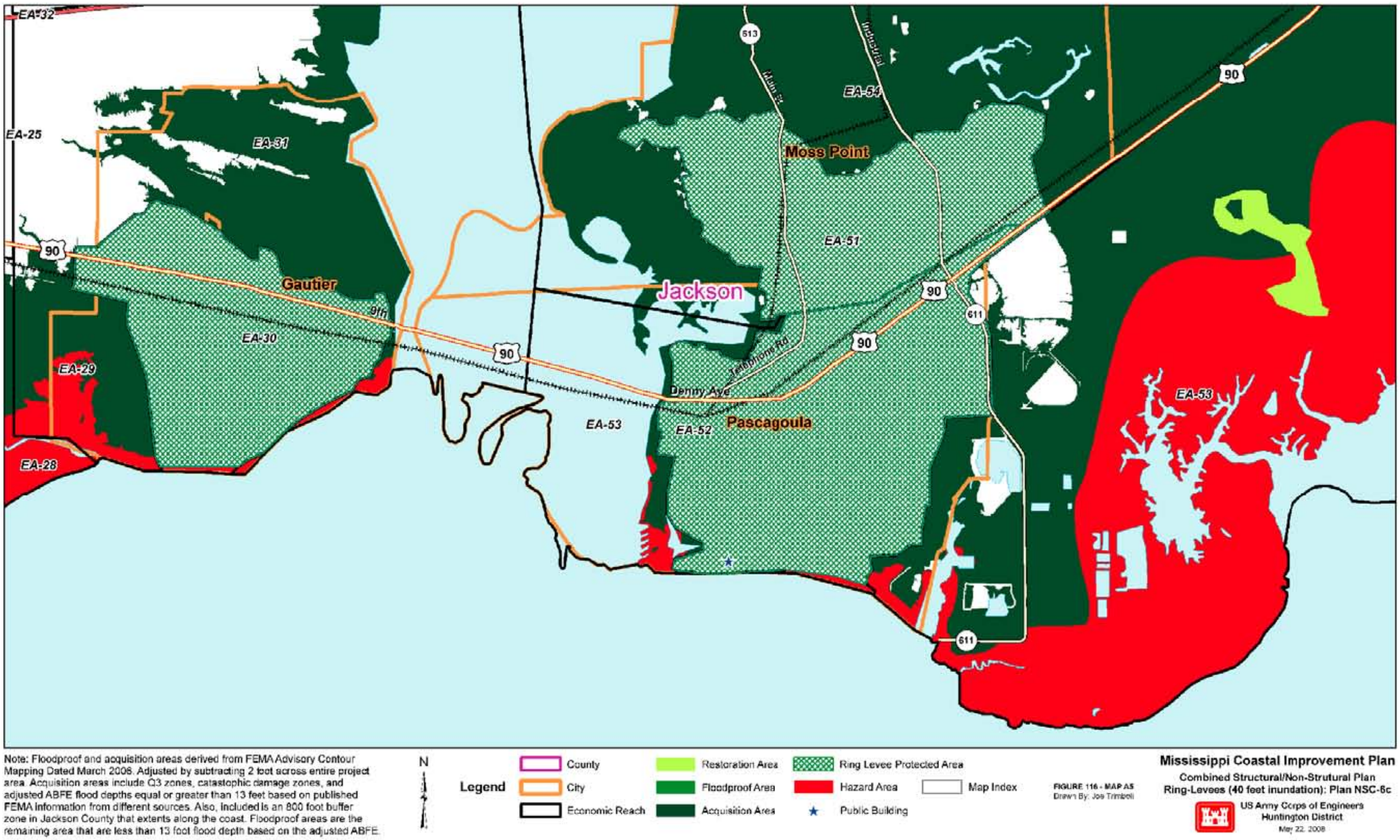


Figure 115 - Plan NSC-6d Combined Nonstructural and Structural Plan (A1)

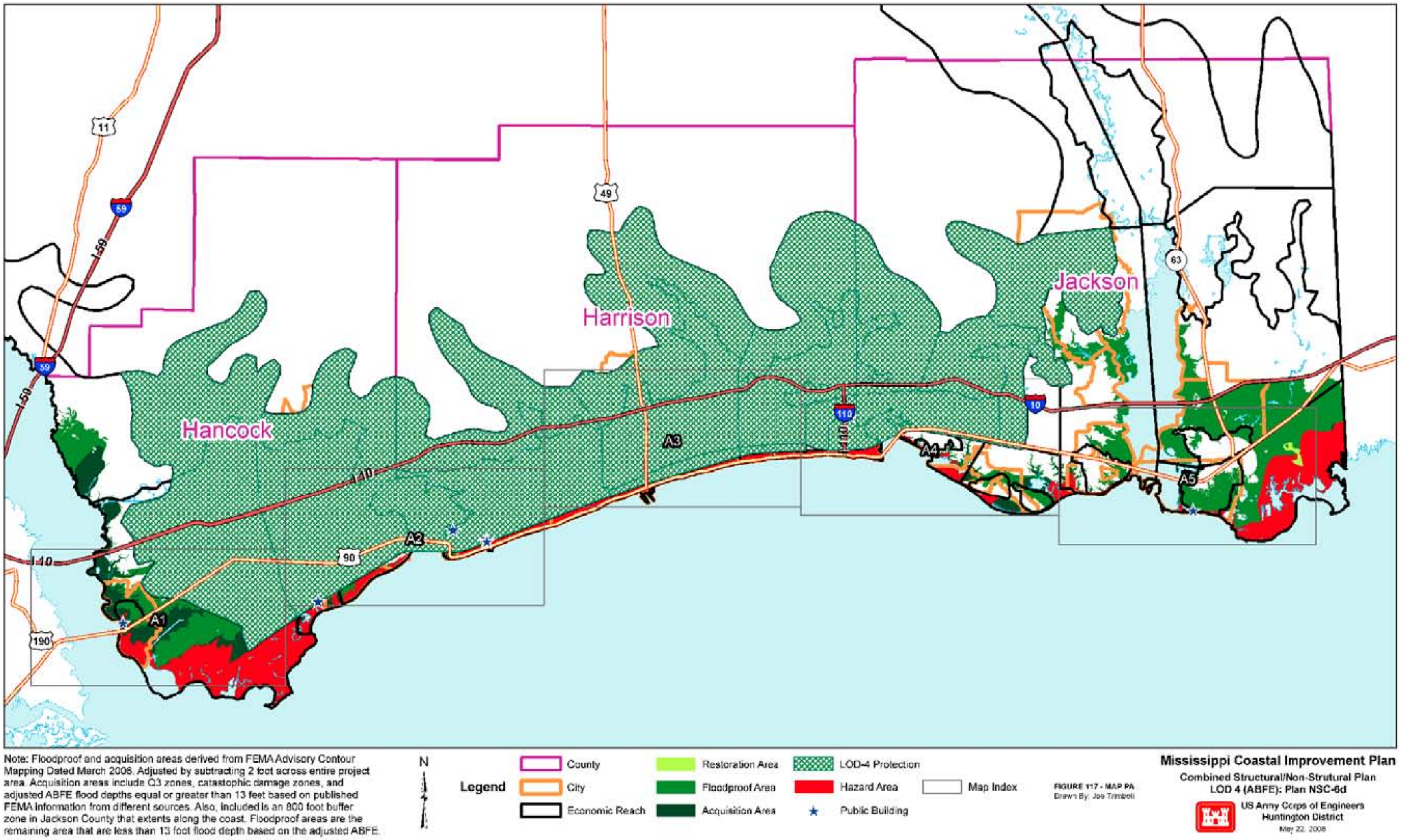


Figure 116 - Plan NSC-6d Combined Nonstructural and Structural Plan (A2)

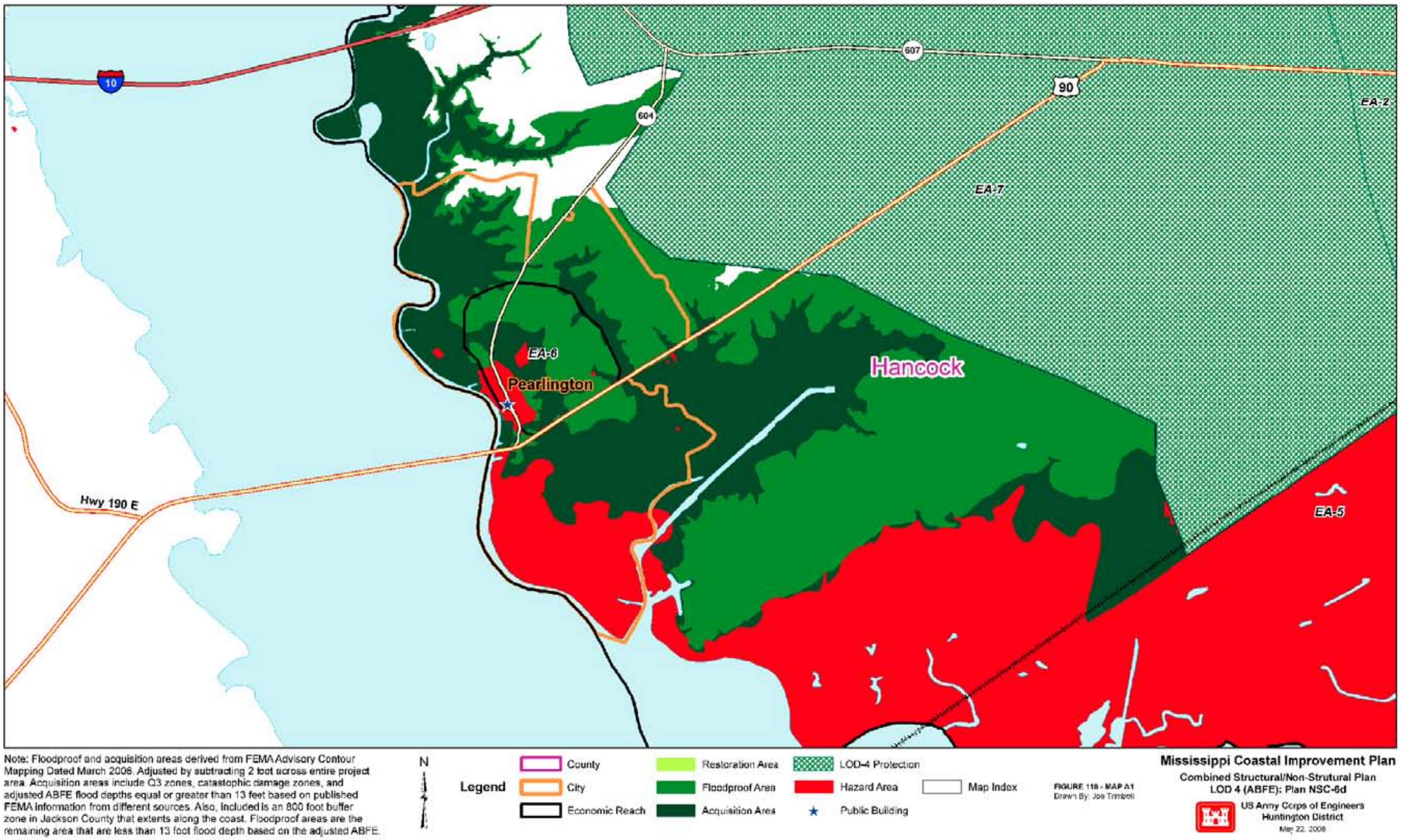


Figure 117 - Plan NSC-6d Combined Nonstructural and Structural Plan (A3)

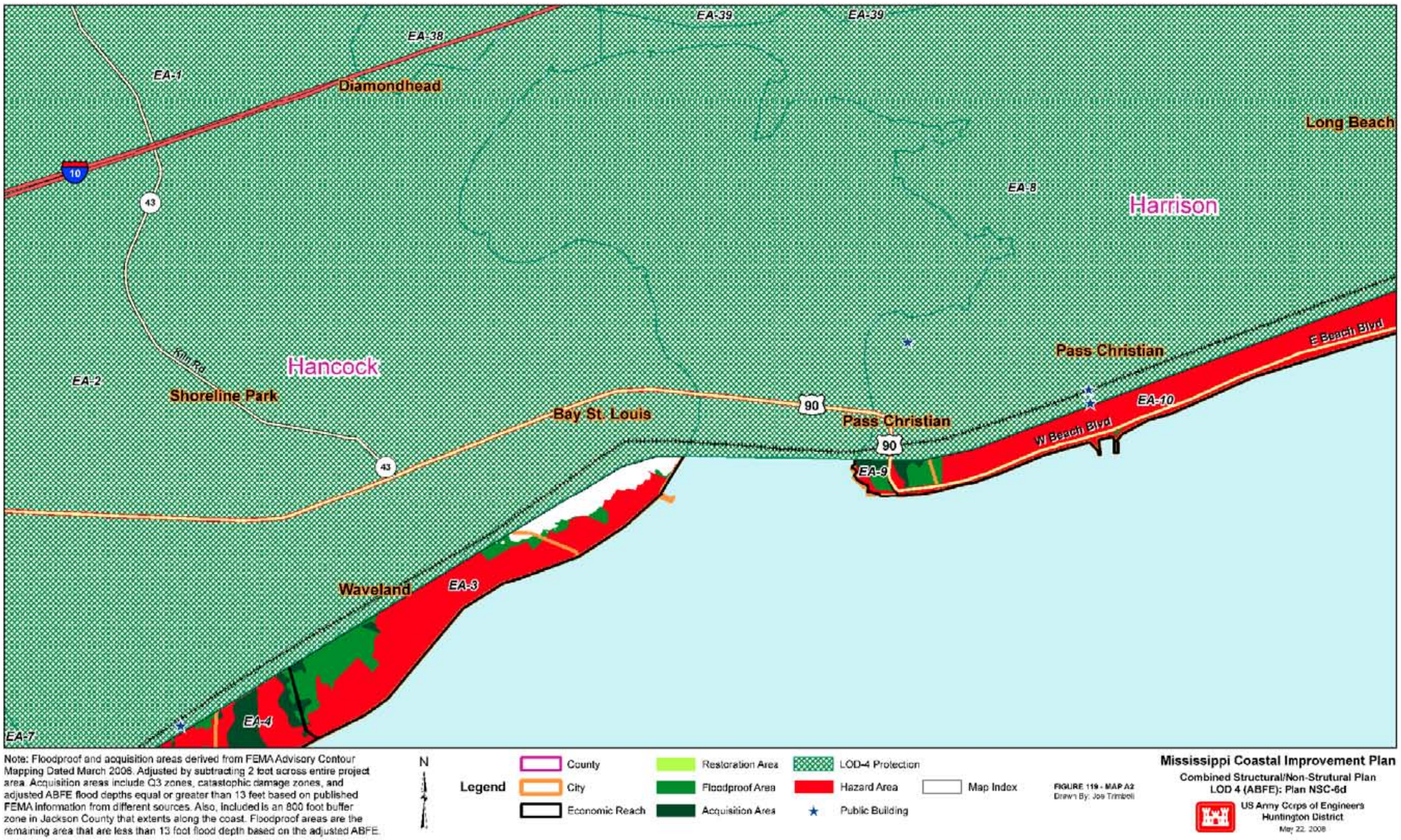


Figure 118 - Plan NSC-6d Combined Nonstructural and Structural Plan (A4)

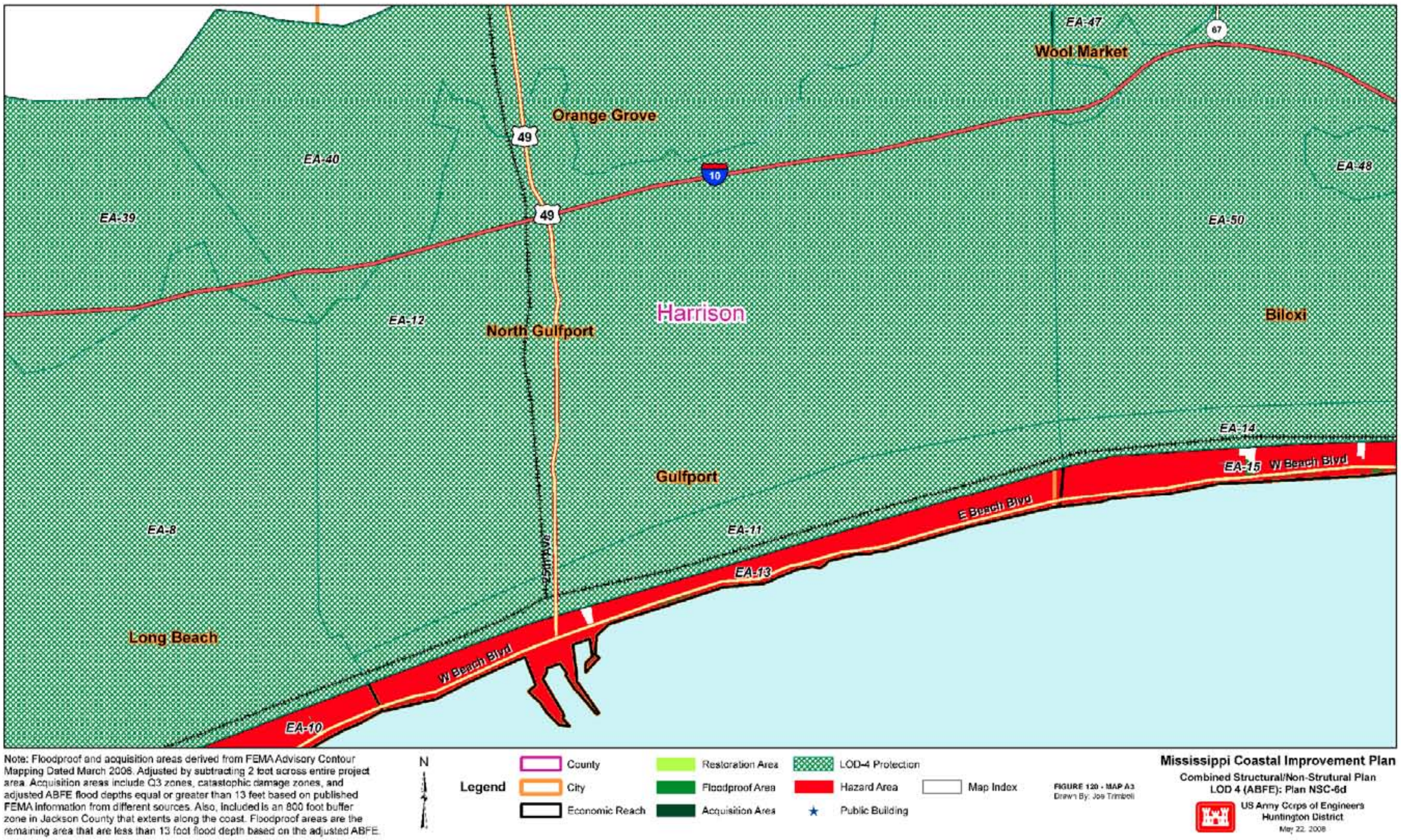


Figure 119 - Plan NSC-6d Combined Nonstructural and Structural Plan (A5)

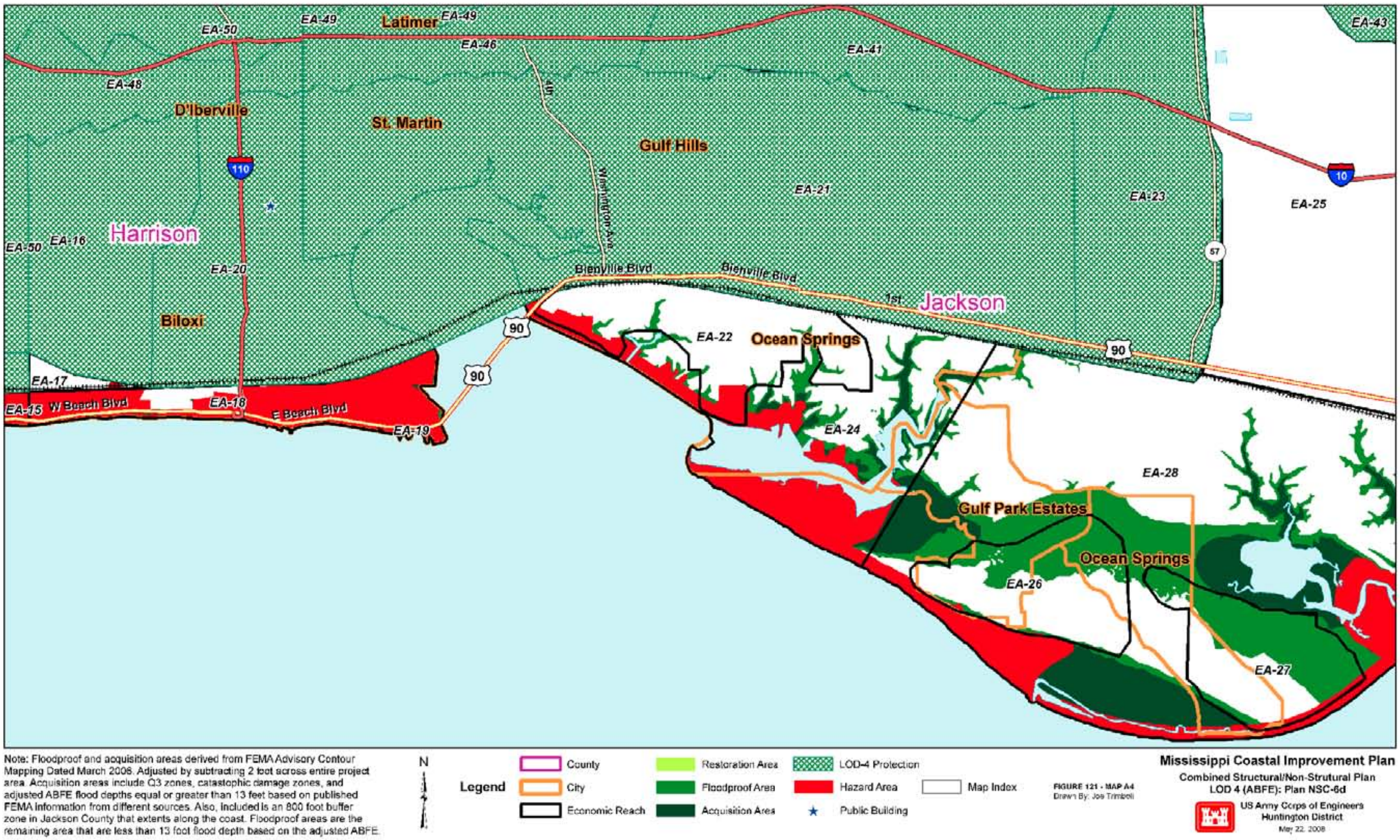


Figure 120- Plan NSC-6d Combined Nonstructural and Structural Plan (A6)

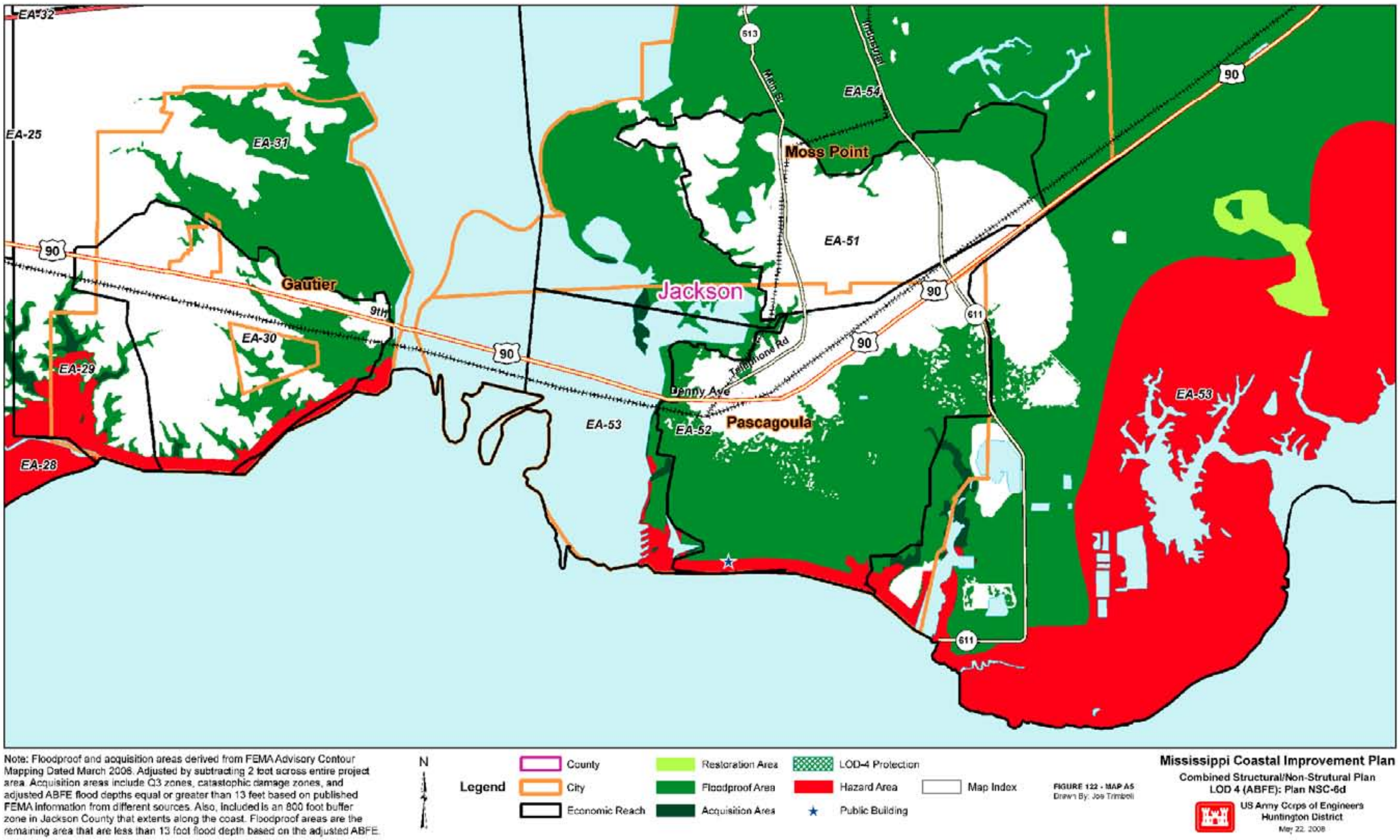


Figure 121- Plan NSC-6e Combined Nonstructural and Structural Plan (A1)

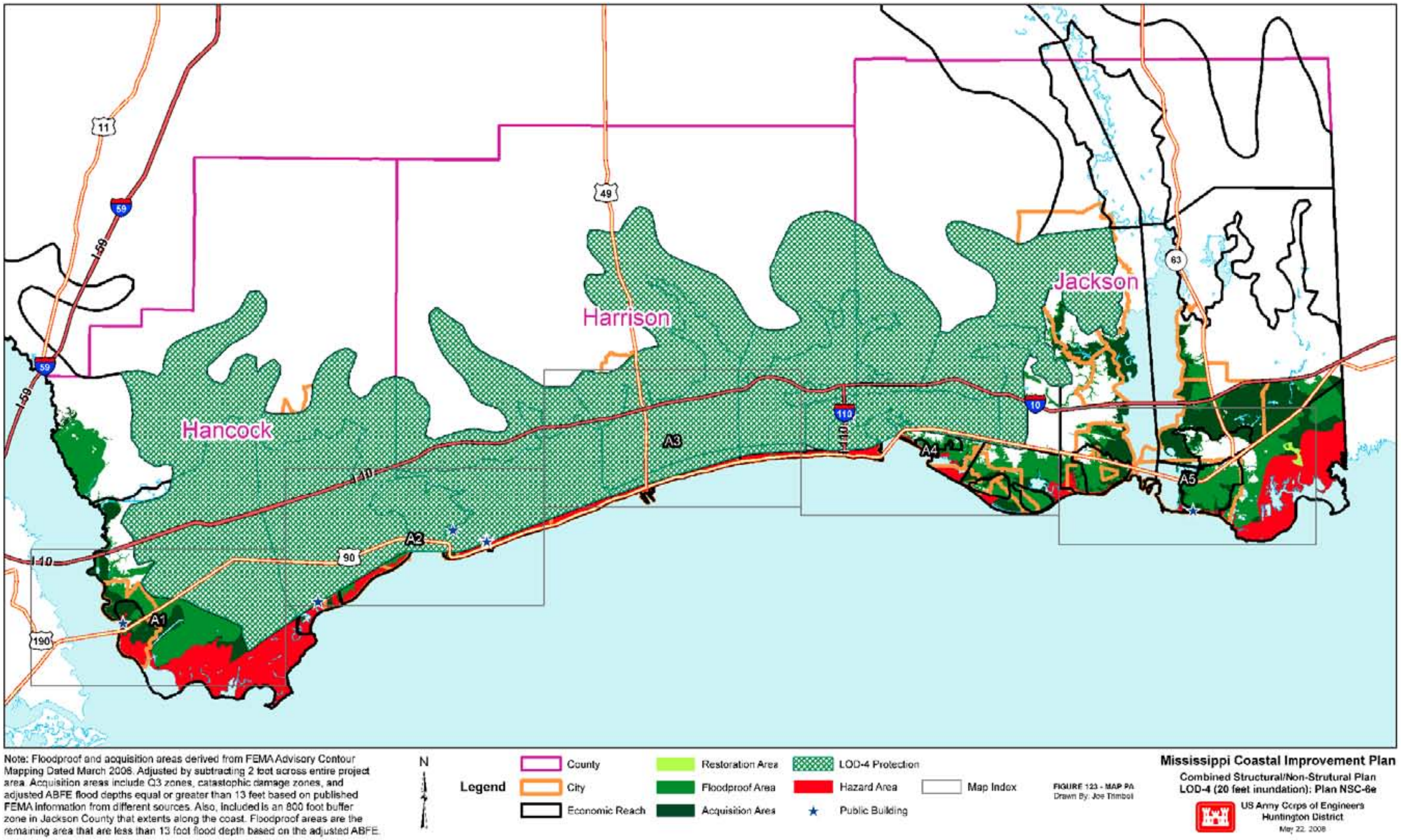


Figure 122- Plan NSC-6e Combined Nonstructural and Structural Plan (A2)

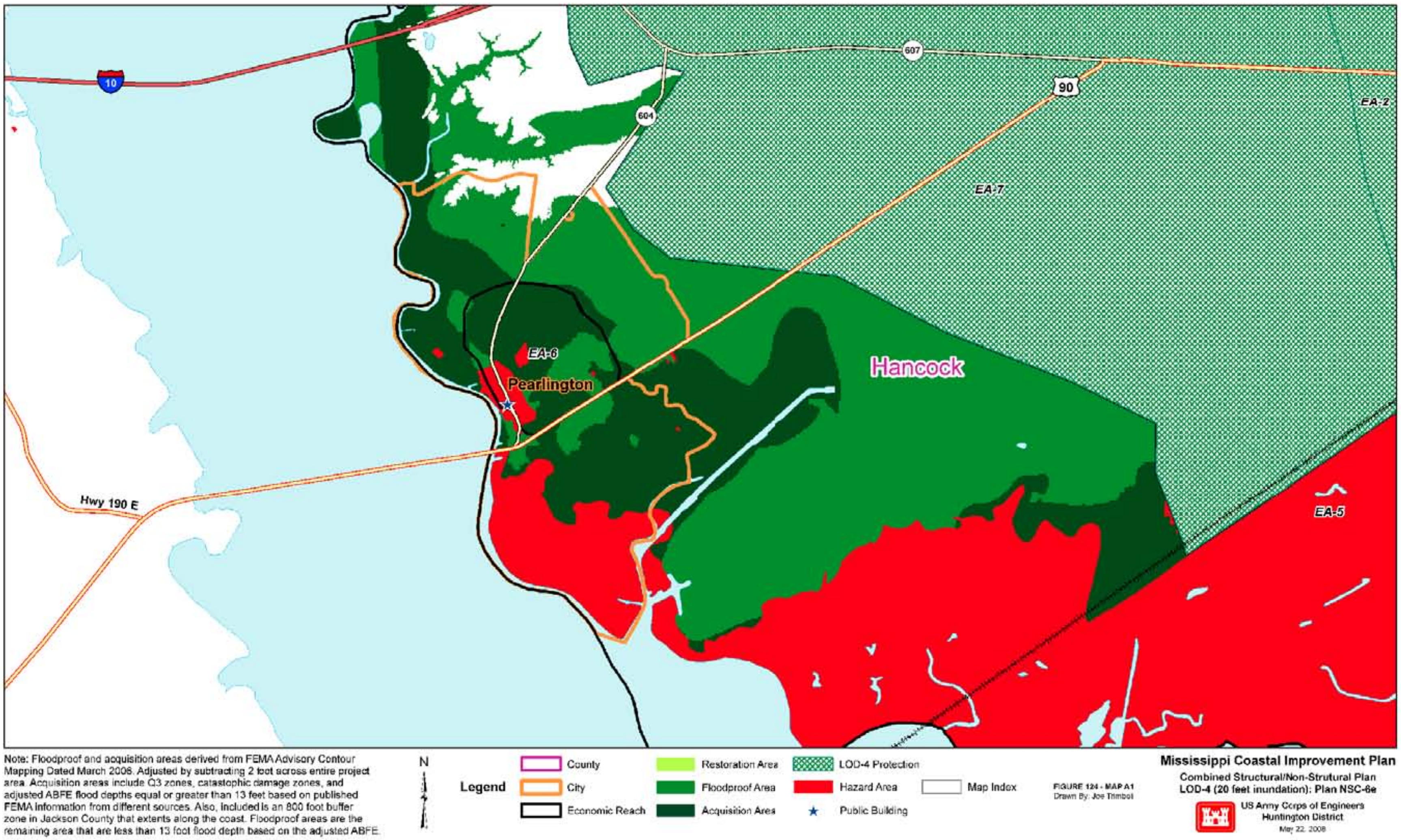


Figure 123 - Plan NSC-6e Combined Nonstructural and Structural Plan (A3)

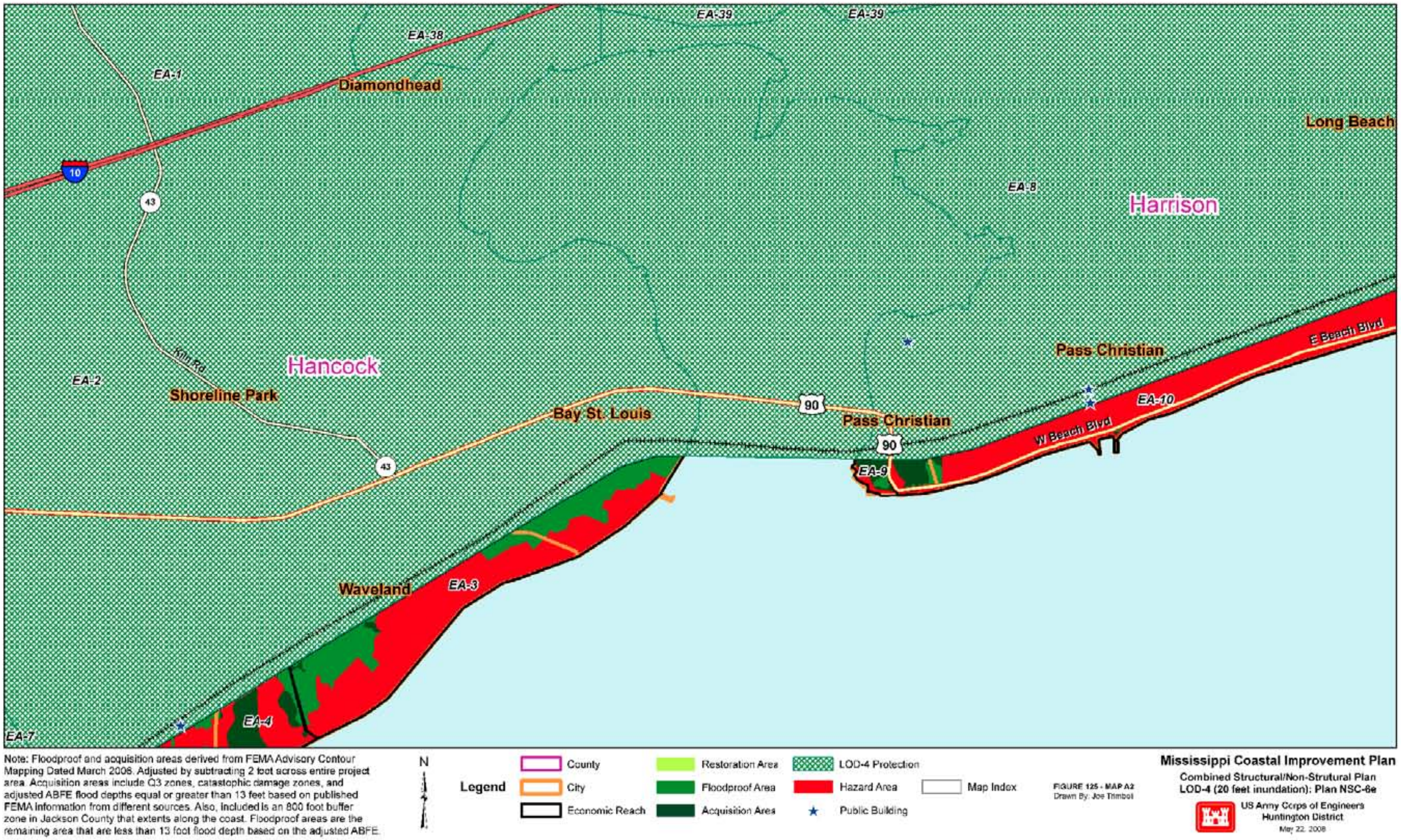


Figure 124 - Plan NSC-6e Combined Nonstructural and Structural Plan (A4)

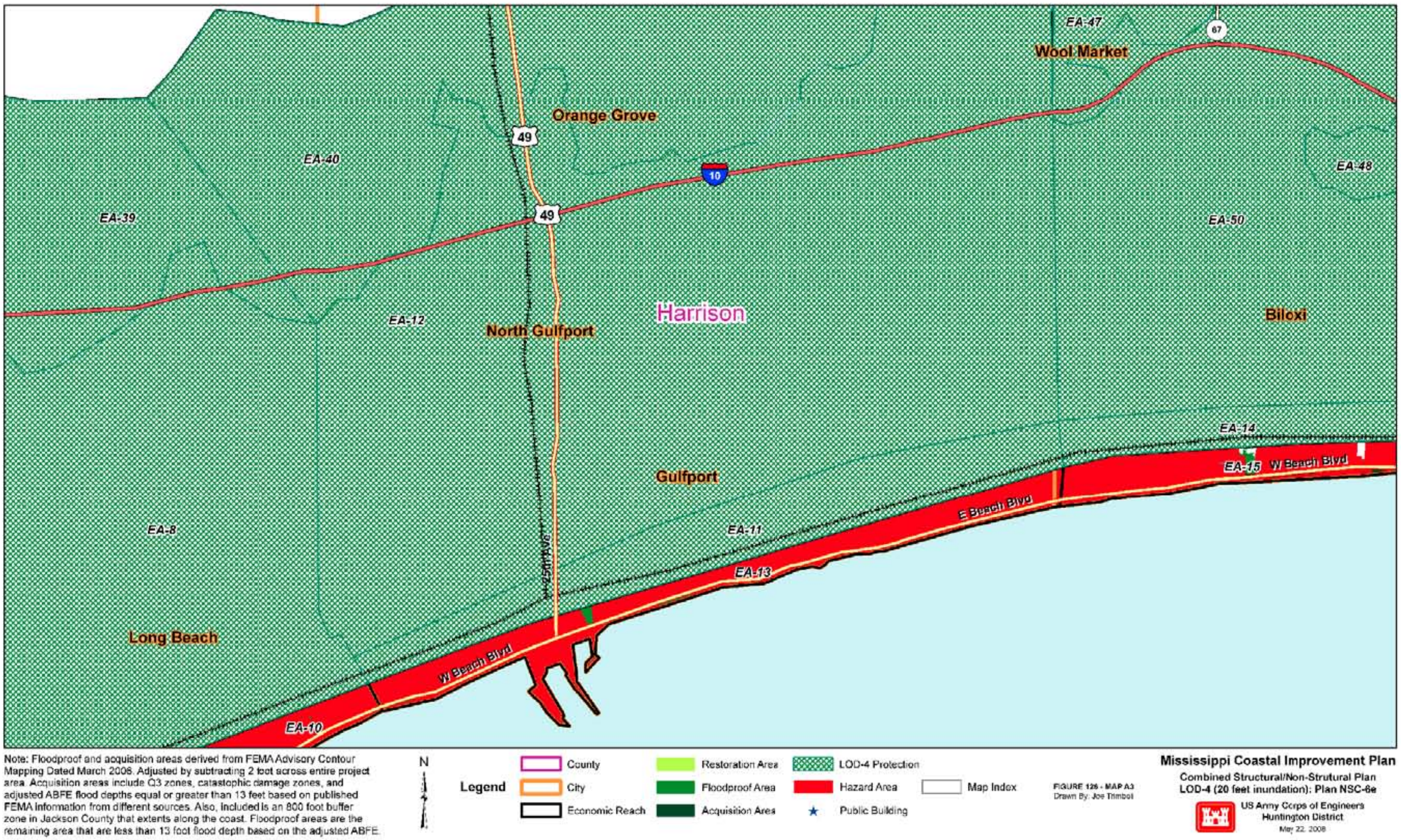


Figure 125 - Plan NSC-6e Combined Nonstructural and Structural Plan (A5)

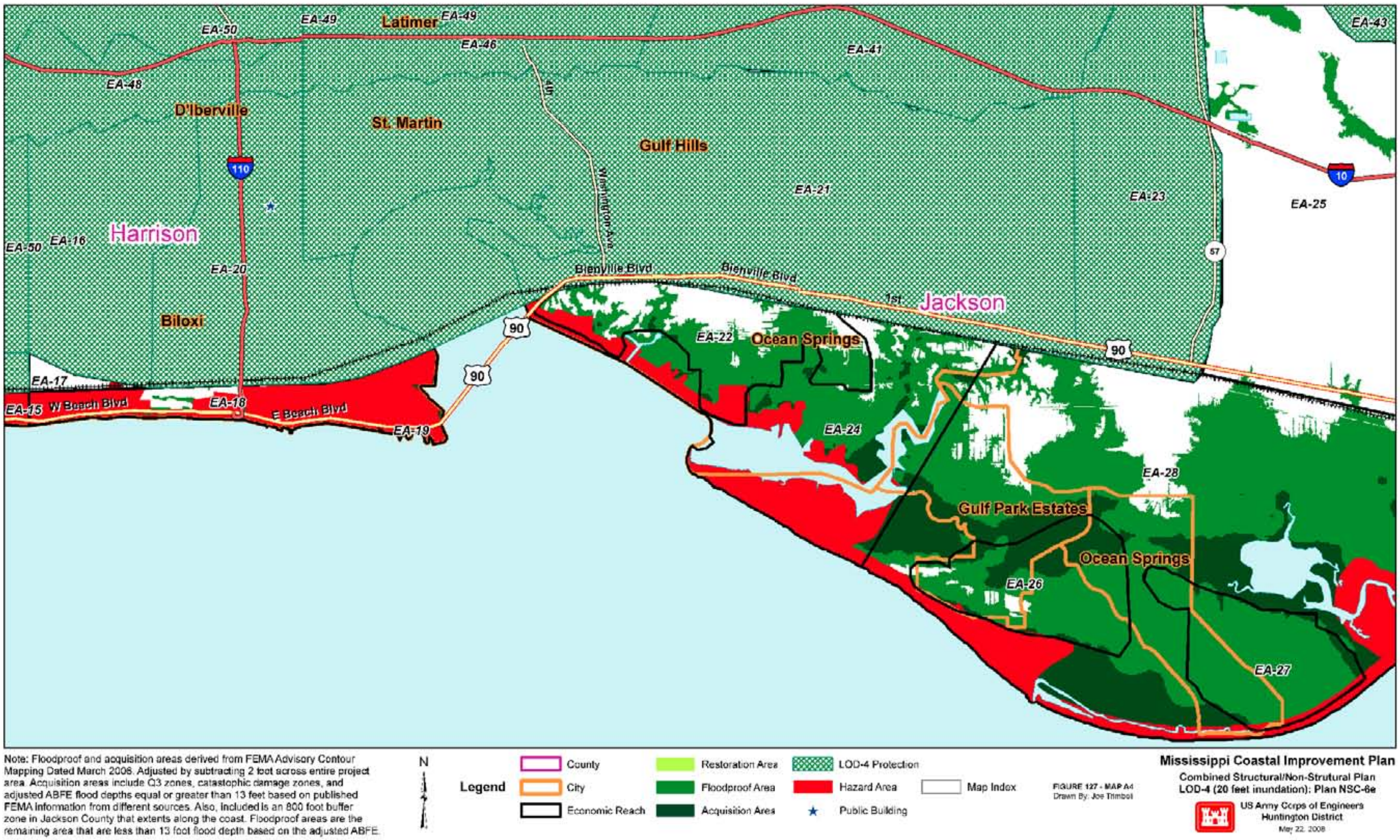


Figure 126 - Plan NSC-6e Combined Nonstructural and Structural Plan (A6)

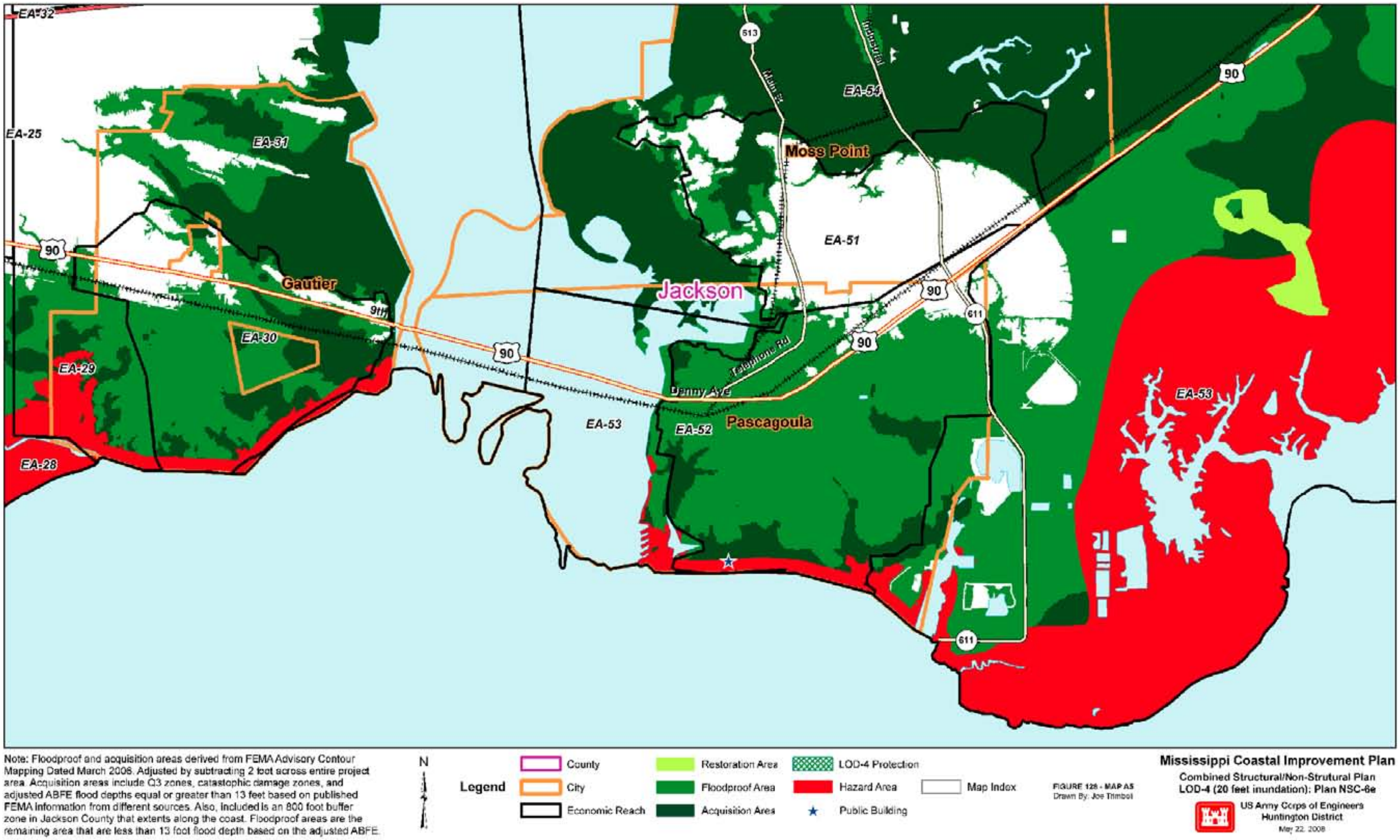


Figure 127 - Plan NSC-6f Combined Nonstructural and Structural Plan (A1)

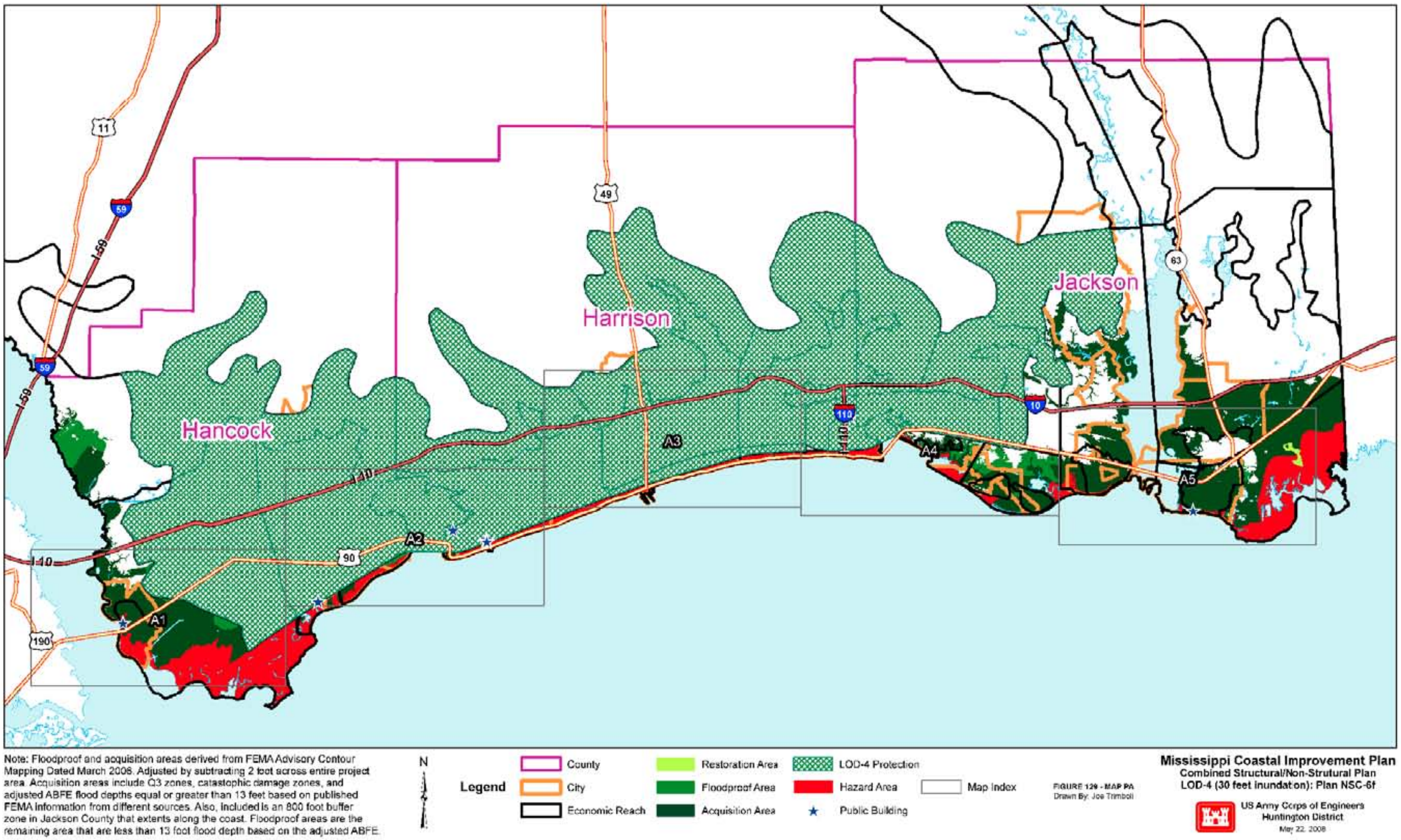


Figure 128 - Plan NSC-6f Combined Nonstructural and Structural Plan (A2)

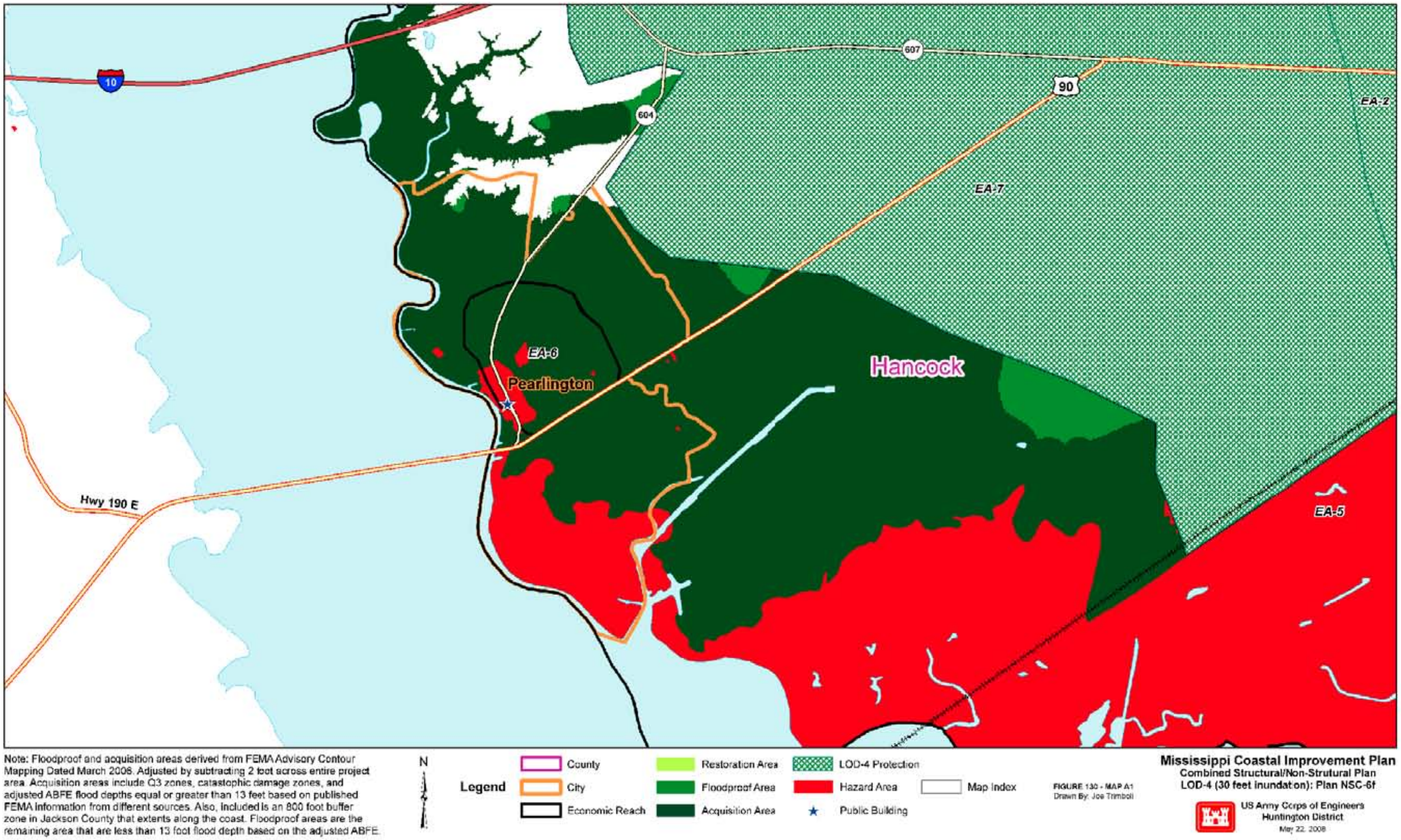


Figure 129 - Plan NSC-6f Combined Nonstructural and Structural Plan (A3)

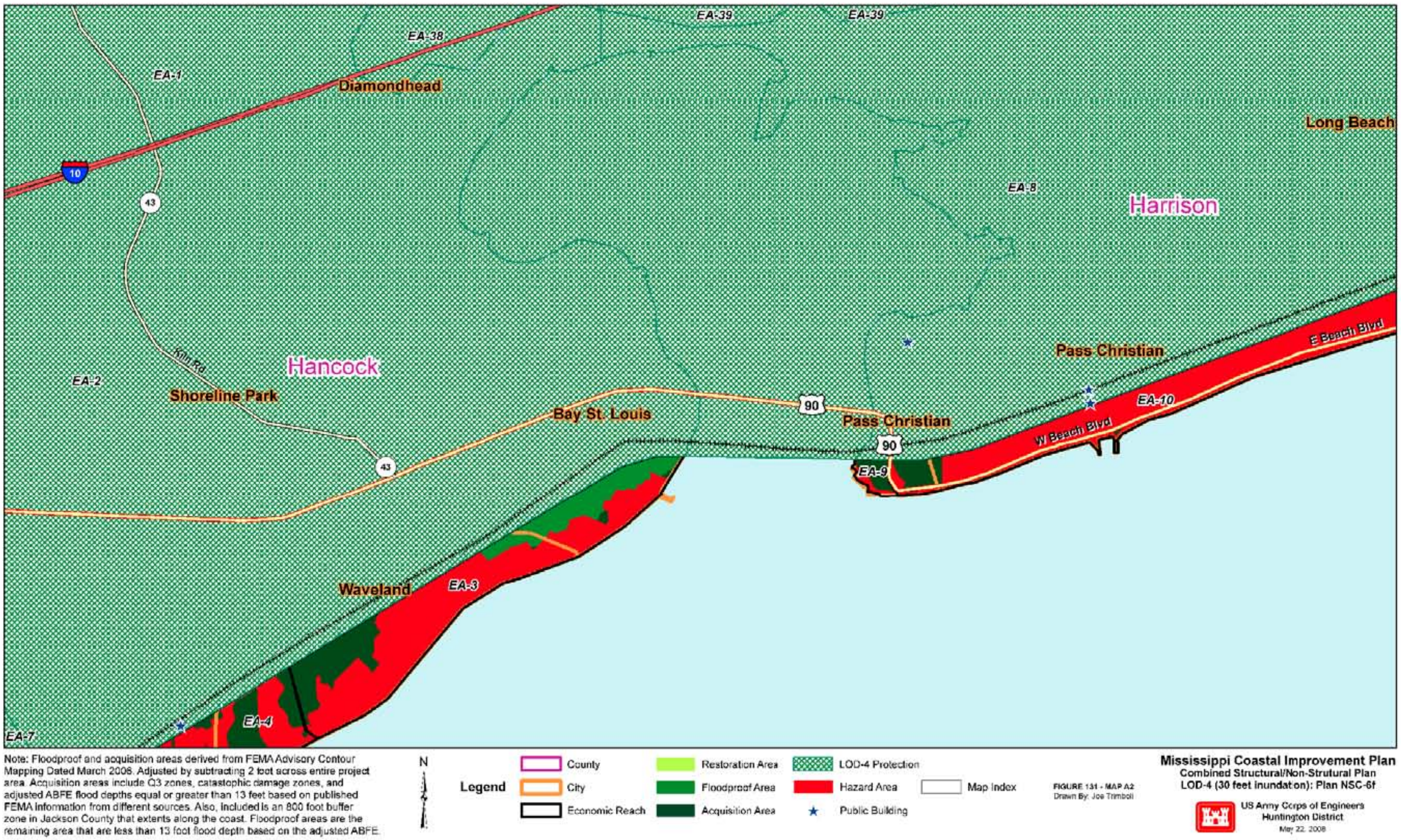


Figure 130 - Plan NSC-6f Combined Nonstructural and Structural Plan (A4)

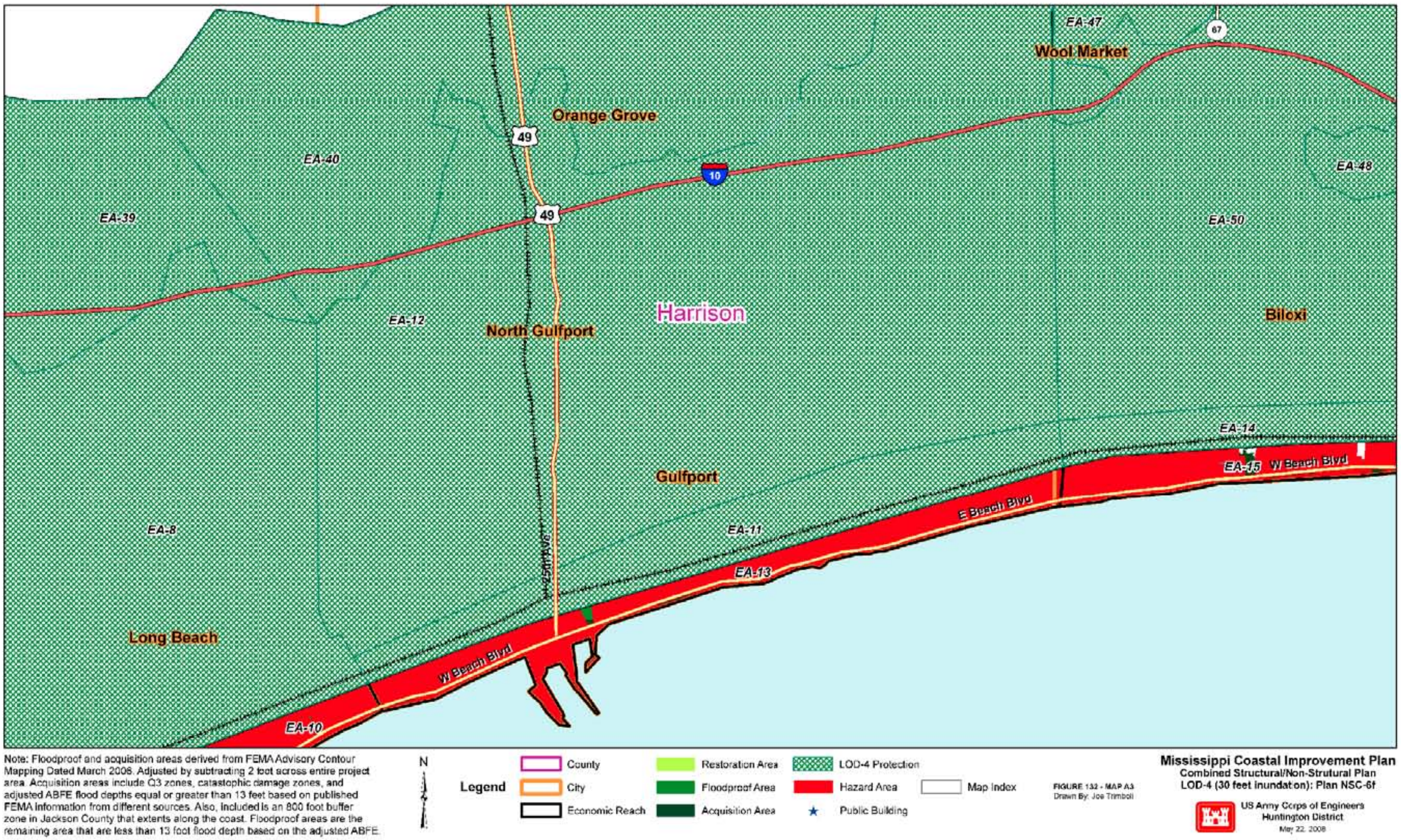


Figure 131 - Plan NSC-6f Combined Nonstructural and Structural Plan (A5)

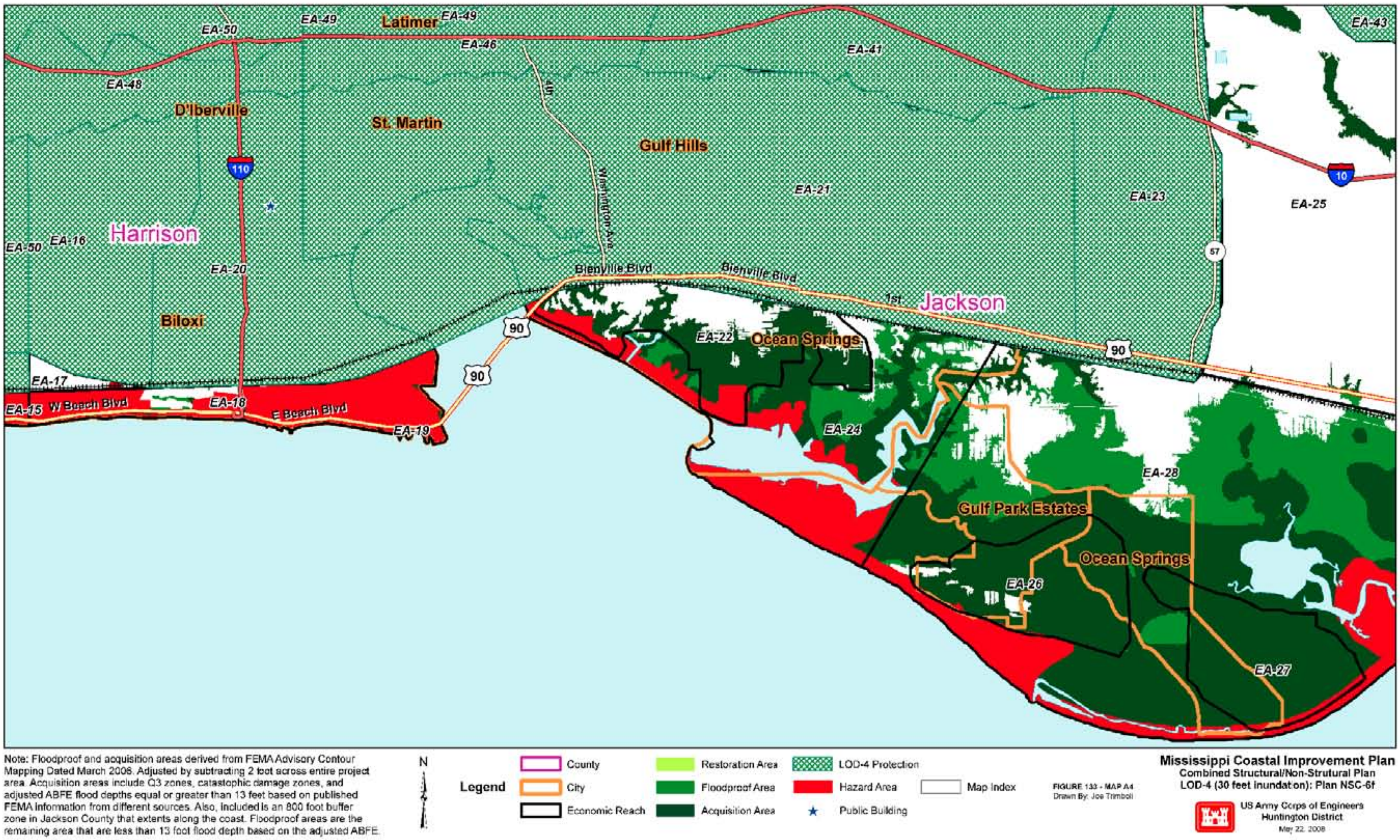


Figure 132- Plan NSC-6f Combined Nonstructural and Structural Plan (A6)

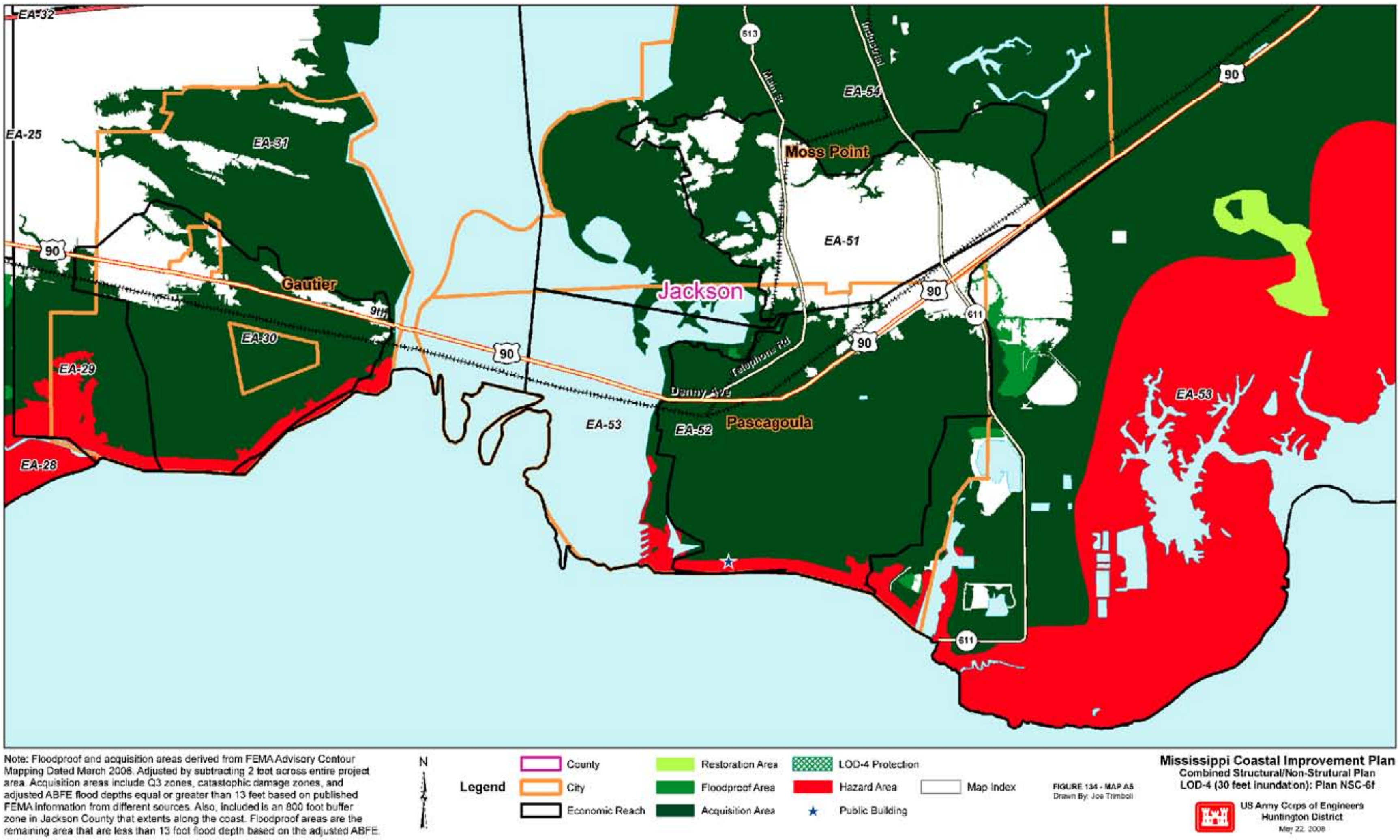


Figure 133 - Plan NSC-6g Combined Nonstructural and Structural Plan (A1)

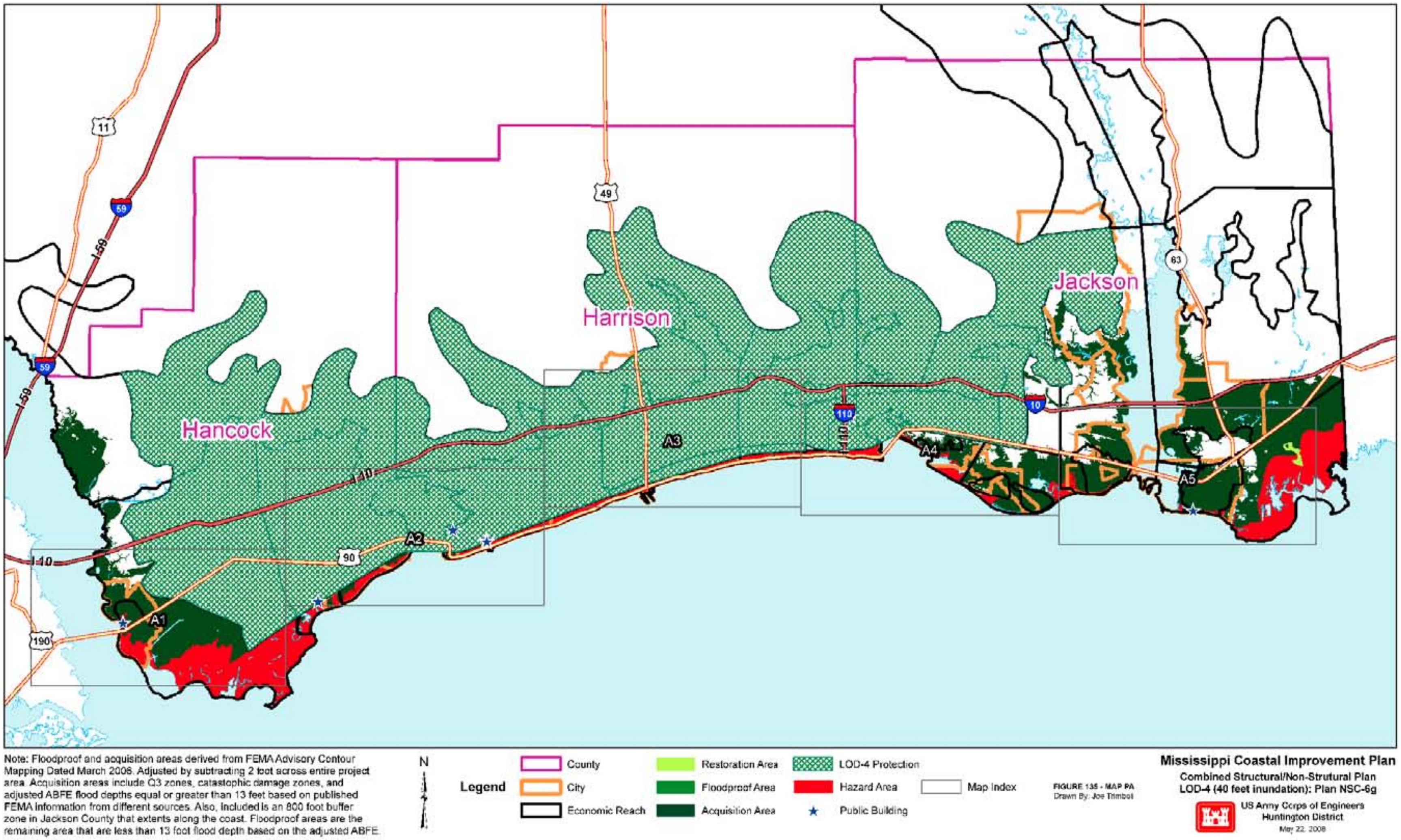


Figure 134 - Plan NSC-6g Combined Nonstructural and Structural Plan (A2)

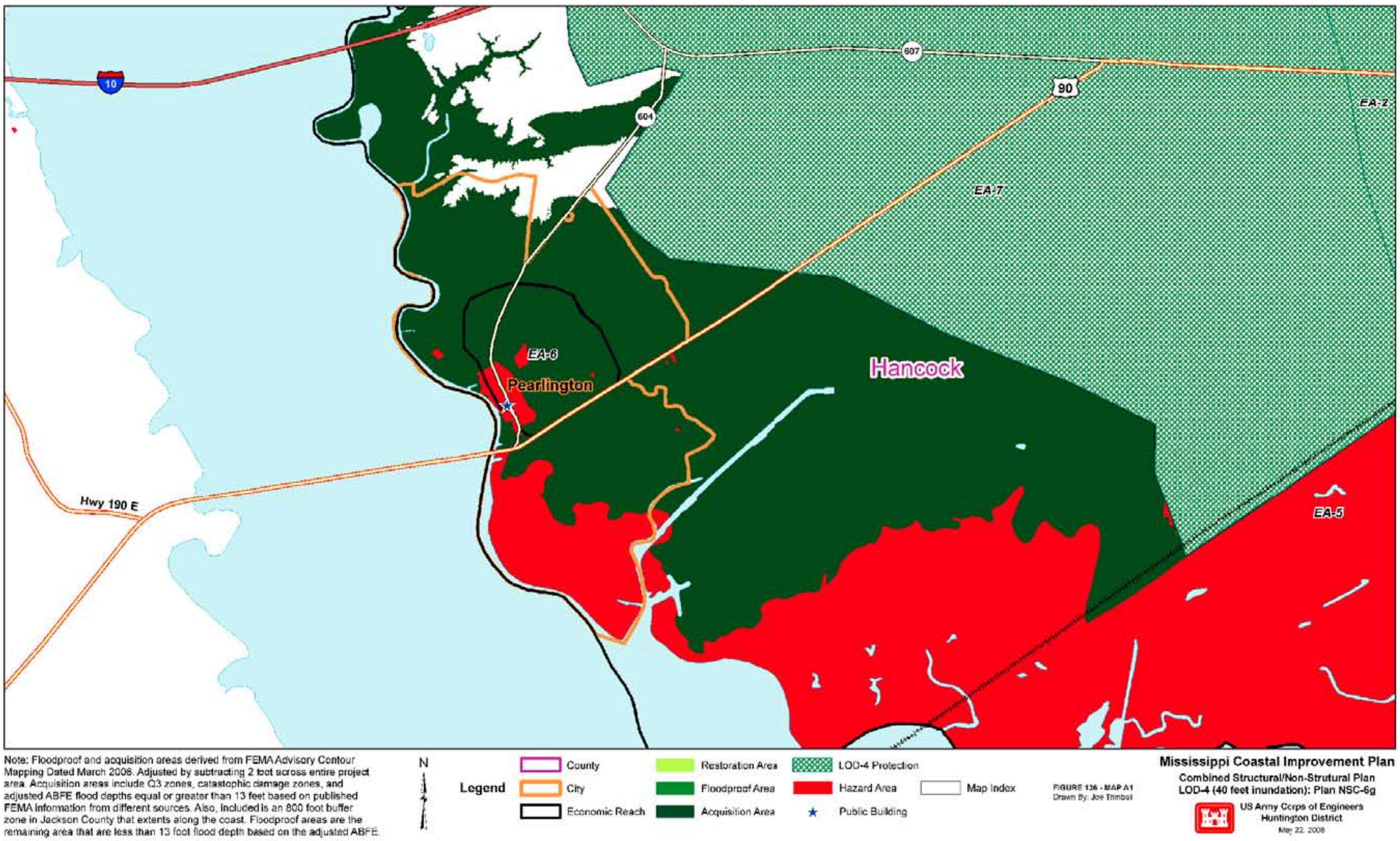


Figure 135 - Plan NSC-6g Combined Nonstructural and Structural Plan (A3)

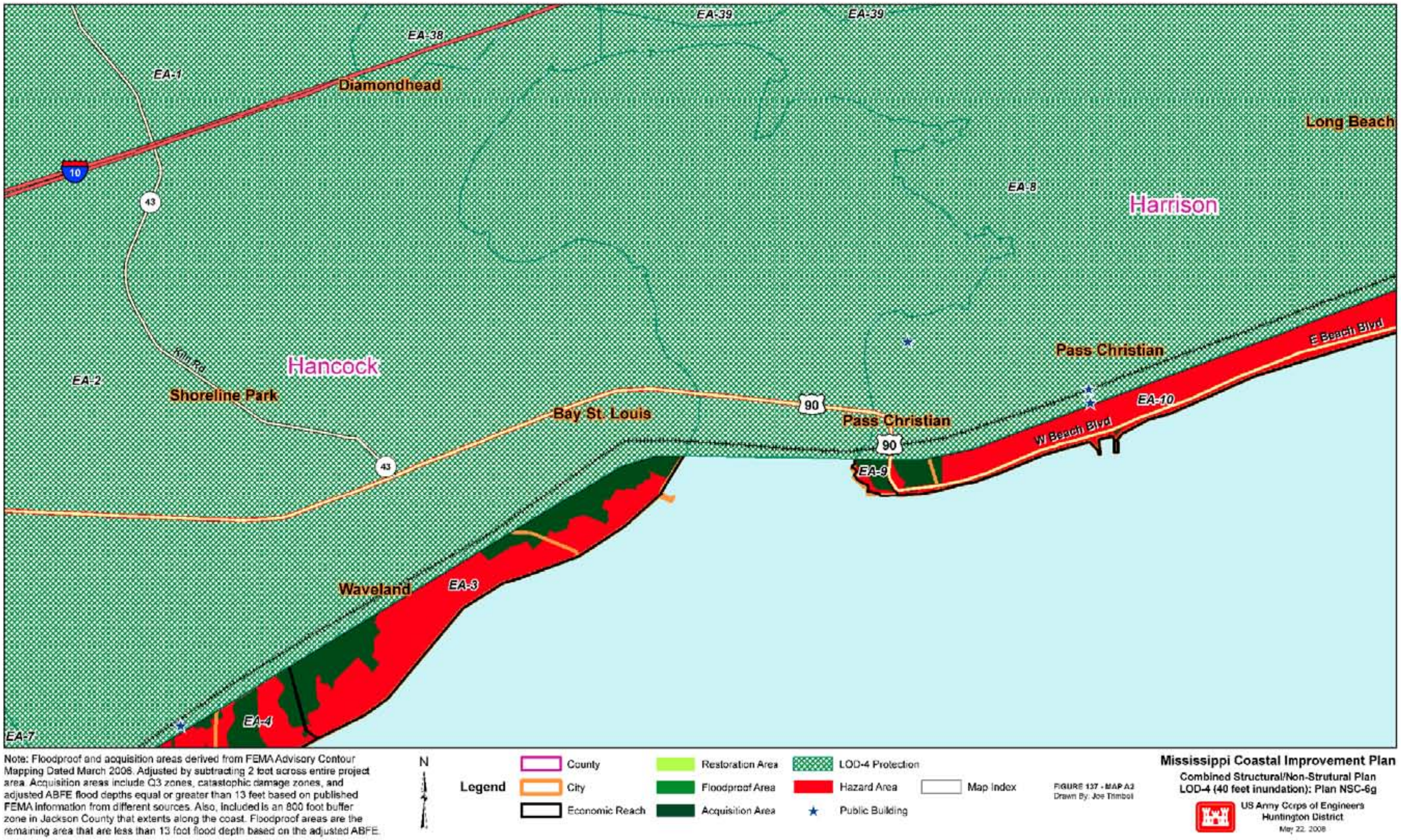


Figure 136 - Plan NSC-6g Combined Nonstructural and Structural Plan (A4)

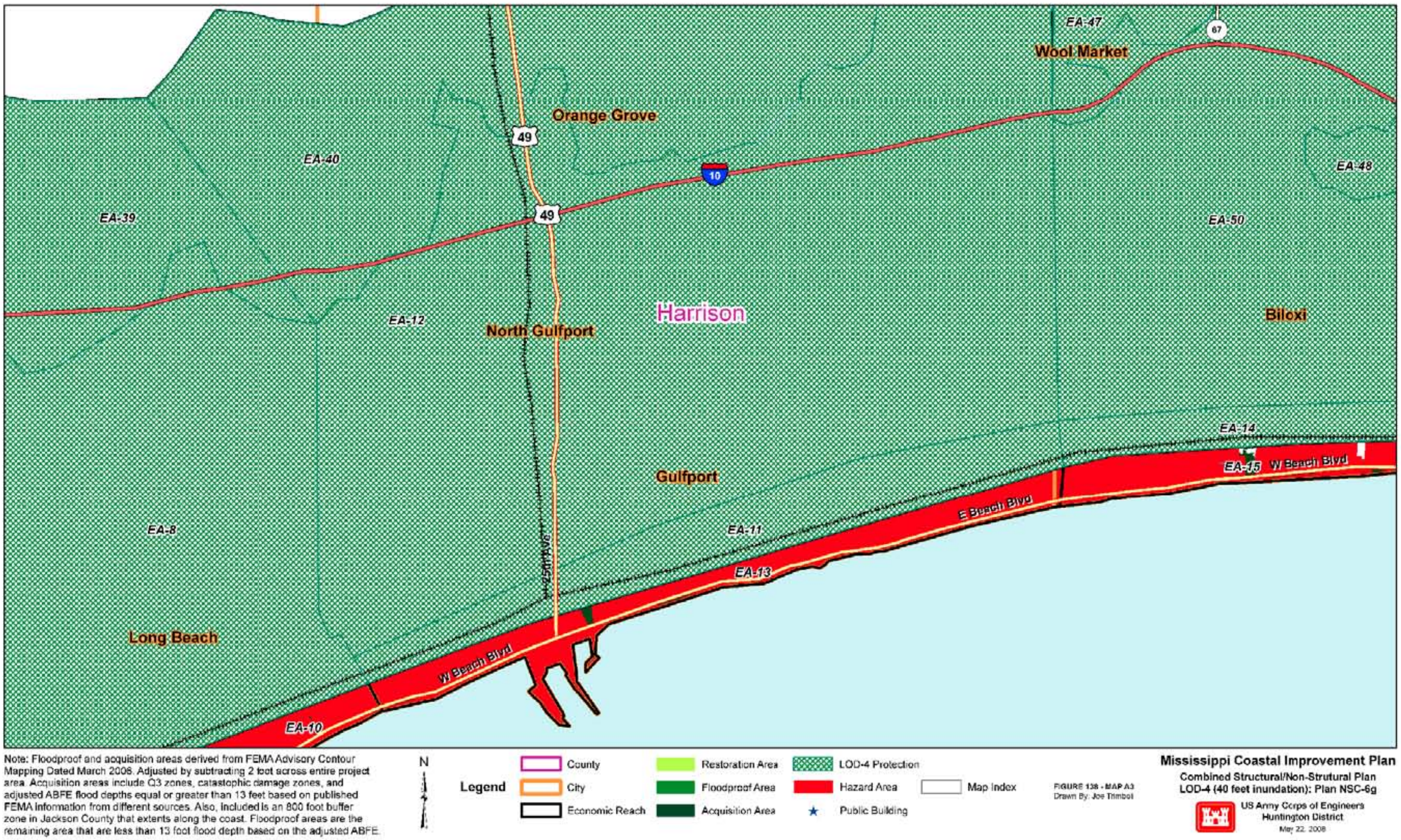


Figure 137 - Plan NSC-6g Combined Nonstructural and Structural Plan (A5)

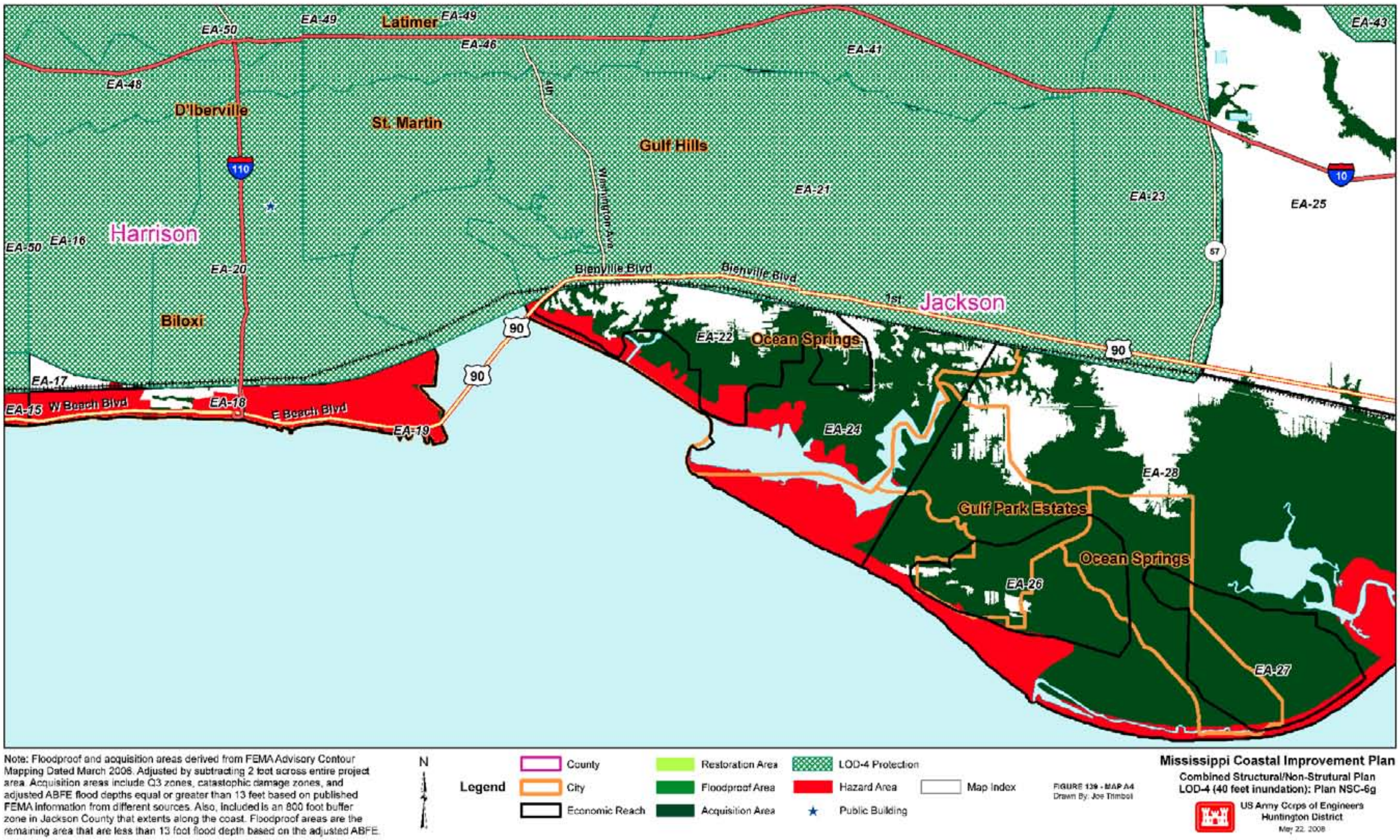
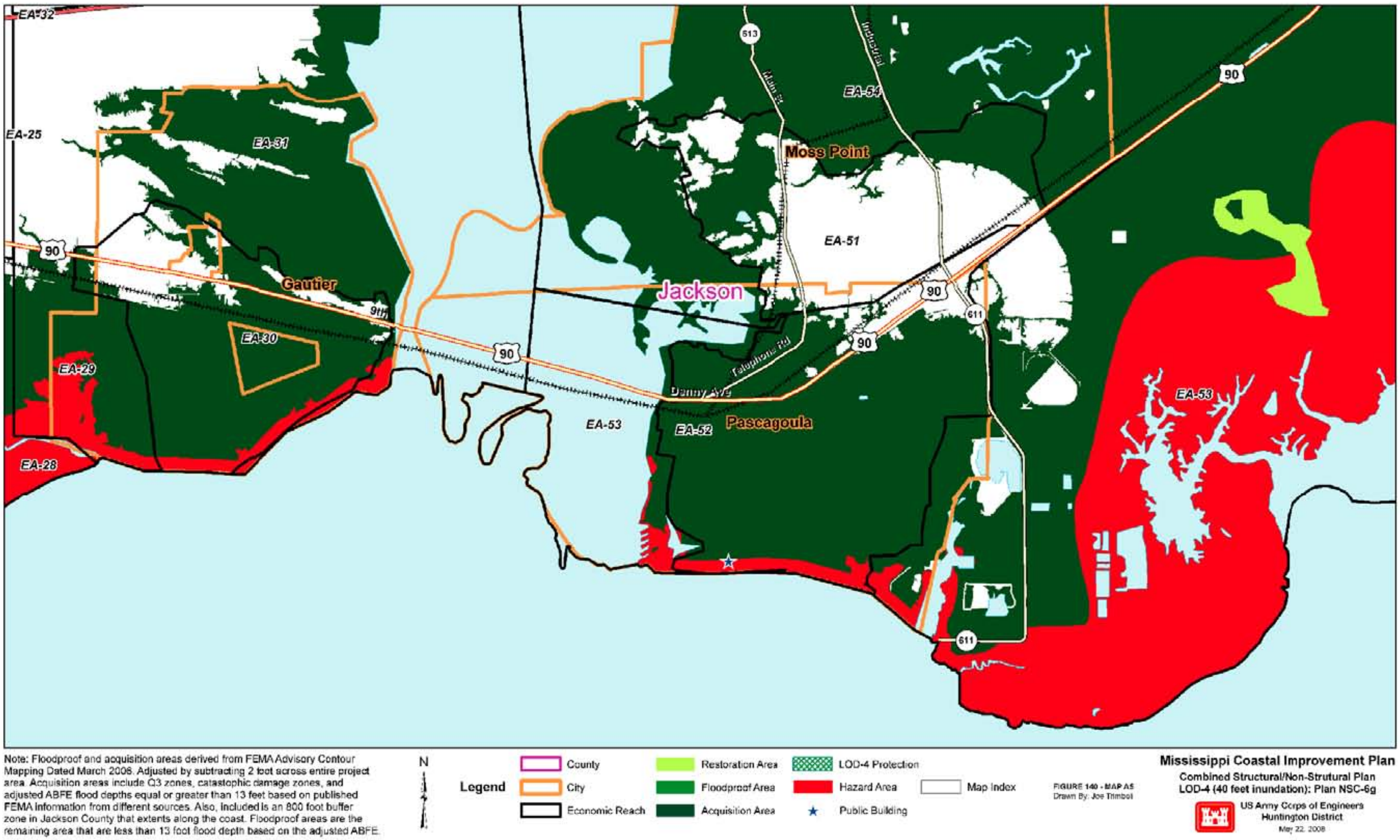


Figure 138 - Plan NSC-6g Combined Nonstructural and Structural Plan (A6)



CHAPTER 7. EVALUATION OF NONSTRUCTURAL PLANS

7.1 General

In Section 4.0 of this Appendix, several nonstructural measures were dropped from further consideration for one or more reasons related to either implementation cost; inability of the measure to meet one or more of the planning objectives, considered to be politically unpalatable, or would result in significant environmental, social or economic impacts to the coastal population. Environmental justice issues were cited several times in the determination to scrub a measure from further consideration. At that initial level of screening, an intuitive evaluation of the outputs of those dropped measures (based largely on experience of the NS PDT, lessons learned from past nonstructural project implementation and research) was sufficient to justify their closure in the process. The remaining measures, although with potential impacts, promise significant benefits or positive outputs if implemented. Having integrated those measures into several plans, identification, quantification and evaluation of their outputs must now be accomplished.

The evaluation process is composed of two steps: 1) assessment or the quantification of the plan affects (may be expressed in relative qualitative as well as quantitative terms) in monetary or numerical terms, and 2) appraisal or the judgment of the worth or significance of the output or improvement. Using these two components of evaluation, each output from each plan can be weighed in relative terms with all other outputs allowing trade-off analysis, sensitivity analysis, and best-deal determinations. At the level of planning detail conducted for the MS Coastal Comprehensive Plan many of the standard metrics used in evaluating plans at a feasibility level are unavailable due to the lack of base data for many of the proposed measures. Collecting and analyzing data for over 70,000 separate parcels of property (some with multiple tracts) requires far more effort in formulating nonstructural measures and plans than time or financial resources allowed in the study. Therefore much more qualitative evaluation is used in the appendix than would normally be used in a standard feasibility study.

In addition, since time and funding constraints did not allow a full economic analysis of each of the several nonstructural plans, only the average annual damages reduced for acquisitions and floodproofing in Plan NSC-1 at the ABFE level were generated in HEC-FDA. This Appendix only identifies, evaluates and compares various nonstructural plans and should not be used as the only document for recommending implementation of any of the plans described herein. Therefore, allowances with the average annual damages figures were taken for comparison of the plans at the ABFE level of inundation. For plans that had either more or less amounts of acquisitions or floodproofing at the ABFE level, the average annual damages were proportionately applied to the various plans (by parcel protected) to compare their outputs.

Subsequent to completion of this evaluation process, the structural alternative labeled “LOD 4” was screened from the list of alternatives due to unsustainable annual O&M costs for the surge gates. Therefore all evaluations involving the structural measure LOD 4 and nonstructural measures shown in plans NSC-6d through NSC-6g are provided for reference only. The combined alternatives that include ringwalls and ring-levees and nonstructural measures (NSC-6 through NSC-6c) are still valid plans for consideration.

The assessment process begins with quantifying and describing the outputs from each formulated plan that would be anticipated to occur in the future with one of the plans (projects) in place. This “future-with project condition” is described below.

7.2 Future With-Project Conditions

7.2.1. General:

The evaluation of nonstructural plans begins with a description of the anticipated future with-project conditions that would emerge if one of the nonstructural plans were to be implemented. The reviewer must remember that the performance of each nonstructural plan is predicated only upon protection to the minimum inundation level of the Advisory Base Flood Elevation. Each of the formulated plans will produce a different future for the project area than would have occurred in the absence of any one of the plans (the future without-project conditions).

The descriptions of these conditions are based upon the stated objectives of the planning process and the metrics determined by the team. Metrics such as reduced flood damages, reduced threats to loss of life, increased wetland acres, reduced emergency costs, and residual damages are all used to define the anticipated future with-project condition. Other benefits of the plans that were not anticipated are likewise noted for each plan. The descriptions of these conditions in whatever metrics may be applicable (monetary flood damage reduction benefits, acres of ecosystem, lives at less risk, improvements to current housing stock, or reductions in emergency costs) are compared with the conditions of the without-project future for the same area to determine whether a plan is worthy of implementation when compared to other alternative plans.

To simplify this process, the various plans are displayed in Table 34 showing the anticipated future with-project conditions in the project area that may occur as a result of their implementation. As the matrix shows, many of the plans generate measurable (quantifiable) outputs such as the reduction of damages, plan and per unit costs for protection and numbers of parcels offered protection to some degree. Several of the plans demonstrate an ability to reduce the potential threats to life and safety due to inundation drowning and still others generate substantial numbers of relocations to flood-safe living units. In many cases, the outputs of each plan are measurable in monetary units, acres protected, structures protected or acres of potential ecosystem restoration land evacuated. In other cases, the plan outputs are either difficult to measure quantitatively or time/funding constraints limited the team's ability to collect the necessary data to support the measurement of the plan outputs and therefore the output is described in qualitative terms.

7.2.2 Plan Outputs:

7.2.2.1 Plan NS-PAHHZ:

This plan provides substantial protection for beachfront structures and their occupants that are at highest risk of severe structural and content damages and loss of life. Field investigations revealed that a substantial number of parcels were made vacant (total structure loss) by Katrina in this zone. Post-Katrina estimates were that at least 30,000 residential structures were destroyed by Katrina and considering the high incidence of structure and content flood related damages in this zone (nearly 90% total loss), reducing damages to residential structures is considered a significant affect.

Composed of one measure, permanent acquisition, this plan affects 14,997 parcels (approximately 7,500 structures) within the three counties. Using a proportionate share of the average annual damages calculated for the ABFE (Plan NSC-1), this plan reduces the without-project average annual damages by approximately $92.0M.

Table 34.
Future With-Project Conditions

PLANS / Parameters/Measures	Plan NS-PAHHZ	Plan NS-PA100	Plan NSC-1 – Federal Agencies Action Plan	Plan NSC-2 – Wet and Dry Floodproofing W/FWEE Upgrades	Plan NSC-3 – Joint Federal and Non-Federal Jurisdiction Plan	Plan NSC-4 – Non-Federal Jurisdiction Plan	Plan NSC-5 – Loss of Life Reduction Plan	Plan NSC-6 – Combined Structural and Nonstructural Plan
Flood Damages Reduced Units Protected	14,997 Total Parcels Removed from Future Development $92.0M AAD Prevented	33,191 Total Parcels Removed from Future Development. $210.0M AAD Prevented	58,617 Total Parcels Protected $315.0M AAD Prevented	25,419 Total Units Protected $105.0M AAD Prevented	At least 58,617 Total Parcels Protected , At least $315.0M AAD Prevented	95,000 Total Units Protected 1) AAD reduced are undetermined at this time	14,997 parcels removed from Future Development $92.0M AAD Prevented	Reductions in AAD have not been computed for the scaled plans greater than the ABFE. ABFE reductions are in Plan NSC-1
Total Plan Cost Cost per Unit Protected	$6.1B $404K/parcel	$8.2B $248K/parcel	$18.7B $323K/parcel	$10.8B $425K/parcel	$19.1B $325K/parcel	$5.5M Cost per unit is undetermined at this time.	$6.1B $404K/parcel	Plan costs range from $8.7B to $25.3B with cost per unit of $288K/parcel to $296K/parcel
Permanent Acquisition (including HARP)	14,997 Parcels Removed from Future Development $92.0M AAD Prevented	33,191 Parcels Protected $210.0M AAD Prevented	33,191 Parcels Protected $210.0M AAD Prevented	Although this plan is purely floodproofing, there could be some acquisitions as an option, but the numbers are unknown at this level of planning.	33,191 Parcels Protected $210.0M AAD Prevented	No permanent acquisitions. A TDR or PDR program could purchase development rights at 80% of the total property value for over 27,000 vacant lots	14,997 parcels removed from future redevelopment $92.0M AAD Prevented	Units Protected range from 44,088 to 85,447 Damages prevented are not available.
Total Permanent Acquisition Cost Cost per Unit Protected	$6.1B $404K/parcel	$8.2B $248K/parcel	$7.9B $323K/parcel	Although this plan is purely floodproofing, there could be some acquisitions as an option, but the numbers are unknown at this level of planning.	$7.9B $323K/parcel	No permanent acquisitions. A TDR or PDR program could purchase development rights at 80% of the total property value for over 27,000 vacant lots	$6.1B $404/parcel	Acquisitions costs range from $4.5B to $23.9B with per parcels costs ranging from $225K/parcel to $281K/parcel
Wet and Dry Floodproofing	No Floodproofing	No Floodproofing	25,419 Total Parcels Protected $105.0M Damages Prevented	25,412 Total Parcels Protected $105.0M Damages Prevented	25,419 Total Units Protected $105.0M AAD Prevented	No Floodproofing	No Floodproofing	Ranges from 0 parcels to 40,964 parcels in Floodproofing
Total Floodproofing Costs Cost per unit Protected	No Floodproofing	No Floodproofing	$10.8B $425K/parcel	$10.8B $425K/parcel	$10.8B $425k/parcel	No Floodproofing	No Floodproofing	Ranges from $0.00 to $11.4B and $0/parcel to $278/parcel
By **Elevation**	No Floodproofing	No Floodproofing	$10.8B $425K/parcel	$10.8B $425K/parcel	25,419 Units Protected $210.0M AAD Prevented	No Floodproofing	No Floodproofing	Ranges from 0 parcels to 40,964 parcels in Floodproofing
Total Elevation Costs Cost per unit elevated	No Floodproofing	No Floodproofing	$10.8B $425K/parcel	$10.0B $425K/parcel	$10.8B $425/parcel	No Floodproofing	No Floodproofing	Ranges from $0.00 to $11.4B and $0/parcel to $278/parcel
Other Floodproofing	No Floodproofing	No Floodproofing	Undetermined at this time.	Undetermined at this time	Undetermined at this time	No Floodproofing	No Floodproofing	Undetermined at this time
Total Other Floodproofing Costs Cost per unit floodproofed	No Floodproofing	No Floodproofing	Undetermined at this time	Undetermined at this time	Undetermined at this time	No Floodproofing	No Floodproofing	Undetermined at this time
Replacements of Public Buildings	No Replacements	No Replacements	7 Total Units Protected	No Replacements	7 Total Units Protected	No replacements	7 Total Units Protected	Undetermined at this time
Total Relocations Costs Cost per unit relocated	No Replacements	No Replacements	$51.8M $7.4M per parcel	No Replacements	$51.8M $7.4M per parcel	No Replacements	$51.8M $7.4M	Undetermined at this time.
Reduced Threat to Loss of Life (based upon 2.6 persons per household)	14,997 potential households protected from flooding 38,900 lives protected	33,191 potential households protected from flooding 86,000 lives protected	42,500 Households protected from flooding 152,000 Potential Lives	25,419 Households protected from flooding 66,000 lives protected	58,617 Households protected from flooding 152,000 Potential Lives	Plan affects over 90,000 parcels .Potential for 234,000 lives to be offered some level of protection.	14,997 potential households protected from flooding 38,900 lives protected	Protected Parcels ranges from 30,508 to 85,447 with potential for 79,300 to 222,000 lives to be protected

Table 34.
Future With-Project Conditions

PLANS Parameters/Measures	Plan NS-PAHHZ	Plan NS-PA100	Plan NSC-1 – Federal Agencies Action Plan	Plan NSC-2 – Wet and Dry Floodproofing W/FWEE Upgrades	Plan NSC-3 – Joint Federal and Non-Federal Jurisdiction Plan	Plan NSC-4 – Non-Federal Jurisdiction Plan	Plan NSC-5 – Loss of Life Reduction Plan	Plan NSC-6 – Combined Structural and Nonstructural Plan
Flood Preparedness (Storm Warning and Emergency Evacuation) and Public Education	No FWEE Upgrades	No FWEE Upgrades	95,000 Parcels Covered 247,000 Population Informed	95,000 Structures Covered 247,000 Population Informed	95,000 Parcels Covered 247,000 Population Informed	95,000 Parcels Covered 247,000 Population Informed	95,000 Parcels Covered 247,000 Population Informed	95,000 Parcels Covered 247,000 Population Informed
Floodplain Management Improvements	No NFIP Upgrades	No NFIP Upgrades	No NFIP Upgrades	No NFIP Upgrades	95,000 Parcels Covered by Updated Floodplain Management Ordinances	95,000 Parcels Covered by Updated Floodplain Management Ordinances	No NFIP upgrades	95,000 Parcels Covered by Updated Floodplain Management Ordinances
Building Codes Upgrades	No Building Code Upgrades	No Building Code Upgrades	No Building Code Upgrades	No Building Code Upgrades	95,000 parcels Covered by Updated Codes	95,000 parcels Covered by Updated Codes	No Building Code Upgrades	No Building Code Upgrades
Development **Impact Fees**	No Development Impact Fees	No Development Impact Fees	No Development Impact Fees	No Development Impact Fees	At least 6,000 New Subdivided Lots Covered by Impact Fees and 27,000 vacant lots	At least 27,000 vacant lots Covered by Impact Fees	No Development Impact Fees	No Development Impact Fees
TDR/PDR	May be used to supplement acquisitions of interspersed vacant properties in high-hazard zones.	May be used to supplement acquisitions of vacant properties in high-hazard zones and areas deeper than 13 feet of water depth.	May be used to supplement acquisitions of interspersed vacant properties in high-hazard zones and areas deeper than 13 feet of water depth.	No TDR or PDR programs	At least 27,000 Interspersed Vacant Properties Development Rights Transferred or Purchased	At least 27,000 Interspersed Vacant Properties Development Rights Transferred or Purchased	No TDR or PDR programs	No TDR or PDR programs
Land Use Zoning and Regulations	No changes in land use zoning	No changes in land use zoning	No changes in land use zoning	No changes in zoning or land use regulations	At least 14,997 Parcels with Changed Zoning Designation to Reduce Flood Damages	At least 14,997 Parcels with Changed Zoning Designation to Reduce Flood Damages	No changes in zoning or land use regulations	No changes in zoning or land use regulations
Development Redirection	Approximately 3000 lots would be constructed out of the inundation zones	Approximately 6000 lots would be constructed out of the inundation zones	6,000 New Residential and Commercial lots developed out of the BFE limits	No redirection of development	6,000 New Residential and Commercial lots developed out of the BFE limits	Some redirection by local jurisdiction but numbers of lots undetermined at this time	Approximately 3000 lots would be constructed out of the inundation zones	Between 6,800 lots and 29,900 lots may be developed out of the BFE limits
Residual Damages	Residual damages to units not participating plus utilities and transportation facilities. Numerous unmovable facilities	Residual damages to units not participating plus utilities and transportation facilities. Numerous unmovable facilities	Residual damages to units not participating plus utilities and transportation facilities. Numerous unmovable facilities	Residual damages to units not participating plus utilities and transportation facilities. Numerous unmovable facilities	Residual damages to units not participating plus utilities and transportation facilities. Numerous unmovable facilities	Residual damages to units not participating plus utilities and transportation facilities. Numerous unmovable facilities	Residual damages to units not participating plus utilities and transportation facilities. Numerous unmovable facilities	Residual damages to units not participating plus utilities and transportation facilities. Numerous unmovable facilities
Risks and Uncertainty	Risks associated with the acquisition program plus H&H level of protection. Uncertainties center on credibility of the base data supporting acquisition costs.	Risks associated with the acquisition program plus H&H level of protection. Uncertainties center on credibility of the base data supporting acquisition costs.	Risks associated with the acquisition program plus H&H level of protection for floodproofing. Uncertainties center on credibility of the base data supporting acquisition costs.	Risks associated with H&H level of protection for floodproofing.	Risks associated with the acquisition program plus H&H level of protection for floodproofing. Uncertainties center on credibility of the base data supporting acquisition costs.	Uncertainty associated with political willingness to apply nonstructural measures and the TDR or PDR programs.	Risks associated with the acquisition program plus H&H level of protection. Uncertainties center on credibility of the base data supporting acquisition costs.	Risks associated with the acquisition program plus H&H level of protection. Uncertainties center on credibility of the base data supporting acquisition costs.
Potential Upgraded Housing Units	Potential for 7,500 new or upgraded Housing Units	Potential for 17,144 new or upgraded Housing Units	Potential for 17,144 new or upgraded Housing Units. A percentage of floodproofed structures will be upgraded while being elevated.	A percentage of floodproofed structures will be upgraded while being elevated.	Potential for 17,144 new or upgraded Housing Units. A percentage of floodproofed structures will be upgraded while being elevated.	No upgrading of housing expected as a result of project implementation other than through new IBC application.	Potential for 7,500 new or upgraded Housing Units	Potential for a range of 6,800 to 29,900 new housing units to be constructed plus upgrades to over 40,000 floodproofed structures.
Evacuated Acres Available for **Wetlands Restoration**	4,000 Acres	9,300 Acres	9,300 Acres	Undetermined at this time	9,300 Acres	0 acres available for restoration.	4,000 acres	Undetermined at this time

Were the plan to be implemented in a mandatory fashion, all 14,997 identified parcels would be acquired and the remaining residents relocated to suitable replacement DSS housing. This massive relocation project may trigger the need for one or more replacement housing sites within the project area to accommodate so many displaced landowners into an anemic housing market. The residential redevelopment sites would be located above the 0.2% annual chance flood elevation either by location or by design and the influx of new DSS housing resources would substantially increase the volume and quality of the region's housing stock from its current state.

Using the average per household size provided in the 2000 US Census figures for this area (2.6 persons per household); approximately 38,900 persons could be removed from these high-hazard zones permanently. Considering that over 250 people lost their lives in MS during Katrina, this reduction in the threat to life and increased safety is a significant affect of the plan. The effectiveness of this plan in reducing the threats to life would be dependent upon the attitudes of the landowners and their perception of the risks of redevelopment in the high-hazard zone.

In addition to the reduction of structural and content damages and reduced threat to life and safety, this plan provides approximately 4,000 acres of land found to be suitable for ecosystem restoration of wetlands many of which are directly connected to the Gulf waters. Considering the importance of estuarine wetland habitats that are directly connected to the Gulf in terms of promoting aquatic diversity, seafood production and shorebird productivity, this product of the plan is considered to be significant.

The cost of implementing Plan NS-PAHHZ is estimated to be $6.1B which translates into $404,000 per unit protected. In addition to the land acquisition, relocations assistance and structure demolition costs reflected in the total cost, the construction of at least 3,000 new housing lots would also be included in that total cost at an average cost of $45,000 per lot.

On the environmental impact side of the ledger, Plan NS-PAHHZ would result in significant migrations of population from the near-shore zone into less flood-prone and less developed areas where good quality habitat may be impacted by new home development (housing redevelopment/subdivision sites). Emphasis on in-fill development in the more urban areas and smaller communities located north of I-10 could reduce those impacts, but the magnitude of the relocations (at least 3,000 new lots) suggests some impacts to natural resources. Suitable redevelopment sites could encompass agricultural land as well as upland forest and grasslands. Wetland areas would be avoided during the redevelopment process.

In addition to the impact on natural resources by this migration, there may be impacts to public services (schools, wastewater collection and treatment systems, police and fire services and water supply systems) as additional users are added to the system. Also, there could be social and economic impacts by the loss of social connections in the affected communities. These impacts would surely be less than the impacts from Katrina itself, but would persist for several years as the program progressed. On the positive side, the Plan would evacuate many acres of high-quality beachfront habitat that would revert to a more natural state in addition to many acres of restored wetland habitat across the region.

Although one-dimensional, Plan NS-PAHHZ does attack the most critical storm damage needs and could significantly reduce threats to loss of life by inundation drowning. Public reaction to this plan would be mixed. Many of those landowners whose homes were destroyed by Katrina and did not have flood insurance would favor an opportunity to be relocated into a new more flood-safe replacement structure with limited personal financial investment. More opposition may be generated by local governments whose loss in tax revenues (already reduced by Katrina) from the relocation of acquired landowners would be hard to replace and whose remaining residents would have to bear the higher costs of remaining public services in those damaged areas.

7.2.2.2 Plan NS-PA100

This plan concentrates on the permanent acquisition of land and structures located in the high-hazard zones (see Plan NS-PAHHZ) and those structures within the FEMA-identified 1% annual chance flood area (as amended by the ABFE) where flood depths from the ABFE are greater than 13 feet above the ground surface. Under a mandatory implementation scheme, this plan would result in the permanent acquisition of an estimated 33,191 parcels of land with attendant structures (estimated 17,144) and families. The reduction in average annual damages due to these acquisitions would be approximately $210.0M. Given the high incidence of total destruction in the high-hazard zone (as much as 90%) and the reduction in annual damages provided by this measure, this would be a significant affect.

Approximately 95,000 acres of land could be acquired through this plan under a mandatory acquisition scheme. The actual number of parcels acquired would be dependent upon the individual landowners' perception of the flood risks and the opportunities for relocation to a flood-safe site. Participation rates could vary substantially depending upon the extent of damages to individuals homes incurred during Katrina and the individual prospects for redevelopment in the current location given higher construction costs and increased FEMA elevation requirements.

As in Plan NS-PAHHZ described above, estimates are that numerous interspersed parcels within the boundaries of Plan NS-PA100 were made vacant by Katrina. Early acquisition of a portion of those vacated lots through the initial HARP would potentially save an estimated $270.0 million dollars in structure acquisition and relocations payments. Also like the previous plan, Plan NS-PA100 potentially generates substantial housing relocations (as many as 17,144 at full participation) which would have to be accommodated in a severely under-stocked housing market. Several residential redevelopment sites holding at least 6,000 new residential lots may have to be constructed above the 0.2% annual chance flood limits to accommodate the displaced homeowners.

Using the average per household size provided in the 2000 US Census figures for this area (2.6 persons per household); approximately 44,600 persons could be permanently removed from the combined high-hazard zones and areas of water depth greater than 13 feet. Being relocated to more flood-safe locations, the threats to loss of life due to inundation drowning would be reduced substantially by this plan. This affect would be considered significant.

In addition to the reduction of structural and content damages and reduced threat to life and safety, this plan provides approximately 9,300 acres of land found to be suitable for ecosystem restoration of wetlands many of which are directly connected to the Gulf waters. This acreage is substantially greater (132% greater) than that generated by Plan NS-PAHHZ since many of the original wetland areas located away from the near-shore high-hazard zones and filled for residential development would be purchased as parcels where water depths at the ABFE would exceed 13 feet. This plan affect would be considered significant.

The cost of implementing Plan NS-PA100 is estimated to be $8.2B which translates into $248,000 per unit protected. In addition to the land acquisition, relocations assistance and structure demolition costs reflected in the total cost, the construction of at least 6,000 new housing lots would also be included in that total cost at an average development cost of $45,000 per lot.

Considering the environmental impacts of the plan, Plan NS-PA100 would result in significant migrations of population from the near-shore zone into less flood-prone and less developed areas where good quality habitat may be impacted by new home development (housing redevelopment/subdivision sites). Needing as many as 6,000 new lots to accommodate displaced landowners could impact over 2,000 acres of heretofore undeveloped land above the 0.2% annual chance flood limits. At these higher elevations there are fewer chances that wetland areas would be impacted by redevelopment and efforts would be made during the planning process to delineate all wetlands and purposefully avoid them during development. Upland forest and grasslands as well as agricultural lands may be most impacted by these redevelopment sites. Emphasis on in-fill development in the more urban areas and smaller communities located north of I-10 could reduce redevelopment impacts, but the magnitude of the relocations suggests some impacts to natural resources.

In addition to the impact on natural resources by this large migration, there could be impacts to public services (schools, wastewater collection and treatment systems, police and fire services and water supply systems) because of lack of capacity as well as social and economic impacts by the loss of social connections in the affected communities. These impacts would surely be less than the impacts from Katrina itself, but the impacts would persist for several years as the programmed acquisition process progressed. Even at a modest rate of participation in the program, many receiving communities would be hard-pressed to accommodate so many new households without substantial investments in new infrastructure and social/public services.

On a more positive environmental side, the permanent acquisition of both the high-hazard zones and areas where water depths at the ABFE exceeded 13 feet would encompass most of the near-shore areas as well as many of the original wetland areas within the inlets where placement of fill over the years had allowed residential and commercial development to occur. Once cleared, this estimated 9,300 acres could be restored to wetland habitat and use for a multitude of public uses including recreation.

As in the case of Plan NS-PAHHZ, Plan NS-PA100 is one dimensional using only permanent acquisition as a method of reducing structure and content damages and risks to life and increasing public safety. This plan does address most directly the highest risk properties that are damaged more frequently due to surge and wave action and does reduce the potential threats to life and public safety in the project area.

The social and economic impacts of this plan would make it unpopular with the local governments and communities unless some form of revenue sharing could be arranged between those communities being evacuated and those receiving new displaced homeowners (read as increased property tax receipts). It is possible that the magnitude of this acquisition program could result in the abandonment of substantial miles of access roads and utilities within heretofore heavily populated neighborhoods thus reducing future damages to these categories of infrastructure as well.

7.2.2.3 Plan NSC-1 Federal Agencies Plan

This plan relies primarily on those actions that could be undertaken by assorted Federal agencies including the Corps of Engineers, FEMA, and NOAA. This plan would feature permanent acquisition of a maximum of 33,191 eligible parcels (approximately 17,100 structures) within the high-hazard zones and areas where water depths would exceed 13 feet at the ABFE (similar to Plan NS-PA100) level. This plan would also feature floodproofing at 25,419 eligible parcels by elevation (meeting current local NFIP requirements) and other means, replacement of 7 public structures to more flood-safe locations and the upgrading of the existing components of the existing flood warning and emergency evacuation system.

This multi-dimensional plan would address several of the planning objectives (reducing flood damages, reducing threats to loss of life and providing opportunities for ecosystem restoration). The plan would provide complete protection through the acquisition of an estimated 33,191 parcels and relocation of at least 17,144 households and businesses and provide a minimum level of protection to the structures of as many as 25,419 landowners through floodproofing in the project area. The total reduction in average annual damages would be approximately \$315.0M (\$210.0 in acquisitions and \$105.0M in floodproofing).

In addition to flood damage reduction, the estimated 33,191 parcel acquisitions represent as many as 86,300 persons residing on those high-risk parcels whose lives would be made safer by relocation to more flood-safe residences through the relocations assistance program. Although the plan would not condone residents remaining in elevated structures during a hurricane event, structures raised above the ABFE would provide protection from drowning due to surge conditions for as many as 63,000 persons. Both of these affects would be considered significant.

As in the case of Plan NS-PA100, this plan could result in the acquisition of up to approximately 95,000 acres of land of which approximately 9,300 acres would be suitable for restoration as wetland ecosystem habitat. This positive affect on the region’s ecosystem would be considered significant. The total acres acquired and those suitable for restoration would be contingent upon program participation rates.

By incorporating a multitude of measures, this plan provides a variety of flood damage reduction and public safety measures not found in other plans. The replacement of 7 public structures (some of which are schools) allows not only continuance of essential public services to the population but can provide needed evacuation centers for those fleeing future flooding events. These affects are considered significant as well.

From an environmental standpoint this plan has both positive and negative affects. The potential clearing of over 93,000 acres of residential and commercial land in flood-prone areas that can be converted to wetlands or other quality habitat as well as used for passive recreation uses is a significant positive affect on the region’s ecosystems. From a negative viewpoint, relocating all of those households would result in some land and vegetation disturbance either through planned redevelopment sites or through the housing market construction process to meet the new housing needs. Needing at least 6,000 new residential and commercial lots would require an estimated 2,000 acres of subdivision development above the 0.2% annual chance floodplain. In-fill within already disturbed urban areas would siphon off a portion of this needed new development, but some land development disturbance is anticipated. Although identified wetlands could be avoided, agricultural lands and forest and grassland habitat may be impacted by this new development. New private market housing may be more dispersed and potentially less concerned about site development impacts while planned redevelopment sites would be evaluated through the NEPA process.

7.2.2.4 Plan NSC-2 Wet and Dry Floodproofing with FWEE Upgrades

This plan relies primarily on floodproofing, by various methods (wet and dry), structures on at least 25,419 eligible parcels within the ABFE footprint and the implementation of upgrades to the existing flood warning and emergency evacuation (FWEE) system. The upgrades to the existing FWEE would be spearheaded by other Federal (FEMA and NOAA), state and local agencies with support by the Corps of Engineers. Given the potential for thousands of families to be perched in elevated structures along the coast following the implementation of this plan, being able to issue credible and timely storm/flood warnings and efficiently and safely evacuate those people to safe storm shelters would be paramount in assuring that those in elevated residences would wisely choose to evacuate to high-ground.

The level of protection for elevated structures in this plan was based upon the ABFE minus 2 feet which was used as an approximation of the anticipated new FEMA-issued Base Flood Elevations following Katrina. The ABFE elevations or increased freeboard requirements (4 feet of additional freeboard) were adopted by each of the municipal and county governments following Katrina (see Table 8). Average annual flood damages for structures and their contents located on the 25,419 eligible parcels would be reduced by an estimated $105.0M as a result of implementation of this plan at that level of protection. This amount of flood damage reduction would be a significant affect produced by this plan.

[*The new BFE elevations were being issued in draft form by FEMA as this Appendix was being completed, but no attempt was made to recalculate the numbers of eligible parcels for floodproofing or to recalculate floodproofing costs based upon the new revised BFE. Once the new BFE elevations have been reviewed by the 11 municipal areas and 3 counties and have been adopted into the existing floodplain management ordinances, those elevations would form the basis of any subsequent detailed planning and engineering documentation by the Corps of Engineers prior to implementation of an authorized and funded nonstructural project*.]

Although people living within the elevated structures would be strongly encouraged to evacuate their floodproofed homes during a storm surge event, past experience indicates that many would choose to remain sheltered in place. Based upon a household size of 2.6 persons, as many as 65,000 people might be protected by this plan during a storm event that did not exceed the ABFE level. Providing some level of safety to people sheltering in place would be a significant affect. Conversely, promoting elevation of homes in high-hazard zones (potential consequences of other Federal programs) may place many families in extreme peril should hurricane surge and waves exceed the design height of the home's elevation (FEMA BFE).

The floodproofing program would affect approximately 136,000 acres of land within the project area. Of those acres approximately 3,800 acres would be suitable for ecosystem restoration as wetlands. Although the floodproofing program wouldn't be directly involved in purchasing those lands, it is possible that a number of structures would be found to be either structurally unsound and therefore unfit for elevation under the guidelines or that the cost of floodproofing the structure would exceed the appraised value of the structure. In these two cases, the owner may be given the option to sell the property to the Federal government (or project sponsor) for the appraised value, opt for a replacement home on-site at a lesser cost than floodproofing or to buy-up to the floodproofing cost with private funds. In the event that the owner would sell the property to the Federal government, they would be relocated under the provisions of the Uniform Relocations Act and the vacated land could be used for ecosystem restoration as wetlands. This determination would be made at the time of implementation of the floodproofing program on a case-by-case basis.

From an environmental perspective, Plan NSC-2 has very minimal impacts since all of the construction work occurs within the confines of an already disturbed residential, commercial or institutional building lot. In most cases, construction would be confined largely to the existing footprint of the structure foundation and all construction (including storage of building materials) would be confined to the owner's property. Since floodproofing construction is hand-labor intensive, there would be minimal use of heavy construction equipment on site (limited engine exhaust, petroleum or hydraulic fluid leakage, or waste water). Operation and maintenance of the structure elevation by the landowner also is environmentally friendly.

7.2.2.5 Plan NSC-3 Combined Federal and Non-Federal Jurisdiction Plan

This plan combines the best measures and attributes of Plans 1 and 4 into a suite of effective components aimed at all parcels affected by Katrina surge inundation within the ABFE footprint. In addition to the permanent acquisition of up to 33,191 parcels (an estimated 17,144 structures), the floodproofing of up to 25,419 structures and replacements of at least 7 public buildings, this plan includes application of numerous local jurisdiction actions that would affect every parcel (approximately 95,000 parcels) in the project area. Reductions in the average annual damages are estimated to be $315.0M based solely upon the affects of acquisitions of at-risk structures and floodproofing by elevation.

Additional reductions in annual damages would be generated by the application of nonstructural measures by the local jurisdictions such as upgraded floodplain management ordinances (application of the revised FEMA BFE), upgraded building codes, revised land use zoning ordinances, implementation of either a TDR or PDR program to address interspersed vacant properties, and the institution of development impact fees. Although incrementally small in comparison to the damage reductions provided by Federally-funded acquisitions and floodproofing, these local measures, when taken in aggregate, would have a significant affect on future damages.

In addition to flood damage reduction, the 33,191 parcel acquisitions (an estimated 17,144 structures) represent as many as 86,300 persons residing on those high-risk parcels whose lives would be made safer by relocation to more flood-safe residences through the relocations assistance program. Although the plan would not condone residents remaining in elevated structures during a hurricane event, structures raised above the ABFE would provide protection from drowning due to surge conditions for as many as 63,000 persons. Both of these affects would be considered significant.

As in the case of Plans NS-PA100 and Plan NSC-1, this plan could result in the acquisition of up to approximately 95,000 acres of land of which approximately 9,300 acres would be suitable for restoration as wetland ecosystem habitat. This positive affect on the region's ecosystem would be considered significant. The total acres acquired and those suitable for restoration would be contingent upon program participation rates.

From an environmental standpoint this plan has both positive and negative affects. The potential clearing of over 93,000 acres of residential and commercial land in flood-prone areas that can be converted to wetlands or other quality habitat as well as used for passive recreation uses is a significant positive affect on the region's ecosystems. Clearing the beachfront properties of residential and commercial development and the pavements and weekly maintenance of lawns and ornamentals (as well as extracting invasive plant species) would release the indigenous vegetation communities to flourish and provide additional storm protection (primarily wave and wind) through dense tree and shrub growth.

From a negative viewpoint, relocating all of those households would result in some land and vegetation disturbance either through planned redevelopment sites or through the housing market construction process to meet the new housing needs. Needing at least 6,000 new residential and commercial lots would require an estimated 2,000 acres of subdivision development above the 0.2% annual chance floodplain. In-fill within already disturbed urban areas would siphon off a portion of this needed new development, but some land development disturbance above the 0.2% annual chance elevation is probable. Planned development sites would avoid identified wetlands, but agricultural lands (especially vacated agricultural lands) and forest and grasslands may be impacted by new housing development. New private market housing may be more dispersed and potentially less concerned about site development impacts while planned redevelopment sites would be evaluated through the NEPA process.

In addition to the impact on natural resources by this large migration, there could be impacts to public services (schools, wastewater collection and treatment systems, police and fire services and water supply systems) because of lack of capacity as well as social and economic impacts by the loss of social connections in the affected communities. These impacts would surely be less than the impacts from Katrina itself, but the impacts would endure for several years as the programmed acquisition process progressed. Even at a modest rate of participation in the program, many receiving communities would be hard-pressed to accommodate so many new households without substantial investments in new infrastructure and social/public services.

The social and economic impacts of this plan would make it unpopular with the local governments and communities unless some form of revenue sharing could be arranged between those communities being evacuated (taxable property lost) and those receiving new displaced homeowners (read as increased property tax receipts). It is also possible that the magnitude of this acquisition program could result in the abandonment of substantial miles of access roads and utilities within heretofore heavily populated neighborhoods thus reducing future damages to these categories of infrastructure as well.

7.2.2.6 Plan NSC-4 Non-Federal Jurisdiction Plan

This plan contains the full palette of flood damage reduction measures that can be implemented through the local jurisdictions' (counties and municipalities). These individual measures affect essentially each and every parcel and structure located with the footprint of the Katrina surgeplain. Most of the measures are regulatory in nature (upgrading and enforcement of building codes, NFIP, and land use zoning), but a few are more proactive in their application such as a TDR/PDR program that would actively acquire or transfer development rights from at-risk properties or the development impact fees that would increase the costs of development in the at-risk zones (hopefully discouraging further development in high-risk zones) as well as generating funds for emergency management purposes.

Unlike the measures listed under Plan NSC-1 Federal Agencies Plan, the measures contained in NSC-4 do not lend themselves to easily quantifying benefits in terms of flood damages reduced or reductions in threats to loss of life. In addition, the application of these regulatory and land use measures do not directly generate additional lands for ecosystem restoration although the TDR/PDR programs could both be used to accomplish the same objectives in that regard as does permanent acquisition and relocations. In most cases, the counties and municipalities have the regulatory measures (land use zoning, NFIP, and building codes) in place to some degree and the incremental differences in reduced damages and loss of life to be gained by upgrading these components would be largely unnoticeable on an individual parcel basis. Only at the aggregate level would the differences be evident following a hurricane event. Intuitively, positive changes in the building codes and increases in the level of the Base Flood Elevation (should that be adopted by the communities) should reduce damages from future events. The presence of such a large number of vacated parcels (developed under previous codes/regulations) following Katrina indicates that updated regulatory codes and floodplain ordinances should generate positive benefits when the rebuilding occurs.

In the absence of a Federal program for storm protection in the project area (known as the No Federal Action Plan in NEPA terminology), these measures could be instituted at the local level to reduce future damages to those types of land uses contemplated in the future without-project condition described in the comprehensive plan and below. With the institution of these local measures and enforcement of upgraded building codes, floodplain management ordinances and land use zoning, future storm-related damages could be significantly reduced. The initiation of a TDR or PDR program that would transfer or purchase development rights on high-risk parcels (up to 33,191 parcels within the 100-year surge inundation footprint) would generate significant damage reduction benefits while potentially increasing development in less flood-prone areas north of I-10. Such limitations on development rights negotiated through the market system or by direct purchase would allow continued maintenance of the coastline properties by private landowners while maintaining some proportion of the original tax revenues to local jurisdictions.

7.2.2.7 Plan NSC-5 Loss of Life Reduction Plan

This plan relies primarily on permanent acquisitions in the high-hazard zone, replacements of public structures and upgrades to the flood warning and emergency evacuation (FWEE) systems. The permanent acquisitions would address 14,997 parcels located in the most dangerous coastal properties where the potential for loss of life due to drowning would be greatest in many categories of hurricanes and tropical storms. This area is subject to surge inundation and high waves, both factors in drowning deaths. The reduction in average annual damages amounts to approximately

$92.0M. The potential reduction in threats to life by surge inundation drowning is approximately 39,000 persons. Considering that over 200 people lost their lives in MS during Katrina, this reduction in the threat to life and safety is a significant affect of the plan. The effectiveness of this plan in reducing the threats to life would be dependent upon the attitudes of the landowners and their perception of the risks of redevelopment in the high-hazard zone.

Were the plan to be implemented in a mandatory fashion, all 14,997 identified properties would be acquired and the remaining residents relocated to suitable replacement DSS housing. This massive relocation project may trigger the need for one or more replacement housing sites within the project area to accommodate so many displaced landowners in an anemic housing market. The residential redevelopment sites would be located above the 0.2% annual chance flood elevation either by location or by design and the influx of new DSS housing resources would substantially increase the volume and quality of the region's housing stock from its current state.

In addition to the reduction of structural and content damages and reduced threat to life and safety, this plan provides approximately 4,000 acres of land found to be suitable for ecosystem restoration of wetlands many of which are directly connected to the Gulf waters. Considering the importance of estuarine wetland habitats that are directly connected to the Gulf in terms of promoting aquatic diversity, seafood production and shorebird productivity, this product of the plan is considered to be significant.

On the environmental impact side of the ledger, Plan NS-PAHHZ would result in significant migrations of population from the near-shore zone into less flood-prone and less developed areas where good quality habitat may be impacted by new home development (housing redevelopment sites). Emphasis on in-fill development in the more urban areas could reduce those impacts, but the magnitude of the relocation effort suggests some impacts to natural resources.

In addition to the impact on natural resources by this migration, there could be impacts to public services (schools, wastewater collection and treatment systems, police and fire services and water supply systems) because of lack of capacity as well as social and economic impacts by the loss of social connections in the affected communities. These impacts would surely be less than the impacts from Katrina itself, but would persist for several years as the program progressed. On the positive side, the Plan would evacuate many acres of high-quality near-shore habitat that would revert to a more natural state in addition to many acres of restored wetland habitat across the region.

In addition, this plan address replacement of public structures including 7 identified public buildings including schools and fire stations. These structures would contain children (one of the segments of the population more susceptible to drowning in surge situations) and first responders during and immediately following a storm event. Their replacement would reduce the potential for loss of life and would provide flood-safe emergency shelters for evacuees.

Upgrades to the flood warning and emergency evacuation system would assure that credible and timely warnings could be issued to a larger segment of the at-risk population so that evacuations could be conducted in a safe and orderly manner encouraging more people to participate in both voluntary and mandatory evacuations. The upgrades to signage and highway routing and emphasis on an ongoing education and awareness program would assure that both residents and visitors would be knowledgeable about evacuation routes and locations for emergency shelters.

7.2.2.8 Plan NSC-6 Combined Structural/Nonstructural Plan

Plan NSC-6 envisions combining several structural projects that either protect individual municipal areas with ring-levees or, as in the case of LOD-4, protect all of those parcels located roughly north of the CSX railway line with a levee and surge gates with nonstructural measures that would address all of those parcels not protected by these projects. Protecting large municipal areas in place with structural projects does eliminate many of the social and economic impacts of full-scale relocations or the visual and access impacts of elevating so vast a number of tightly confined structures. The benefits of LOD-4 when combined with nonstructural measures (primarily permanent acquisitions) is the generation of many acres of land suitable for ecosystem restoration as wetlands between the levee alignment and the Gulf.

This basic NSC-6 plan (combinations of nonstructural measures and structural projects) and its several scales (ABFE, 20 foot, 30 foot and 40 foot inundation) were formulated using just the measures described in Plan NSC-1 set in combination with various ring-levees and the Line of Defense 4 (LOD-4). Other measures described in the local jurisdiction plan (Plan NSC-4) could be applied in the nonstructural areas in NSC-6, but issues of combinability would emerge as shown in Plan NSC-3. Specific data on the numbers and costs of replacements of public buildings was eliminated for the 20 foot, 30 foot and 40 foot levels of inundation since data on the specific locations of these critical facilities at these increased flooding depths was not available from local, Corps or FEMA sources.

In addition, since only the annual flood damage reductions were calculated for the nonstructural measures at the ABFE level, specific reductions in average annual damages for the higher level of inundation were not available for this Appendix. What is known are the numbers of structures that would be included in the various scales of the nonstructural plan and estimates of the plan cost shown in Tables 25 through 33. Also, based upon the structures being afforded protection by each scale of the alternative, the approximate number of persons afforded protection from loss of life by nonstructural measures in the several scales of this plan can be estimated. These figures are shown in Table 25.

In addition to the numbers of parcels that would be eligible for acquisitions and floodproofing in the scales of NSC-6, there may be a need for several redevelopment sites located above the 0.2% annual chance floodplain (north of I-10). Numbers of needed relocation lots range from 6,800 to 29,000 to accommodate the numbers of structures that would be displaced by the nonstructural acquisitions in inundation depths from the ABFE to the 40 foot level. This need would require between 2,200 acres and 9,600 acres of land to address this number of displaced persons. Careful planning of these new subdivision sites could reduce significant environmental impacts normally associated with land development on this scale, but impacts to upland grasslands and forested sites may be unavoidable.

Specific data on the number of acres that would be acquired by permanent acquisition in the 20 foot, 30 foot and 40 foot levels of inundation was not available for this appendix, but in the options that involved the ring-levee alignments, the number of acres that would be purchased and suitable for ecosystem restoration would approximate those displayed for the single-measure permanent acquisition plans NS-PAHHZ and NS-PA100.

In comparison with the nonstructural plans, the combined structural nonstructural plan would open up the potential for more in-fill redevelopment in protected urban areas so that the relocation of displaced households could occur in areas with in-place infrastructure and public services rather than more rural areas without infrastructure. The combined plan featuring LOD-4 with nonstructural measures would accomplish the objective of moving most development away from the beachfront north towards the I-10 corridor. This movement, part of the “tiering” concept, would accomplish significant reductions in flood damages while spurring significant growth along that highway corridor.

7.3 Comparison with Future Without-Project Conditions

7.3.1. General

Following the description and display of the future with project outputs from each of the plans, those plan outputs are then compared to the anticipated future without-project conditions to determine to what extent the plans affect or improve the anticipated future condition. The MsCIP PDT formulated a series of future without-project scenarios based upon different mixes of land uses re-occupying the high-hazard zones and the possible effects of various sea-level rise amounts that may occur along the project area during the planning period (100 years). The two primary land use types were residential (single-family homes) and a mixed-use redevelopment featuring residential and commercial uses. Sea-level rise was divided into no relative rise, an expected relative sea level rise and a high relative sea level rise. In all, six scenarios were developed by the team including:

1) Residential redevelopment with no relative sea-level rise,
2) Residential redevelopment with an expected relative sea-level rise,
3) Residential redevelopment with a high relative sea-level rise,
4) Mixed use (residential/commercial) with no relative sea-level rise,
5) Mixed use (residential/commercial) with an expected relative sea-level rise, and
6) Mixed use (residential/commercial) with a high relative sea-level rise.

In each case the rate of redevelopment demonstrates an expected vigorous rebuilding program that would result in most of the previous development being back in place within 10 years. This growth rate is not unusual given the rates of growth that were common within the project area prior to Katrina. The combination of revised FEMA floodplain mapping and ordinances to guide redevelopment and the resurgence of various sectors of the economy in the region, rebuilding of the coast, barring a recurrence of Katrina-like events, could be swift and sustained.

In this re-building environment, the nonstructural plans would produce, in varying amounts, an array of storm damage reduction benefits, reductions in potential losses of life and opportunities for substantially increasing the acres of high-quality wetland and other ecosystem habitats in the region. The affects of the various amounts of anticipated relative sea level rise could be compensated for in the nonstructural measures by adjusting the geographical limits of permanent acquisition (to account for greater depths of inundation or expansions of the V-zone) and floodproofing by elevation. Since both of these nonstructural measures are applied on a structure-by-structure basis, program adjustments accounting for changes in inundation depths are relatively simple and incrementally inexpensive on a per structure basis. The performance of each nonstructural plan with respect to the various future without-project condition scenarios is discussed below.

7.3.2. Comparisons with Future Without-Project Conditions

7.3.2.1. Plan NS-PAHHZ

This plan addresses a geographic area of the coast (approximately 57,000 acres) that is defined not by elevation above the gulf, but by lateral extent from the waterline based on the presence of velocity waters (V-zone) and the damages observed after Katrina. In this regard, all of the changes in sea level contemplated by the scenarios have little affect on the effectiveness of this plan unless the changes in sea level were to translate into a regulatory modification of the V-zone and other damage zones that comprise this area in the Plan.

This plan addresses those parcels (14,997) and attendant structures (7,510) residing in the high-hazard zones of the project area. Since a number of structures were totally destroyed during Katrina, this plan is particularly effective in reducing damages and threats to life and public safety since all of the scenarios described above would see this area completely repopulated with new structures within 4 years. Even elevated to the revised BFE's published by FEMA and adopted by the local jurisdictions, the new structures may still be highly susceptible to massive damages by any storm surge level and waves that would exceed the revised BFE level in this zone.

Residential construction was observed to be highly susceptible to the battering affects of surge and waves in this zone. Therefore, the scenarios featuring residential growth (scenarios 1-3) in this high-hazard zone would be most susceptible to heavy damages which would be completely eliminated by mandatory application of this Plan. The eventual effectiveness of this plan would be contingent upon a high rate of participation in a non-mandatory plan. Plan NS-PAHHZ would also be effective under scenarios 4-6 featuring a mix of residential and commercial growth. It is anticipated that any land use development including commercial that is rebuilt in this zone to the revised BFE's would remain susceptible to heavy damages by storm surge and waves that exceeded the BFE elevation. Given the risks that commercial uses (especially retail uses) would assume in rebuilding in this high-hazard zone, their flood insurance burden may demand greater elevation of first floors and greater use of building materials and construction practices that would reduce damages. In any case, this plan would significantly reduce those damages through permanent acquisition and relocation of commercial uses as well as residential uses.

Continued threats to life and public safety under any of the 6 scenarios would be significantly reduced by this plan through permanent acquisition and relocation of the at-risk households. Were the high-hazard zone to be rebuilt within a 10 year period under any of the scenarios, the potential losses of life by surge inundation may be substantial and potentially greater than that experienced in Katrina. New development in the high-hazard zone under revised NFIP guidelines may encourage elevation of homes and businesses thus instilling a false sense of security and tendency for homeowners to seek shelter in elevated structures during larger storms. Permanent acquisition and relocation of these at-risk properties removes the risk to life and public safety.

More importantly, the proposed initial High Hazard Area Risk Reduction (HARP) would be most effective in reducing future damages and loss of life in this zone under any of the 6 scenarios of redevelopment. By purchasing interspersed vacant properties in the high-hazard zone prior to the initiation of any of the 6 scenarios of the future without-project condition, the potential damages that could occur with new growth would be eliminated.

7.3.2.2. Plan NS-PA100

This plan addresses only permanent acquisitions in the high-hazard zone and the area affected by the 1% annual chance flood event where water depths would exceed 13 feet at the ABFE. As such, the effectiveness of this plan in the high-hazard zone under each of the 6 scenarios is the same as described above in Plan NS-PAHHZ. According to field observations and the structure databases, the incidence of structure loss in the area inundated by the 1% annual chance flood where water depths would exceed 13 feet at the ABFE was much less than observed in the high-hazard zone. Although there are interspersed vacant acres of land in this deep water zone that could be affected by any one of the 6 scenarios of the future without-project condition, the anticipated increase in placement of damageable property is much less than would be expected in the largely decimated high-hazard zone. There are approximately 95,000 acres of land included within this plan area (an additional 37,000 more than Plan NS-PAHHZ).

Conversely, there remain a significant number of structures still susceptible to flood damages in this deep-water zone that would continue to suffer future damages in spite of any substantial redevelopment in the zones covered by this plan. Permanent acquisition of these remaining structures would significantly reduce damages under any of the 6 scenarios and especially in the scenarios that contemplate rises in sea level (scenarios 2, 3, 5 & 6) for those remaining structures. As such, Plan NS-PA100 would show incremental storm damage reduction benefits in excess of Plan NS-PAHHZ just based upon the substantial number of additional parcels (structures) included in this plan (approximately 10,000 additional parcels affected) over Plan NS-PAHHZ.

Threats to loss of life would be substantially lessened by this plan through at least 4 of the 6 scenarios since any sea level rise would result in an increase in the numbers of structures that would be acquired in lieu of elevation in place (floodproofing) in the deep water area. Although this area is not subject to the wave action encountered in the high-hazard zone, inundation of homes by deeper water would place more persons in jeopardy of drowning before evacuation would be possible. Acquisition of these structures through this plan would remove this threat.

7.3.2.3. Plan NSC-1

This plan not only addresses both permanent acquisition of the high-hazard zone and areas where water depths would be in excess of 13 feet at the ABFE but also elevates additional structures and their contents above the ABFE. This plan generates substantial storm damage benefits under any of the 6 scenarios as described in the above two plans (Plan NS-PAHHZ and Plan NS-PA100) and additionally generates storm damage benefits through elevation of structures on an additional 25,419 parcels. Compared to the zones described in the two plans above where wave action and deep water may have resulted in substantial numbers of destroyed structures, the geographic area comprising the 25,419 parcels eligible for floodproofing by elevation (about 136,000 acres) is mainly susceptible to inundation damages with substantially fewer losses of structures.

This plan is effective under any of the 6 scenarios since the elements of the plan associated with permanent acquisitions eliminate many of the potential future damages that would occur by either residential or mixed-use redevelopment of the high-hazard zone and areas where water depths would exceed 13 feet. The balance of structures covered by this plan through floodproofing and any additional vacated acres of land within the total 136,000 acres of this zone that may be redeveloped under one of the 6 scenarios would be protected by elevating the first floor of new structures above the design flood elevation. Since the plan is implemented on a structure-by-structure basis, adjustments to the design flood height (0-3 feet) to account for any anticipated sea level rise would not increase costs substantially on an individual structure. Storm damage reduction benefits and reduced threats to loss of life could be maintained by slight adjustments in design criteria for elevating structures or increasing the number of acquired structures.

An added feature of this plan is the replacements of public buildings to flood-safe areas. Under any of the 6 future without-project scenarios, replacements will be effective in both reducing damages to these critical facilities as well as maintaining essential services both during and immediately after a storm event. Given the increased regulatory requirements for locating critical facilities (usually above the 0.2% annual chance flood zone) under the NFIP, it is improbable that many of these types of structures would populate the high-hazard zones in future redevelopment scenarios. Since the flood frequency elevations that govern location of these structures would be sensitive to sea level rise, the replacements component of Plan NSC-1 could be easily adjusted during implementation to account for anticipated sea level rise at either an expected relative level or relative high level.

Threats to life and public safety under this plan are substantially reduced under any of the 6 scenarios. With permanent acquisition of the high-hazard zone and areas where water depths exceed 13 feet, most of the threat is substantially reduced. Since the program does not recommend that people remain in elevated structures during a storm surge event and would be evacuated to high-ground, the threats to that population would be substantially reduced under all of the scenarios.

7.3.2.4. Plan NSC-2

This plan relies mainly on floodproofing by elevation and upgrades to the flood warning and emergency evacuation system (FWEE) to reduce storm surge related damages and threats to life and public safety. The upgrades to the FWEE will be spearheaded by NOAA and FEMA in cooperation with state and local emergency management offices with support and coordination from the Corps.

Since this plan does not include permanent acquisition of the high-hazard zone or areas where water depths at the ABFE would exceed 13 feet, its ability to reduce damages as a result of the 6 redevelopment scenarios is substantially less that other plans. This plan can be effective in reducing damages despite sea level rise for structures on the 25,419 parcels included in the floodproofing component because the heights of elevation can be easily adjusted during implementation of the program at minimal cost per structure lifted. The only impact that sea level rise anticipated in 4 of the 6 scenarios would have on this plan is the transfer of some structures to the permanent acquisition component of the project due to water depths in excess of 13 feet at the structure. The mix of new development considered in the 6 scenarios would not impact the effectiveness of this plan since either residential or commercial structures can be elevated to reduce flood damages.

However, since most of the redevelopment would occur in those areas where the majority of interspersed vacant land is now located (notably the high-hazard zone), this plan is largely ineffective in reducing storm surge damages or threats to life and public safety for upwards of 33,191 parcels and attendant structures (an estimated 17,144). Given an average of 2.6 persons per household in the region, this leaves potentially 86,300 persons unprotected by this plan under the 6 redevelopment scenarios.

7.3.2.5. Plan NSC-3

This plan combines the best nonstructural measures (9 total measures) that can be jointly implemented by Federal agencies and local jurisdictions to reduce storm-related damages, reduce threats to life and public safety and increase the acreage of wetland ecosystems in the project area. With such a broad array of effective measures available, this plan can be adjusted on a parcel-by-parcel basis to meet any of the new conditions or threats that would be generated by the 6 future without project condition scenarios.

In addition to the nonstructural components included in Plan NS-PA100 and Plan NSC-2 above that would address future damages in the high-hazard zones by acquisition, this plan features the application of local jurisdictional measures such as upgraded NFIP requirements, upgraded building codes, a TDR or PDR program for acquiring development rights on at-risk parcels, development impact fees, and modifications of existing land use zoning codes. In terms of the redevelopment scenarios that feature either residential or a mix of residential and commercial land uses, the application of a voluntary TDR or PDR program would significantly limit redevelopment of these damageable structures in the high-risk areas of the coast by securing the development rights of each parcel in perpetuity. In addition, development rights could be purchased on parcels that possessed existing wetland thereby restricting further development of these sensitive ecosystems in the future scenarios.

Upgrading the existing floodplain management ordinances according to new FEMA floodplain mapping and the FEMA 550 guidelines would significantly reduce damages to the redeveloped land uses anticipated in the 6 scenarios. As these ordinances can be easily adjusted to account for any sea level rise, storm-related damages to new development would be reduced through enforcement of the floodplain management ordinances and revised building codes. Upgrading and enforcing the existing International Building Codes and International Residential Codes in each county and municipal jurisdiction would assure that any new construction anticipated in the 6 scenarios would be able to withstand hurricane force wind loads as well as wind-driven rain penetration and the corrosive effects of a saltwater environment.

This plan performs very well under any of the future without-project conditions described in the 6 scenarios through reduction of storm-related damages, reduced threats to life and public safety and opportunities for increasing the acres of ecosystem restoration for wetlands and other sensitive habitat types.

7.3.2.6. Plan NSC-4

This plan emphasizes those nonstructural measures that can be implemented by local jurisdictions such as the 3 counties and 11 municipalities in the project area. These measures are primarily regulatory in nature and would be easily applied to all of the parcels that were affected by Katrina's surge floodplain. Any redevelopment of the project area under the 6 scenarios would be subject to the upgraded floodplain management ordinances, building codes, land use zoning ordinances and development impact fees all capable of reducing storm-related damages and threats to loss of life and public safety through application and enforcement. Generally these regulatory measures are mandatory in nature and therefore do not depend upon individual parcel owner's voluntary participation to be effective. Changes in sea level could be accommodated by the various regulations through modification of the ordinances.

Of the local jurisdictional measures, the application of either a voluntary TDR or PDR program in the project area could have the most impact under all 6 scenarios of redevelopment. By securing the development rights of a substantial number of high-risk parcels, the anticipated placement of damageable assets under the scenarios would not take place thereby significantly reducing storm-related damages and threats to life and public safety for the occupants. Although the development rights would be secured in perpetuity, the landowner would still retain the property and be able to enjoy whatever use of the property the purchase agreements allowed. In addition to maintaining the property according to municipal or county requirements, the landowner would still be paying property taxes (a minimal amount) that would support a minimal level of public services to interspersed vacated land).

Despite the ability of the local jurisdictional measures in this plan to have an effect on the redevelopment of the coast anticipated in the 6 scenarios, these measures do little to reduce further damages to existing structures that survived Katrina. Structures remaining in the high-hazard zone and those that could be elevated or purchased and relocated in other risk zones would not be addressed by this plan.

7.3.2.7. Plan NSC-5

This plan emphasizes reductions in loss of life and treats to public safety through permanent acquisitions of parcels in the high-hazard zone, replacements of critical public facilities in flood-hazard areas and upgrades to the FWEE. Upgrades to the FWEE would be led by NOAA, FEMA and state and local emergency management departments with support and cooperation from the Corps. These upgrades to the existing system would make early warning of approaching storms and hurricanes more credible and timely allowing the at-risk population more time to safely evacuate the potential surge inundation areas and seek shelter in safe evacuation centers. Under any of the 6 scenarios the upgraded FWEE would be able to provide credible and timely warnings to the anticipated additional occupants of the high-risk parcels.

The permanent acquisition component of the plan would purchase (on a volunteer basis) parcels within the high-hazard zone where much of the development anticipated in the 6 scenarios would occur. Therefore under any scenario, this plan removes a portion of the future damages that may occur in future storm events. The effectiveness of the plan under any of the scenarios would be based upon the participation rate of the individual landowners in the high-hazard zone. Potential sea level rises would not affect this component of the plan since the delineation of the high-hazard zone for permanent acquisition is not sensitive to elevation, but lateral extent of the V-zone and post-Katrina damage documentation by FEMA. This component would also reduce threats to life and public safety by removing potential occupants from the high-hazard parcels.

The replacement of public structures from hazard areas would significantly reduce storm-related damages and threats to life and public safety by relocating these critical facilities to higher elevations and away from hazard areas. During replacements planning, the affects of potential future placement of either residential or mixed use development back into the hazard zones (minus those parcels acquired through this plan) that could affect the service areas of relocated structures would be taken into account. Only the effects of sea level rise in the scenarios would affect the replacements portion of this plan. However, under any of the sea level rise scenarios, the locations or construction of the relocated structures (elevated first floors) could be modified to accommodate the anticipated rises in sea level described in the 4 scenarios.

7.3.2.8. Plan NSC-6

This nonstructural plan is a modification of Plan NSC-1 with three scales of surge inundation above the base ABFE level of protection that would be applied to all of those areas not protected by either a series of ring-levees or by LOD-4. Since the ring-levee alignments protect most of the high-density urban development, the nonstructural measures would address the less densely developed areas and some displaced households or businesses through the permanent acquisition component may relocate into the urban areas protected by structural projects. This “in-fill” opportunity for displaced households and businesses would reduce program costs and impacts to the tax base.

As described above for Plan NSC-1, this plan features permanent acquisition in the high-hazard zones and non-floodproofing areas where water depths would exceed 13 feet. This plan also uses floodproofing by elevation as a means of reducing storm inundation damages to structures and their contents and the replacements of critical public facilities to further reduce storm-related damages and threats to life and public safety.

As described in Plan NSC-1 above, the use of permanent acquisition in the high-hazard zone, where much of the redevelopment contemplated in the 6 scenarios could occur, would reduce future damages by a significant amount (the percent reduction would be contingent upon the program participation rate). This reduction in damages would also hold true for any sea level rise scenario since the high-hazard zone is not sensitive to water elevation but lateral extent of the V-zone and the damage zone observed in Katrina.

The floodproofing component of the plan, depending upon the determination of the final level of protection for each structure would be sensitive to sea level rise although being implemented on a structure-by- structure basis, this measure can be easily adjusted to account for changes in the Gulf’s water level and the freeboard included in the floodproofing design gives some increment of protection against future rises in the Gulf levels. Under any of the redevelopment scenarios, floodproofing by elevation would be applicable through the current NFIP requirements by setting first floors above the BFE. Since this regulatory requirement is mandatory in the flood hazard areas defined in the local ordinances, each new building constructed would be subject to this requirement in order to obtain a building permit.

The replacement of public structures from hazard areas would significantly reduce storm-related damages and threats to life and public safety by relocating these critical facilities to higher elevations and away from hazard areas. During replacements planning, the affects of potential future placement of either residential or mixed use development back into the hazard zones (minus those parcels acquired through this plan) that could affect the service areas of relocated structures would be taken into account. Only the effects of sea level rise in the scenarios would affect the replacements portion of this plan. However, under any of the sea level rise scenarios, the locations or construction of the relocated structures (elevated first floors) could be modified to accommodate the anticipated rises in sea level described in the 4 scenarios.

7.4 Plan Comparisons with Planning Objectives

7.4.1 Planning Objectives

The MsCIP team developed a series of planning objectives for the Comprehensive Study in concert with project stakeholders and cooperating agencies. In total, 29 separate and distinct planning objectives were formulated for the study. Among those objectives were 10 objectives that could be specifically addressed through nonstructural measures. Other objectives being pursued by the study such as protection against saltwater intrusion and restoration of the barrier islands are not consistent with the nonstructural measures identified and evaluated in this appendix. The plans are also evaluated with the 4 primary civil works project objectives prescribed in the P&G. Those planning objectives that can be addressed by nonstructural measures are:

1) Reduction of the potential for future storm created flood damages,

2) Reduction of the potential for future storm related threats to life and safety,

3) Reduce costs for storm related emergency services,

4) Provide environmental justice in recommended solutions,

5) Provide complete solutions (in accordance with the P&G),

6) Provide solutions “acceptable” to communities & resource agencies,

7) Provide environmentally sound solutions,

8) Provide solutions that fit within existing laws, policies, regulations, and the general plans of local governments and communities,

9) Minimize impacts to the environment, and

10) Generate opportunities for ecosystem restoration of wetland habitat.

7.4.2. Comparisons with Planning Objectives

It is against this abridged listing of planning objectives, objectives that can be reasonably addressed by nonstructural measures, that the various plans have been evaluated. Table 35 shows the comparisons of the various plans with respect to the planning objectives and indicates whether or not and to what extent the plans accomplish one or more of the stated objectives.

Table 35

Comparison of Plans with Study and Principles and Guidelines (P&G) Objectives

Plans	**NS-PAHHZ**	**NS-PA100**	**NSC-1**	**NSC-2**	**NSC-3**	**NSC-4**	**NSC-5**	**NSC-6**
Objectives								
Reduce Storm Damages	Partially meets objective - $92.0M in AAD prevented	Partially meets objective - $210.0M in AAD prevented	Meets objective - $315.0M in AAD prevented	Partially meets objective - $105.0M in AAD prevented	Meets objective - $315.0M in AAD prevented	Partially meets objective – but AAD prevented would be minimal	Partially meets objective - $92.0M in AAD prevented	Meets objective – AAD prevented is undetermined
Reduce threats to life and public safety	Partially meets objective – 38,900 lives potentially given protection	Partially meets objective – 86,300 lives potentially given protection	Meets objective – 152,000 lives potentially given protection	Partially meets objective – 65,900 lives potentially given protection	Meets objective – 152,000 lives potentially given protection	Partially meets objective - lives given protection is undetermined	Partially meets objective – 38,900 lives potentially given protection	Meets objective – 222,000 lives potentially given protection
Reduce storm related emergency costs	Partially meets objective – reduces emergency costs for at least 14,997 parcels	Partially meets objective - reduces emergency costs for at least 33,100 parcels	Meets objective - reduces emergency costs for at least 42,513 parcels	Partially meets objective - reduces emergency costs for at least 25,419 parcels	Meets objective - reduces emergency costs for at least 42,513 parcels	Partially meets objective - potentially reduces emergency costs for at least 27,000 parcels	Partially meets objective – reduces emergency costs for at least 14,997 parcels	Meets objective - reduces emergency costs for at least 42,513 parcels
Provide environmental justice in recommended solutions	Plan impacts do not disproportionately affect impact minority or low income sectors of the population	Plan impacts do not disproportionately affect impact minority or low income sectors of the population	Plan impacts do not disproportionately affect impact minority or low income sectors of the population	Plan impacts do not disproportionately affect impact minority or low income sectors of the population	Plan impacts do not disproportionately affect impact minority or low income sectors of the population	Plan impacts do not disproportionately affect impact minority or low income sectors of the population	Plan impacts do not disproportionately affect impact minority or low income sectors of the population	Plan impacts do not disproportionately affect impact minority or low income sectors of the population
Provide complete solutions (in accordance with the P&G	Provides complete solution for specific geographic zone of the project area	Provides complete solution for specific geographic zones of the project area.	Provides complete solution for the project area.	Provides complete solution for specific geographic zones of the project area.	Provides complete solution for the project area.	Does not meet the objective for the project area – is incomplete	Provides complete solution for specific geographic zone of the project area	Provides complete solution for the project area.
Provide solutions "acceptable" to communities & resource agencies	Does not meet objective with respect to community acceptance in target area. Meets the objective from resources agencies viewpoint.	Does not meet objective with respect to community acceptance in target area. Meets the objective from resources agencies viewpoint.	Does not meet objective with respect to community acceptance in target areas. Meets the objective from resources agencies viewpoint.	Does meet objective with respect to community acceptance in target area. Meets the objective from resources agencies viewpoint.	Does not meet objective with respect to community acceptance in target areas. Meets the objective from resources agencies viewpoint.	Does meet objective with respect to community acceptance in target areas. Meets the objective from resources agencies viewpoint.	Does not meet objective with respect to community acceptance in target areas. Meets the objective from resources agencies viewpoint	Does meet objective with respect to community acceptance in target areas. Partially meets the objective from resources agencies viewpoint
Provide environmentally sound solutions	Meets the objective	Meets the objective	Meets the objective	Meets the objective	Meets the objective	Meets the objective	Meets the objective	Partially meets the objective
Provide solutions that fit within existing laws, policies, regulations, and the general plans of local governments and communities	Partially meets objective – relocation of structures from the HHZ may not meet current community plans	Partially meets objective – significant relocation of structures may not meet current community plans	Partially meets objective – significant relocation of structures may not meet current community plans	Meets objective	Partially meets objective – significant relocation of structures may not meet current community plans	Meets objective	Partially meets objective – significant relocation of structures may not meet current community plans	Meets objective
Minimize impacts to the environment	Meets the objective – only impacts are through redevelopment sites	Meets the objective – only impacts are through redevelopment sites	Meets the objective – only impacts are through redevelopment sites	Meets the objective	Meets the objective – only impacts are through redevelopment sites	Meets the objective	Meets the objective – only impacts are through redevelopment sites	Partially meets the objective

Plans	**NS-PAHHZ**	**NS-PA100**	**NSC-1**	**NSC-2**	**NSC-3**	**NSC-4**	**NSC-5**	**NSC-6**
Objectives								
Generate opportunities for ecosystem restoration of wetland habitat	Meets the objective – 4,000 acres made available for ER	Meets the objective – 9,200 acres made available for ER	Meets the objective – 9,200 acres made available for ER	Does not meet the objective – no acres would be available for ER	Meets the objective – 9,200 acres made available for ER	Does not meet the objective – no acres would be available for ER	Meets the objective – 4,000 acres made available for ER	Meets the objective – 9,200 acres made available for ER
Completeness	Partially meets the objective – complete for the identified zone being targeted	Partially meets the objective – complete for the identified zone being targeted	Meets the objective	Partially meets the objective – complete for the identified zone being targeted	Meets the objective	Does not meet the objective	Partially meets the objective – complete for the identified zone being targeted	
Effectiveness	Effectiveness is contingent upon landowner participation rates; thus meeting the objective is uncertain at this time.	Effectiveness is contingent upon landowner participation rates; thus meeting the objective is uncertain at this time.	Effectiveness is contingent upon landowner participation rates; thus meeting the objective is uncertain at this time.	Partially meets the objective	Effectiveness is contingent upon landowner participation rates; thus meeting the objective is uncertain at this time.	Partially meets the objective	Partially meets the objective	Effectiveness is contingent upon landowner participation rates; thus meeting the objective is uncertain at this time.
Efficiency	Does not meet the objective with respect to other plans	Does not meet the objective with respect to other plans	Meets the objective with respect to other plans	Does not meet the objective with respect to other plans	Meets the objective with respect to other plans	Meets the objective with respect to other plans	Does not meet the objective with respect to other plans	Meets the objective with respect to other plans
Acceptability	Meets the objective from the standpoint of feasibility of implementation, but would not be acceptable to local communities affected.	Meets the objective from the standpoint of feasibility of implementation, but would not be acceptable to local communities affected.	Meets the objective from the standpoint of feasibility of implementation, but would not be acceptable to local communities affected.	Meets the objective from the standpoint of feasibility of implementation and acceptability to local communities affected.	Meets the objective from the standpoint of feasibility of implementation, but would not be acceptable to local communities affected.	Meets the objective from the standpoint of feasibility of implementation and acceptability to local communities affected.	Meets the objective from the standpoint of feasibility of implementation, but would not be acceptable to local communities affected.	Meets the objective from the standpoint of feasibility of implementation and acceptability to local communities affected.
Sustainability	Meets the objective since acquired lands would have minimal O&M requirements	Meets the objective since acquired lands would have minimal O&M requirements	Meets the objective since acquired lands would have minimal O&M requirements	Meets the objective since floodproofed structures would have minimal O&M requirements	Meets the objective since acquired lands and floodproofed structures would have minimal O&M requirements	Meets the objectives since local measures are sustainable with local revenues	Meets the objective since acquired lands would have minimal O&M requirements	Meets the objective since acquired lands and floodproofed structures would have minimal O&M requirements

As the table shows, several of the plans perform very well with respect to the planning objectives and 4 primary civil works project objectives in the P&G. In general, those plans including significant amounts of permanent acquisitions meet the objectives of storm damage reduction and reduced threats to life and public safety while providing substantial amounts of land for ecosystem restoration as wetlands and other sensitive habitat. Generally speaking these plans also are environmentally friendly having only minimal impacts (construction impacts at redevelopment sites) that can be mitigated and do not disproportionately affect low income or minority populations. Conversely, plans featuring substantial displacement of households may not be well accepted by the communities or local governments due to potential social and economic impacts (lost tax revenues).

Although effective in reducing damages throughout the project area (approximately $105M AAD) and reducing threats to loss of life and public safety for numerous parcels (25,419), Plan NSC-2 – Floodproofing with FWEE upgrades does not produce significant acres of land for ER and does not address those high-hazard parcels so susceptible to destruction and loss of life.

The Non-Federal Jurisdiction Plan (Plan NSC-4) does address several of the planning objectives and because of its mandatory regulatory nature, can assure compliance with upgraded ordinances and codes that would reduce damages for new growth in the future without-project conditions. However, the plan with the exception of a possible TDR or PDR program in place does little to address objectives for reducing damages to existing structures and providing acres for ecosystem restoration.

Plans NS-PAHHZ and NS-PA100 meet the objectives regarding reduction of damages and threats to life and public safety as well as providing lands suitable for ER and are environmentally friendly, but they are confined to smaller geographic zones and would not be well received by local governments or communities due to their potential social and economic impacts.

Plan NSC-6 which combines the nonstructural measures in Plan NSDC-1 with structural components at several communities or a single line of defense (LOD-4) meets or partially meets several objectives while having few instances where the nonstructural plan portion of the combined project would not meet an objective. Among the plans, Plan NSC-6 (with ring-levees) at the ABFE level of protection would meet most objectives while partially meeting many others.

Plan NSC-1 meets several of the objectives (damage reduction, loss of life and ER opportunities) but like the other plans including permanent acquisitions as a component of the plan, the plan may not be popular and perhaps unacceptable to local governments and communities due to the number of displaced landowners.

Plan NSC-3 provides the widest array of measures that can be applied to the various planning objectives and generally fully meets or partially meets most of the planning objectives with the one exception of the issue of local acceptability. The large number of permanent acquisitions that would result in displaced landowners would be a concern for the local governments and communities. The anticipated social and economic impacts that could accompany this plan when implemented make this plan less popular than some of the other plans that do not include large numbers of displaced landowners. There are a number of mitigative actions that be taken that would lessen the anticipated social and economic impacts of large migrations away from the coast to safer areas, all of which are discussed in this Appendix.

CHAPTER 8. COMPARISON OF ALTERNATIVE PLANS

8.1 General

Having displayed and discussed the various outputs of the plans and evaluated the plans with respect to the future without-project conditions and with respect to the planning objectives and P&G objectives, the plans can now be compared against one another for the purpose of indentifying major differences between them and ranking the plans based upon their attributes. Table 36 displays the plans and compares them through their contributions to 9 individual output categories.

Although this Appendix does not conclude with selection of a best or optimal nonstructural plan, this comparison does show which plans perform the best with respect to one another in certain categories of relative outputs and impacts. An objective ranking of the plans would depend upon a consensus agreement by the stakeholders of what constituted the most important category of plan outputs or most insidious impacts.

Since the MsCIP Main Report addresses many other alternatives (i.e. structural plans) in addition to the nonstructural plans, the identification of an optimal or best plan is relegated to that document. Regrettably, not all of the output categories discussed below involve metrics expressed in dollars or numbers of structures protected, lives protected or acres of ecosystem restoration land provided. Many comparison categories are not commensurable or the plan outputs are not measurable at this level of study. Where possible, comparisons are provided in like units of measurement.

8.2 Plan Comparisons

8.2.1. Plan NSC-3

Among the various plans being compared, Plan NSC-3 provides the widest array of nonstructural measures available. There are 9 measures provided that include the best practices for reducing storm-related damages in a joint effort by Federal agencies and state and local governments. Although the complete metrics that would show the full benefits of this plan are not available at this level of study, the nonstructural measures included are proven in other Corps projects to be cost effective compared to other alternatives and can be modified to adjust to a multitude of changing conditions as have been anticipated in the future without-project conditions. The local jurisdiction measures have been proven to reduce flood damages in other coastal areas and would be largely regulatory and administrative in nature.

This plan is the most expensive plan of those considered ($19.1B) since it includes administrative costs necessary to accomplish the non-Federal jurisdiction actions as well and its cost per parcel protected is relatively high at $325K per parcel. In most respects, this plan is very similar to Plan NSC-1 from a Federal perspective with similar damage reduction and reductions to loss of life (reducing the threat to as many as 152,000 people) characteristics. Plan NSC-3 at least partially addresses many of the planning objectives and performs well through all of the 6 future without project scenarios. The only concern for this plan is the potentially large number of displaced households (33,191) which would be a concern for the local communities. Those choosing not to participate could continue to carry flood insurance in accordance with the NFIP. Other mitigative actions through the Uniform Relocations Act and various revenue sharing processes could address these relocation and public revenue concerns.

From an environmental standpoint, Plan NSC-3 could provide over 9,200 acres of land suitable for restoration as wetlands through the acquisition program. Additional land for wetland restoration could be provided through the floodproofing program as well during implementation. The only environmental impacts generated by this plan are those associated with construction of redevelopment sites for displaced households and businesses. If constructed through a Corps program under the last report housing provisions of the Uniform Relocations Act, these sites would be subject to scrutiny through an EA or EIS process and the impacts mitigated in collaboration with Federal and state resource agencies.

8.2.2. Plan NSC-1.

Similar to Plan NSC-3 is Plan NSC-1 which provides substantial AAD reductions ($315.0M) and reduces threats to loss of life for at least 152,000 people living in the storm surge zones through a combination of acquisitions and floodproofing. Compared to the other plans for which AAD figures are available this plan produces the most FDR benefits and has a low per parcel cost ($323K/parcel) compared to other nonstructural plans evaluated. Plan NSC-1 is expensive at $18.7B, but it is effective in reducing damages and does reduce the threat of massive property damage and possible loss of life in another hurricane event.

NSC-1 does not include the array of local jurisdiction measures that could be applied (in particular the TDR and PDR programs) to the many parcels within the ABFE footprint, but even without additional upgrades to existing regulations and ordinances, the ability of local jurisdictions to police coastal development and redevelopment activities is potent and effective. When new FEMA BFE mapping is adopted by the counties and municipalities, any development activities that occur within the defined flood hazard areas will be provided some level of protection through existing ordinances.

As with Plan NSC-3 this plan could provide a substantial number of acres of land (9,200 acres) suitable for wetlands restoration and with the exception of potential impacts caused by the redevelopment sites, is environmentally friendly to natural resources. Like plan NSC-3 this plan does acquire a large number of parcels voluntarily and that potential displacement of households and businesses is a concern for local governments and communities regarding social and public services and property tax revenue issues. Were a local TDR or PDR program to be established in conjunction with Plan NSC-1, the costs of securing the vacated parcels in the high-hazard zone would be reduced by 20-30 percent as only the development rights of the property would be purchased.

8.2.3. Plan NSC-6

Plan NSC-6 includes all of the nonstructural measures of Plan NSC-1 and when combined with LOD 4 at the 20 feet inundation level has the lowest per parcel protected cost of $210K for all nonstructural plans. With costs between $8.0B and $25.0B, these plans are more expensive that several other plans (Plan NS-PAHHZ, Plan NS-PA100 and Plan NSC-5) considered. Other variants of Plan NSC-6 that combine nonstructural measures with structural components at varying levels of inundation may provide substantial reductions in AAD (not determined at this phase of the study) and may provide protection for many people located outside of the lines of protection. Estimates of the numbers of people whose threat of drowning by surge inundation would be lessened by Plan NSC-6 variants range from 79,000 to 222,000. Combined with those protected by the structural measures, the variants of Plan NSC-6 are very effective in protecting at-risk residents.

Each of the scaled plans developed as a part of Plan NSC-6 will produce substantial acres of ecosystem restoration for wetlands (specific acreages not yet determined) and other sensitive habitat. Like Plan NSC-1 the permanent acquisition component of the NSC-6 variants will result in displacement of many thousands of households and businesses. The acquisitions range from

19,556 to 85,447 parcels across the 8 variants and required redevelopment lots range from 6,800 to 29,900 lots. This large number of displaced persons would be a concern for local governments and communities. These numbers clearly exceed anything found in the other plans and would have devastating effects on the social and economic systems of the project area.

The one benefit that Plan NSC-6, in its several scales, provides that is slightly different than other plans is its ability to protect, by use of structural means, the major commercial centers within the project area thus reducing the social and economic impacts associated with acquisitions within the urban centers that power the coastal economy. Either by means of the several ring-levees or the LOD 4 protection system, many of the major centers could be protected from surge flooding without resorting to high levels of population relocation.

8.2.4. Plan NS-PA100

This plan compares favorably with other plans at the ABFE level of protection in damages reduced ($210.0M) and lives protected (86,000) from surge inundation drowning. The plan has a lower per parcel protected cost at $248K/parcel and does produce 9,200 acres of land suitable for ecosystem restoration as wetlands. Among the plans considered this plan is very efficient on a per parcel protected basis, but is geographically limited to the 100-year surge floodplain in its effect and may not be acceptable to local governments and communities due to the displacement issues.

8.2.5. Plan NSC-2

This plan has a high project cost at $10.8B and is not efficient (compared to other alternatives) at $425K/parcel protected. The plan would reduce average annual flood damages by $105.0M. This plan does not provide many acres of land suitable for ecosystem restoration as wetlands and although it provides some potential increment of protection for as many as 69,900 lives, the inhabitants of floodproofed structures would be encouraged to seek shelter outside of the elevated structure.

This plan would be technically feasible and probably acceptable to the local communities and local governments compared to other plans that have large permanent acquisition components. The plan would have limited environmental impacts except perhaps for historic structures that may not be able to be elevated in place and maintain their significance. The plan would be applicable at several levels of protection although due to the depth restrictions for elevating structures at higher level of inundation (30 feet and 40 feet) floodproofing is not an option for most of the parcels in the project area.

8.2.6. Plan NS-PAHHZ

This plan in comparison to other nonstructural plans is relatively efficient at $404K/parcel protected. Its project cost is relatively high given the limited geographical extent of its coverage (high-hazard zone) and the number of displacements although lower than other plans still would be a concern for local governments and communities. The plan offers the least amount of reduction in average annual damages ($92.0M) but is relatively effective in reducing threats to life and public safety (38,900 lives) compared to the other plans.

The plan does provide 4,000 acres of land suitable for ecosystem restoration as wetlands and its environmental impacts would be relatively insignificant compared to the other plans since it has a limited geographical impact.

8.2.7. Plan NSC-5

This plan is dedicated to reducing loss of life and increasing public safety. At a cost comparable to Plan NS-PAHHZ ($6.1B) the plan is relatively inexpensive compared to other plans but at a per parcel cost of $404/parcel) this plan is relatively inefficient compared to all the other plans (i.e. NS-PA100 and NSC-1). The plan is comparable to Plan NS-PAHHZ in geographic extent and community impacts and therefore may not the best nonstructural plan.

The plan does create 4,000 acres of land suitable for ecosystem restoration as wetlands and its public buildings replacement component would enable these critical facilities to be relocated to higher ground, but its per parcel cost is much higher than other plans also featuring relocations as well.

8.2.8. Plan NSC-4

This plan is unique in that all of the measures within it are non-Federal and implemented by local jurisdictions. It has a relatively low cost (estimated to be $5.5M) compared to the other more robust plans since the majority of the costs are administrative and enforcement related and some like building codes are actually reimbursed through the building construction permit process. Although the plan is simple in its delivery and its effectiveness is not contingent upon a participation rate since the regulatory ordinances are mandatory in nature, the plan does not address damages for existing structures and is contingent upon the political will of the local leadership to upgrade and enforce the necessary ordinances and codes to control new development.

Since the plan is locally based and does not have a permanent acquisition component that would generate opposition, this plan can be effective in reducing future damages. Since there are so many vacated parcels in the project area that would be rebuilt upon (all 6 scenarios suggest a rebuilt environment in 10-12 years) and since the ordinances and codes that control such redevelopment rest in the hands of the local jurisdictions, this plan has merit.

In order to address the future damages on the vacated parcels and protect sensitive environmental areas, the initiation of either a TDR or PDR program by the three counties would allow securing the development rights of many parcels and accomplishing the same flood damage reduction objectives as can be met by the permanent acquisition components of several of the plans. At a much reduced cost for acquisition (just the development rights) or in the case of a TDR program where all transactions are within the land market, using these programs to forestall redevelopment and new development in perpetuity would increase the completeness of the plans and make them more efficient on a per parcel cost basis.

Table 36
Comparison of Plans

Plans	Plan NS-PAHHZ	Plan NS-PA100	Plan NSC-1	Plan NSC-2	Plan NSC-3	Plan NSC-4	Plan NSC-5	Plan NSC-6
Metrics								
Reduction of Average Annual Damages and Parcels protected	$92.0M in AAD prevented and 14,997 parcels removed from future development	$210.0M in AAD prevented and 33,191 parcels removed from future development	$315.0M in AAD prevented and 58,617 parcels protected.	$105.0M in AAD prevented and 25,419 parcels protected – some additional protection offered by the FWEE.	$315.0M in AAD prevented and 58,617 parcels protected	AAD prevented have not been determined for this Plan at this time.	$92.0M in AAD prevented and 14,997 parcels removed from future development	AAD have not been determined for this plan at this time.
Plan Costs and Cost per parcel protected	$6.1B $404K/parcel	$8.2B $248K/parcel	$18.7B $323K/parcel	$10.8B $425K/parcel	$19.1B $325K/parcel	$5.5M No per parcel cost has been determined at this time	$6.1B $404K/parcel	Costs range from $8.8B to $25.3B and per parcel cost range from $221K/parcel to $306K/parcel
Completeness	Plan complete in addressing damages in geographical target area.	Plan complete in addressing damages in geographical target area.	Plan complete in addressing damages	Plan not complete in addressing damages in project area	Plan Complete in addressing damages	Plan not complete in addressing damages to existing structures	Plan complete in addressing loss of life issues in project area.	Various plan variants complete for those areas located outside lines of structural protection.
Efficiency	Less efficient plan based upon per parcel cost to protect $404K/parcel	Very high efficiency at $248K/parcel protected	Medium level of efficiency compared to other plans at $323K/parcel protected	Very low efficiency at $425K/parcel protected	Medium level of efficiency at $325K/parcel protected	Efficiency yet to be determined based upon application of local regulatory codes and ordinances	Less efficient plan based upon per parcel cost to protect - $404/parcel	Plan NSC-6 at 20 feet inundation with LOD-4 is most cost efficient plan at $221K/parcel protected
Effectiveness	Plan is effective in addressing damages in geographic target area. Effectiveness will be contingent upon participation rate	Plan is effective in addressing damages in geographic target area. Effectiveness will be contingent upon participation rate	Plan is effective in addressing damages and threats to life in project area.	Plan not effective in addressing damages in geographic target area. Effectiveness will be contingent upon participation rate.	Plan is effective in addressing damages and threats to life in project area.	Plan is not effective in reducing damages to existing structures but would reduce damages for structures built upon approx. 27,000 vacant acres in flood zones.	Plan is effective in addressing damages in geographic target area. Effectiveness will be contingent upon participation rate	Plan is effective in addressing damages and threats to life in project areas located outside of structural protection.
Acceptability	Plan is technically feasible but may be unacceptable to local communities	Plan is technically feasible but may be unacceptable to local communities	Plan is technically feasible but permanent acquisitions may be unacceptable to local communities	Plan is technically feasible and may be acceptable to local communities	Plan is technically feasible but permanent acquisitions may be unacceptable to local communities	Plan is technically feasible and may be acceptable to local communities	Plan is technically feasible but permanent acquisitions may be unacceptable to local communities	Plan is technically feasible but permanent acquisitions may be unacceptable to local communities
Sustainability	Plan is sustainable in long term since evacuated parcels have minimal O&M requirements	Plan is sustainable in long term since evacuated parcels have minimal O&M requirements	Plan is sustainable in long term since evacuated parcels and floodproofed structures have minimal O&M requirements	Plan is sustainable in long term since floodproofed structures have minimal O&M requirements	Plan is sustainable in long term since evacuated parcels and floodproofed structures have minimal O&M requirements	Plan is sustainable since costs are primarily administrative in nature and supported by existing taxes and assessments which are anticipated to grow.	Plan is sustainable in long term since evacuated parcels have minimal O&M requirements	Plan is sustainable in long term since evacuated parcels and floodproofed structures have minimal O&M requirements
Public Safety	Plan potentially protects at least 38,900 lives	Plan potentially protects at least 86,000 lives	Plan potentially protects at least 152,000 lives	Plan potentially protects at least 60,000 lives	Plan potentially protects at least 152,000 lives	Plan potentially protects at least 220,000 lives	Plan potentially protects at least 38,900 lives	Plan potentially protects between 69,000 and 220,000 lives depending upon the level of protection selected.

Plans	Plan NS-PAHHZ	Plan NS-PA100	Plan NSC-1	Plan NSC-2	Plan NSC-3	Plan NSC-4	Plan NSC-5	Plan NSC-6
Metrics								
Environmental Impacts	Plan is environmentally acceptable and creates 4,000 acres of potential wetlands creation. Potential impacts to social and economic systems that can be mitigated.	Plan is environmentally acceptable and creates 9,200 acres of potential wetlands creation. Potential impacts to social and economic systems that can be mitigated.	Plan is environmentally acceptable and creates 9,200 acres of potential wetlands creation. Potential impacts to social and economic systems that can be mitigated.	Plan is environmentally acceptable but does not create many acres of potential wetlands creation. No significant displacements of landowners through acquisition.	Plan is environmentally acceptable and creates 9,200 acres of potential wetlands creation. Potential impacts to social and economic systems that can be mitigated.	Plan is environmentally acceptable but does create any acres potential wetlands creation	Plan is environmentally acceptable and creates 4,000 acres of potential wetlands creation. Potential impacts to social and economic systems that can be mitigated.	Plan is environmentally acceptable but acres of potential wetlands created are unknown at this time. Potential impacts to social and economic systems that can be mitigated.

Table 37.
National Register of Historic Buildings and Sites

	City	Date
Hancock County		
Beach Blvd. Historic District (Bay St. Louis MRA)	Bay St. Louis	25 Nov 1980
Building at 242 St. Charles (Bay St. Louis MRA)	Bay St. Louis	25 Nov 1980
Claiborne Site (22-Ha-501) (A)	Pearlington	12 Nov 1982
Glen Oaks/Kimbrough House (Bay St. Louis MRA Amdmt)	Bay St. Louis	21 Nov 1986
Jackson Landing Site (22-Ha-504) (A)	Pearlington Vicinity	27 Jul 1973
Main St. Historic District (Bay St. Louis MRA)	Bay St. Louis	25 Nov 1980
Nugent Site (22-Ha-592) (A)	Kiln Vicinity	13 Apr 1988
Onward Oaks	Bay St. Louis	1 Nov 1996
Rocket Propulsion Test Complex (NHL)(F)	Bay St. Louis	3 Oct 1985
SJ Mound (22-Ha-594) (A)	Pearlington Vicinity	13 Apr 1988
Sycamore St. Historic District (Bay St. Louis MRA)	Bay St. Louis	25 Nov 1980
Taylor House (Bay St. Louis MRA Amdmt)	Bay St. Louis	21 Nov 1986
Taylor School (Bay St. Louis MRA Amdmt)	Bay St. Louis	15 Jan 1987
Three Sisters Shell Midden (22-Ha-596) (A)	Pearlington Vicinity	28 Jul 1988
Up the Tree Shell Midden (22-Ha-595) (A)	Pearlington Vicinity	13 Apr 1988
Washington St. Historic District (Bay St. Louis MRA)	Bay St. Louis	25 Nov 1980
Webb School (Bay St. Louis MRA Amdmt)	Bay St. Louis	21 Nov 1986
Williams Site (22-Ha-585) (A)	Pearlington Vicinity	28 Jul 1988
Harrison County		
Bailey House (Holy Angels Nursery) (Biloxi MRA)	Biloxi	18 May 1984
Barq, E., Pop Factory (Biloxi MRA)	Biloxi	18 May 1984
Bass, Raymond Site (22-Hr-636) (A)	Biloxi	26 Feb 1987
Beauvoir (NHL)	Biloxi	3 Sep 1971
Benton, Thomas & Melinda, House	Gulfport	9 Aug 2002
Biloxi Downtown Historic District	Biloxi	3 Sep 1998
Biloxi Garden Center (see Old Brick House)		
Biloxi Lighthouse	Biloxi	3 Oct 1973
Biloxi's Tivoli Hotel (Trade Winds) (Biloxi MRA)	Biloxi	18 May 1984
Biloxi Veterans Administration Medical Center (F)	Biloxi	14 Feb 2002
Bond House (Biloxi MRA)	Biloxi	18 May 1984
Brielmaier House (Biloxi MRA)	Biloxi	18 May 1984
Brunet-Fourchy House (Mary Mahoney's) (Biloxi MRA)	Biloxi	18 May 1984
Church of the Redeemer (Biloxi MRA)	Biloxi	18 May 1984
Clemens House (Biloxi MRA)	Biloxi	18 May 1984
Dantzler, G.B., House	Gulfport	1 Dec 1989
Fisherman's Cottage (Biloxi MRA)	Biloxi	9 Mar 1990
Fort Massachusetts (Ship Island) (F)	Gulfport Vicinity	21 Jun 1971
French Warehouse (Gulf Islands NTL SS) (22-Hr-638) (A) (F)	Biloxi	13 Dec 1991
Gillis House [Relisted – 1978]	Biloxi	7 Jul 1978
Grass Lawn (see Milner House)		
Gulf Coast Ctr for the Arts (Old Library) (Biloxi MRA)	Biloxi	8 May 1984
Harbor Square Historic District	Gulfport	13 Aug 1985
Hermann House (Biloxi MRA)	Biloxi	18 May 1984

	City	Date
Hewes Building	Gulfport	7 Oct 1982
Hewes, Finley B., House	Gulfport	15 Aug 2002
Holy Angels Nursery (see Bailey House)		
House at 121 West Water Street (Biloxi MRA)	Biloxi	18 May 1984
House at 407 E. Howard Ave	Biloxi	17 Jul 1986
Josephine (shipwreck) (22-Hr-843)	Biloxi Vicinity	22 Nov 2000
Magnolia Hotel	Biloxi	14 Mar 1973
Harrison County		
Bailey House (Holy Angels Nursery) (Biloxi MRA)	Biloxi	18 May 1984
Barq, E., Pop Factory (Biloxi MRA)	Biloxi	18 May 1984
Bass, Raymond Site (22-Hr-636) (A)	Biloxi	26 Feb 1987
Beauvoir (NHL)	Biloxi	3 Sep 1971
Benton, Thomas & Melinda, House	Gulfport	9 Aug 2002
Biloxi Downtown Historic District	Biloxi	3 Sep 1998
		1973
Mary Mahoney's (see Brunet-Fourchey House)		
Milner House (Grass Lawn)	Gulfport	31 Jul 1972
Nativity B. V. M. Cathedral (Biloxi MRA)	Biloxi	18 May 1984
Old Brick House (Biloxi Garden Center)	Biloxi	3 Oct 1973
Peoples Bank of Biloxi (Biloxi MRA)	Biloxi	18 May 1984
Quarles, W. J., House	Long Beach	16 Oct 1980
Redding House (Biloxi MRA)	Biloxi	18 May 1984
Reed, Pleasant, House (Reed House)	Biloxi	11 Jan 1979
Saenger Theater (Biloxi MRA)	Biloxi	18 May 1984
Scenic Drive Historic District	Pass Christian	7 May 1979
Scherer House (Spanish House) (Biloxi MRA)	Biloxi	18 May 1984
Seashore Campground School (Biloxi MRA)	Biloxi	18 May 1984
Spanish House (see Scherer House)		
Suter House (Biloxi MRA)	Biloxi	18 May 1984
Swetman, Glenn, House (Biloxi MRA)	Biloxi	18 May 1984
Tivoli Hotel (see Biloxi's Tivoli Hotel)		
Toledano/Philbrick/Tullis House	Biloxi	5 Nov 1976
Trade Winds (see Biloxi's Tivoli Hotel)		
U.S. Post Office & Customhouse (F)	Gulfport	19 Mar 1984
U.S. Post Office, Courthouse/Customhouse/Biloxi City Hall	Biloxi	30 Jan 1978
West Beach Historic District (Biloxi MRA)	Biloxi	18 May 1984
West Central Historic District (Biloxi MRA)	Biloxi	18 May 1984
West Central Historic District (Addl Documentation)		1997
Jackson County		
Applestreet Site (22-Ja-530) (A)	Gautier Vicinity	12 Sep 1985
Back Bay of Biloxi Shipwreck Site (22-Ja-542)	Ocean Springs Vic	22 Apr 1999
"Bellevue" ("Longfellow House")	Pascagoula	12 Dec 2002
Bertuccine House & Barbershop (Ocean Springs MRA)	Ocean Springs	9 Jun 1987
Bodden, Capt. Willie, House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Brash, Anna C., House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Carter-Callaway House (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Clark, Clare T., House (Pascagoula MPS)	Pascagoula	20 Dec 1991

	City	Date
Clinton, Capt. F. L., House	Pascagoula	20 Dec 1991
Cochran-Cassanova House (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Colle Company Housing (Pascagoula MPS)	Pascagoula	20 Dec 1991
Colle, Capt. Herman H. Sr., House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Cottage by the Sea Tavern (Pascagoula MPS)	Pascagoula	20 Dec 1991
Cudabac-Gantt House	Moss Point	24 Jul 1990
Dantzler, A. F., House	Moss Point	26 Mar 1987
Degroote Folk House	Hurley Vicinity	4 May 1982
Dejean House	Pascagoula	25 Feb 1993
Farnsworth R. A. Summer House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Ford, Mayor EBB, House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Frentz, George, House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Front Street Historic District	Pascagoula	17 May 1984
Gautier, Adam, House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Gautier, Eugene, House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Gautier, Walter, House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Graveline Mound Site (22-Ja-503) (A)	Gautier Vicinity	2 Jul 1987
Griffin House	Moss Point	7 Jul 1983
Halstead Place (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Hansen-Dickey House (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Herrick, Lemuel D., House (Pascagoula MPS)	Pascagoula	20 Dec 1991
House at 1112 Bowen Ave (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
House at 1410 Bowen Ave (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Hughes, William, House (Pascagoula MPS)	Pascagoula	21 Oct 1993
Hull, Edgar W., (Pascagoula MPS)	Pascagoula	20 Dec 1991
Indian Springs Historic District (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Keys, Thomas Isaac, House (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Kinne, Georgia P., House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Krebs, Agnes V., House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Krebs, James, House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Krebsville Historic District (Pascagoula MPS)	Pascagoula	20 Dec 1991
Levin, Leonard, House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Lewis, Col. Alfred E., House (Oldfields)	Gautier	16 Oct 1980
Louisville & Nashville Railroad Depot	Pascagoula	27 Aug 1974
Louisville & Nashville Railroad Depot	Ocean Springs	31 Dec 1979
Lover’s Lane Historic District (Ocean Springs MRA)	Ocean Springs	9 Jun 1987
Marble Springs Historic District (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Nelson Tenement (Pascagoula MPS)	Pascagoula	20 Dec 1991
Nelson, John C., House (Pascagoula MPS)	Pascagoula	20 Dec 1991
O’Keefe-Clark Boarding House (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Ocean Springs Comm Center (Walter Anderson thematic)	Ocean Springs	24 Aug 1989
Oldfields (see Col. Alfred E. Lewis House)		
Old Farmers & Merchants State Bank (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Old Ocean Springs Historic Dist (Ocean Springs MRA)	Ocean Springs	7 Oct 1987
Old Ocean Springs High School	Ocean Springs	2 Aug 1990
Old Spanish Fort	Pascagoula	3 Sep 1971
Olsen, Lena, House (Pascagoula MPS)	Pascagoula	20 Dec 1991

	City	Date
Orange Avenue Historic District	Pascagoula	14 Aug 2001
Pascagoula Central Fire Station #1	Pascagoula	8 Dec 1978
(Old) Pascagoula High School	Pascagoula	6 Apr 2000
Pascagoula St. Railroad & Power Co (Pascagoula MPS)	Pascagoula	20 Dec 1991
Randall's Tavern (Pascagoula MPS)	Pascagoula	20 Dec 1991
Round Island Lighthouse	Pascagoula Vicinity	9 Oct 1986
Shearwater Historic District (Walter Anderson thematic)	Ocean Springs	24 Aug 1989
St. John's Episcopal Church (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
St. Mary's by the River	Moss Point	2 May 1991
Sullivan-Charnley Historic Dist (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Tabor, Dr. Joseph A., House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Thompson, George, House (Pascagoula MPS)	Pascagoula	20 Dec 1991
Vancleave Cottage (Ocean Springs MRA)	Ocean Springs	20 Apr 1987
Westphal, Laura, House (Pascagoula MPS)	Pascagoula	20 Dec 1991

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Figure 139 – Land Surface Elevations of Economic Reaches w/Respect to the Gulf (A1)

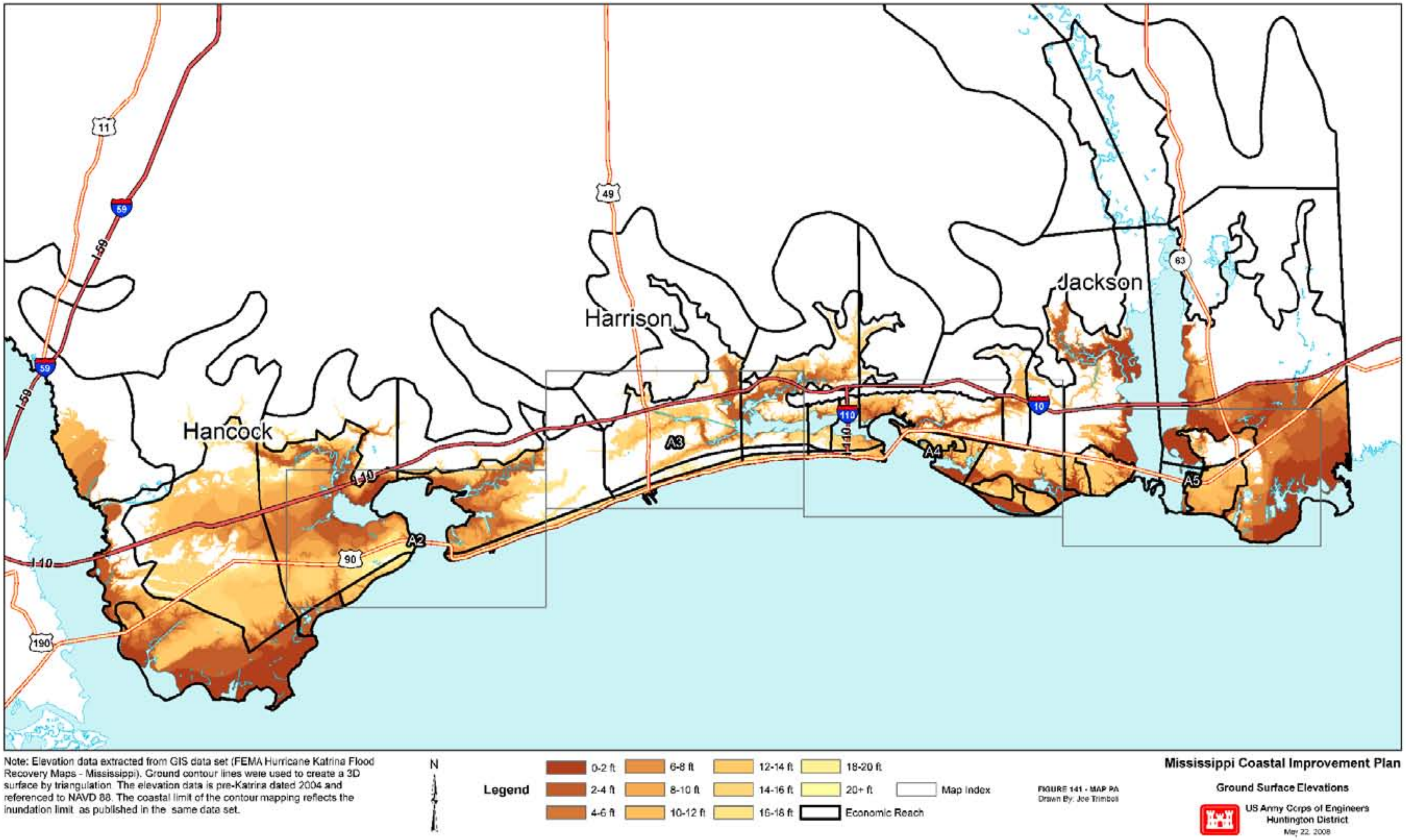


Figure 140- Land Surface Elevations of Economic Reaches w/Respect to the Gulf (A2)

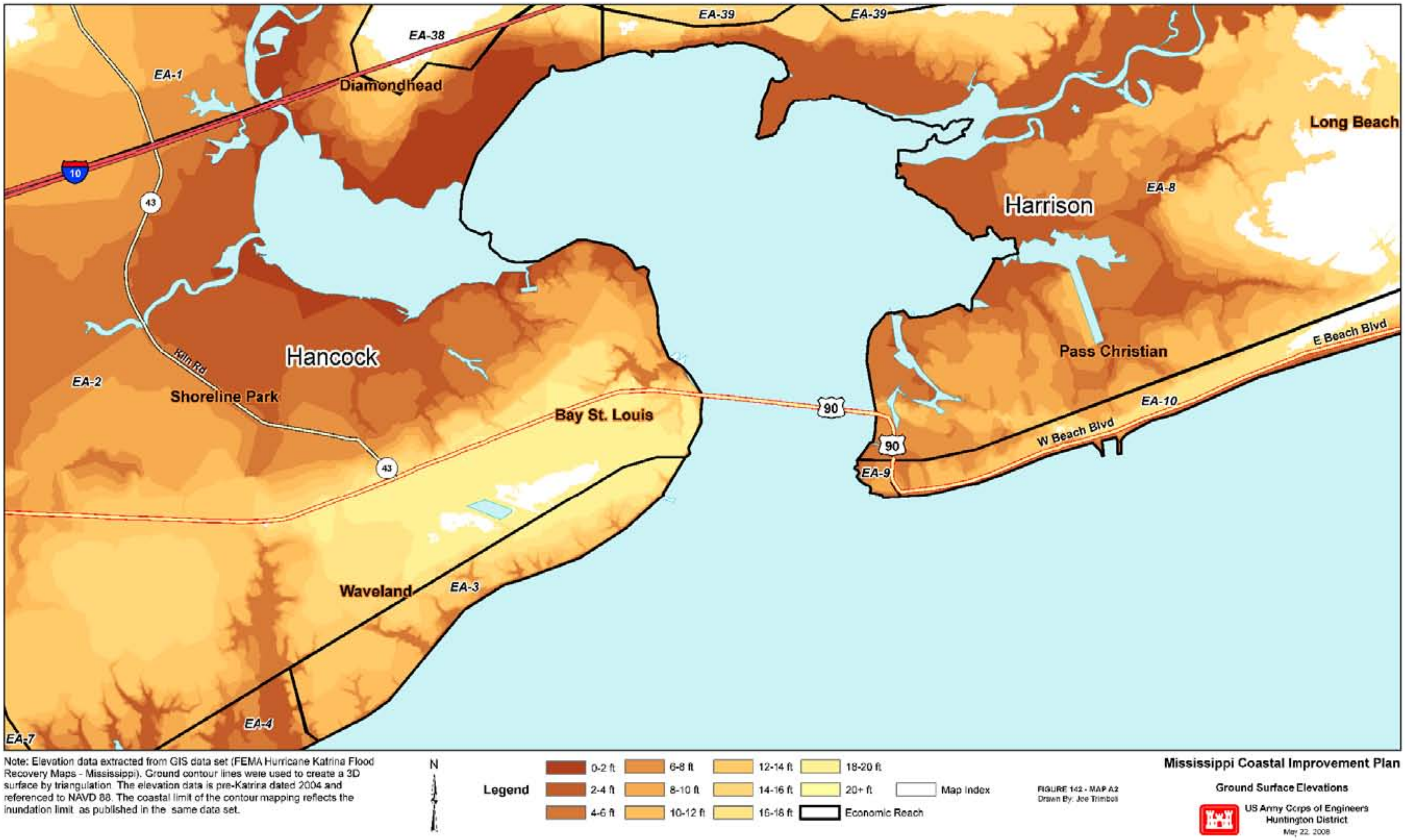


Figure 141 - Land Surface Elevations of Economic Reaches w/Respect to the Gulf (A3)

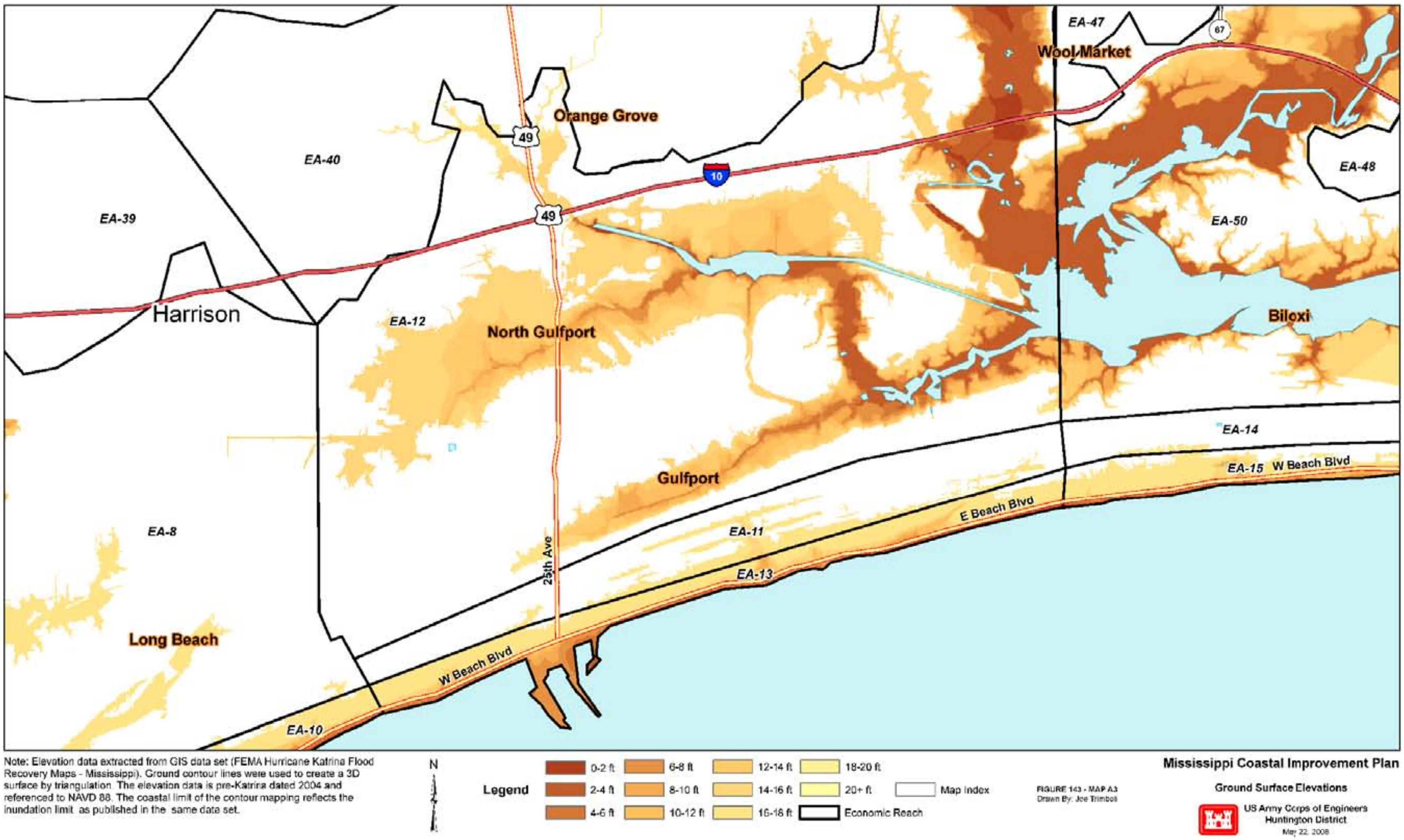


Figure 142 - Land Surface Elevations of Economic Reaches w/Respect to the Gulf (A4)

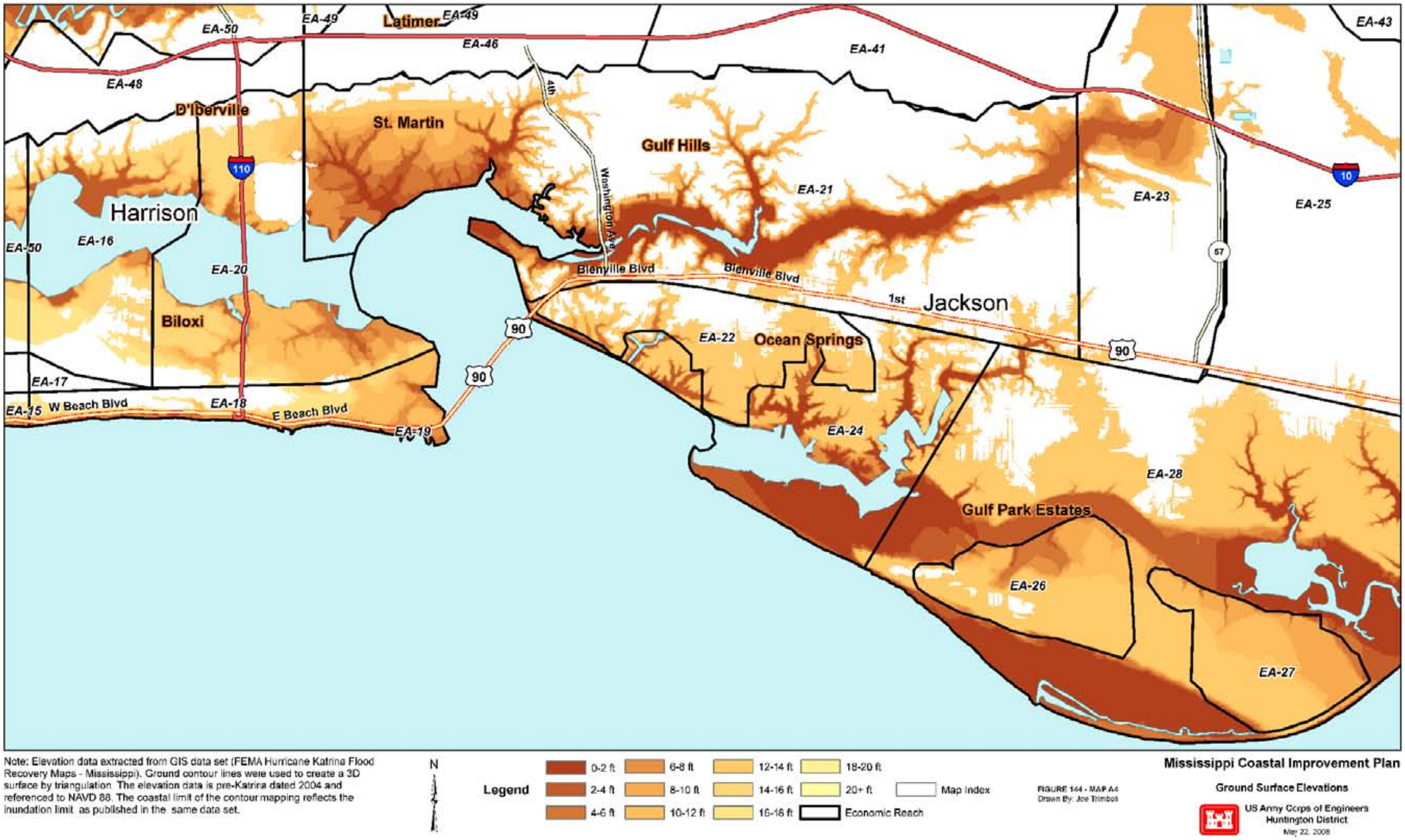
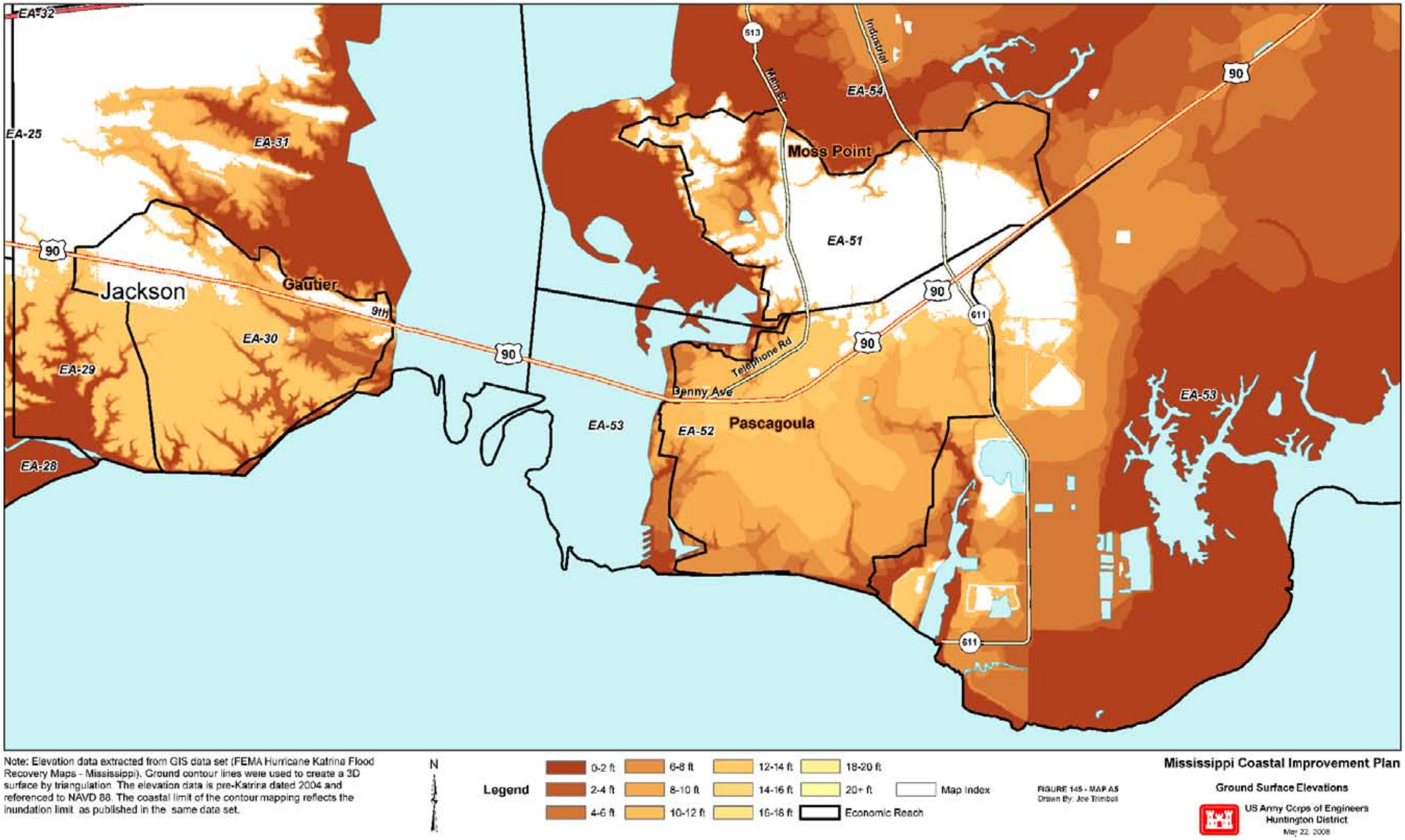


Figure 143 - Land Surface Elevations of Economic Reaches w/Respect to the Gulf (A5)



AFTERWORD

Rather than abruptly conclude this Appendix with the text in Chapter 8 on page 288, the team decided to prepare this short Afterword. Many of the concepts within this document are captured within the Main Report of the MsCIP and will hopefully be the focus of future, more detailed planning and implementation plans.

Much thought, analysis and teamwork went into the plan formulation and preparation of this document, but the plan is not the end of the process in and of itself. The proof of the pudding as many say is in the successful implementation of the plan itself. An old planning cliché states that "Action without planning can be fatal, but planning without action is futile." It would be sad indeed were this current planning effort to end in futility.

All of the thought processes that supported the formulation of the nonstructural measures and alternatives displayed in text and graphics in this document must be reaffirmed on the ground with the various neighborhood and community residents and local officials before the efficacy of the plans can be proven. As those collaborative workshops, charrettes, community meetings and small-group gatherings take place, a vision of a future disaster-resilient community needs to be formed through consensus-building – a vision that all can support to some degree and that all can participate in as citizens of the coast.

The Nonstructural PDT encourages all those who will participate in the coastal visioning efforts to be open-minded, future-oriented and committed to a coastal community that is sensitive to the diverse natural resources of the region, individual citizen rights and the rich culture and history of the Gulf Coast.

Essayons