Houston-Galveston Area Council

BACK HOME

Rapid Housing Recovery Pilot Program

Final Report on the Back Home Rapid Housing Recovery Pilot Program

Executive Summary

The Back Home Rapid Housing Recovery Pilot Program was created by the Texas State Legislature after Hurricane Ike to test modular construction technologies as an alternative to the current process of housing residents displaced by disaster. The Houston-Galveston Area Council was tasked with constructing ten disaster recovery pilot homes in Harris County and ten pilot homes in Galveston County employing modular technology and a phased approach; emulating the two-phases of the federal response to disaster housing. The federal response is divided between the initial temporary disaster response housing administered by FEMA and the permanent disaster recovery housing administered by HUD. The Back Home program was created to design and construct a livable modular homes that could be deployed immediately after a natural disaster. Once deployed, the homes needed to be able to accept additional bedroom and bathroom modules as insurance funds, financing, or disaster recovery funding became available.

Prior to the designing the home, H-GAC conducted extensive research and community outreach to ensure that the program successfully met the needs of communities in the region. The process began by researching past disaster recovery housing efforts employing modular housing technology for lessons learned. H-GAC then interviewed city and county staff to determine the local post-disaster housing conditions and regulations. Once the local post-disaster housing landscape was understood, H-GAC released a request for proposals for a partner to design and build the homes. After a team was contracted, a series of public meetings were held around Harris and Galveston counties to understand public opinion and desires for disaster recovery housing. The team created an initial design for the homes based on the research, interviews, and public input collected. This design was reviewed and critiqued based by city and county staff. During this process, priorities and goals for the homes were identified. The design team created an updated design based on the feedback, which was then built as a prototype home. The prototype allowed the team to test the phased build approach, and the home's energy efficiency, and allowed potential applicants and local officials to experience the home in person. At this juncture, low-to-moderate income homeowners in Harris and Galveston counties with Hurricane Ike damage were encouraged to apply for the program. Construction began after applicants were qualified.

The Back Home program was successful in meeting its goals of developing a durable, efficient, and aesthetically pleasing home that can be deployed in phases using modular technologies. While modular homes can be deployed rapidly, barriers remain for making modular the preferred construction technology in disaster housing recovery. The time savings of constructing modular housing offsite are often negated by the current protracted processes required to rebuild. The current requirements for funding housing recovery, qualifying homeowners, and the various local authorizations required to rebuild are all more significant time constraints to rapid reconstruction than the manner of construction technology employed.

Damage from Hurricane Ike in Gilchrist, on the Bolivar Peninsula in Galveston County, Texas (Jocelyn Augusitno/FEMA)

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Introduction

The Houston-Galveston Area Council (H-GAC) created the Back Home Rapid Housing Recovery Pilot Program as part of Hurricane Ike recovery efforts. The goal of this program is to minimize displacement of residents by developing a strategy for the rapid, efficient, large scale deployment of permanent housing following future natural disasters. Through this pilot program, H-GAC has developed a plan for the expedited return of residents to their homes and communities and has constructed ten pilot homes in Harris County and ten pilot homes in Galveston County.

Participation in the pilot program was voluntary and limited to low-to-moderate-income households that are eligible to participate in Ike Disaster Recovery owner-occupied and single-family housing programs. The construction is phased to simulate the phases of disaster relief and recovery funding following a natural disaster. The two-phased strategy includes placement of a core unit (consisting of a living area, kitchen, bedroom, and bathroom) on the original home site that meets short-term housing needs followed by a build out of additional living space (bedrooms and bathrooms) to achieve a complete home. Both phases of the home meet all building regulations, and provide high quality, durable, appealing housing acceptable to the local jurisdictions and communities.

H-GAC met with local government staff in Harris and Galveston counties to identify policy barriers to deployment of the phased housing and gauge interest in program participation. In addition to local governments, the Back Home program engaged the public to solicit feedback on the types of housing that would be preferred if disaster struck. The program also sought input from the public and local government staff on the housing's design. In partnership with Tegrity Homes, Home Innovation Research Labs, and Architend, H-GAC developed a prototype unit, which served as a model for the pilot homes.

This report explores the processes undertaken to develop the design of the Back Home, from research into existing disaster recovery programs to the final design. The report also outlines the policy and programmatic barriers in the region and the state to the rapid deployment of disaster recovery housing and provides suggestions of how these challenges can be overcome. The report concludes with an analysis of policy barriers to the rapid deployment of permanent housing in the event of a disaster. The appendices provide construction specifications, plans, design standards, and renderings.

Background

Hurricane Ike as seen from the International Space Station, September 10, 2008 (Source: NASA)

Hurricane Ike

On September 13, 2008, Hurricane Ike made landfall over Galveston, Texas, as a Category 2 Hurricane with sustained winds nearing 110 mph. A storm surge of up to 20 feet hit the shore, inundating entire communities along the coast. Hurricane Ike caused an estimated $29.4 billion in damages to the Texas Gulf Coast, which is still recuperating from the losses. Estimates from cities and counties in the areas impacted by Hurricane Ike indicate approximately $3.4 billion in total housing damage. Some communities were disproportionately damaged. In Gilchrist, on the Bolivar Peninsula, only one home was left standing after the storm. Many of the homes that were destroyed or damaged along the Galveston Bay were 1960-1970's vintage homes that were constructed prior to current floodplain regulations and the adoption of the International Residential Code windstorm standards. Homes that were elevated above the flood plain and constructed to current windstorm standards generally escaped the devastation visited on older homes. Overall, the region lost over 8,000 housing units due to the storm.

Background

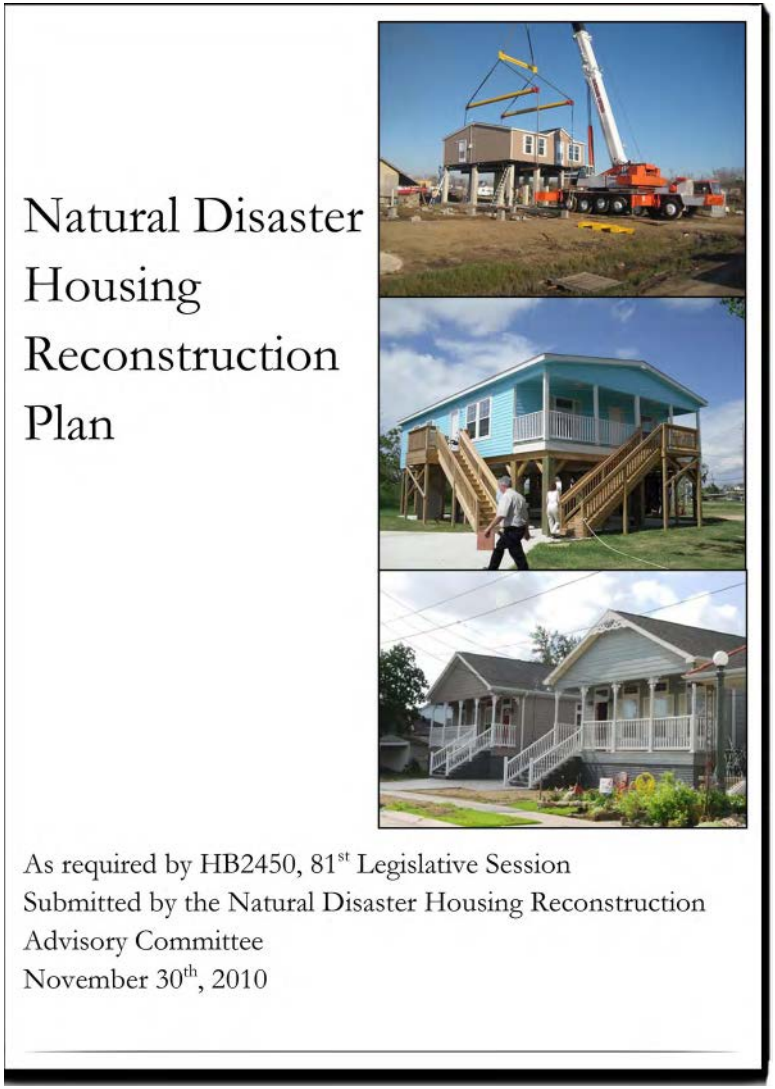
Legislative Response

On May 26, 2009, the Texas State Legislature passed House Bill 2450 creating the Natural Disaster Housing Reconstruction Advisory Committee, charged with developing the Natural Disaster Housing Reconstruction Plan. The legislation outlined the requirements for the plan including the following:

- Evaluate existing systems of providing temporary housing to victims of natural disasters and develop alternative systems to increase efficiency and cost-effectiveness
- Evaluate existing models for providing permanent replacement housing to victims of natural disasters
- Design alternatives to existing models to improve the sustainability, affordability, desirability, and quality of housing rebuilt in the event of future natural disasters
- Evaluate economic circumstances of elderly, disabled, and low-income victims of natural disasters and develop models for providing affordable replacement housing
- Recommend programs for the rapid and efficient large-scale production of temporary and permanent replacement housing following a natural disaster
- Encourage the participation, coordination, and involvement of appropriate federal organizations

The bill concludes (in Section 2036.542) with the establishment of a housing reconstruction demonstration pilot program: "to encourage the development of a model plan for future reconstruction efforts to increase the effective and efficient delivery of natural disaster housing recovery services by state agencies."

Background



Cover of Natural Disaster Housing Reconstruction Plan

Natural Disaster Housing Reconstruction Plan

The Natural Disaster Housing Reconstruction Advisory Committee, created by the Texas State Legislature and composed of government, non-profit, and private sector representatives, held meetings and three community roundtables to get a clear understanding of current housing rebuilding activities. Based on this research, the committee formulated a set of recommendations that became the Natural Disaster Housing Reconstruction Plan, released on November 30, 2010. The Natural Disaster Housing Reconstruction Plan examined a variety of post-disaster housing assistance/recovery strategies and programs undertaken by Federal Emergency Management Agency (FEMA), US Department of Housing and Urban Development (HUD), and by state and local government entities to analyze the models that worked and to understand the reasons why other programs failed.

The plan contains conclusions regarding temporary housing, permanent housing replacement; design alternatives; the condition of elderly, disabled and low-income storm victims; and federal involvement and concludes with 23 policy recomendations to be established before a natural disaster strikes and recommendations for immediate and long-term recovery following a natural disaster.

Background

Grantee Organization

H-GAC provides planning programs in most areas of shared governmental concern. With the oversight of GLO, H-GAC serves as the regional administrator of the HUD's Community Development Block Grant for Disaster Recovery (CDBG-DR) program in some of the Texas counties affected by Hurricane Ike: Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Matagorda, Montgomery, Waller, Walker, and Wharton. H-GAC was charged with creating a pilot program for rapid housing recovery under Round 2 of the CDBG-DR in Harris and Galveston counties.

To the left is a map of the 13-county H-GAC region, with an inset map of representing the region's relation to the rest of the State of Texas.

Background

Program Design

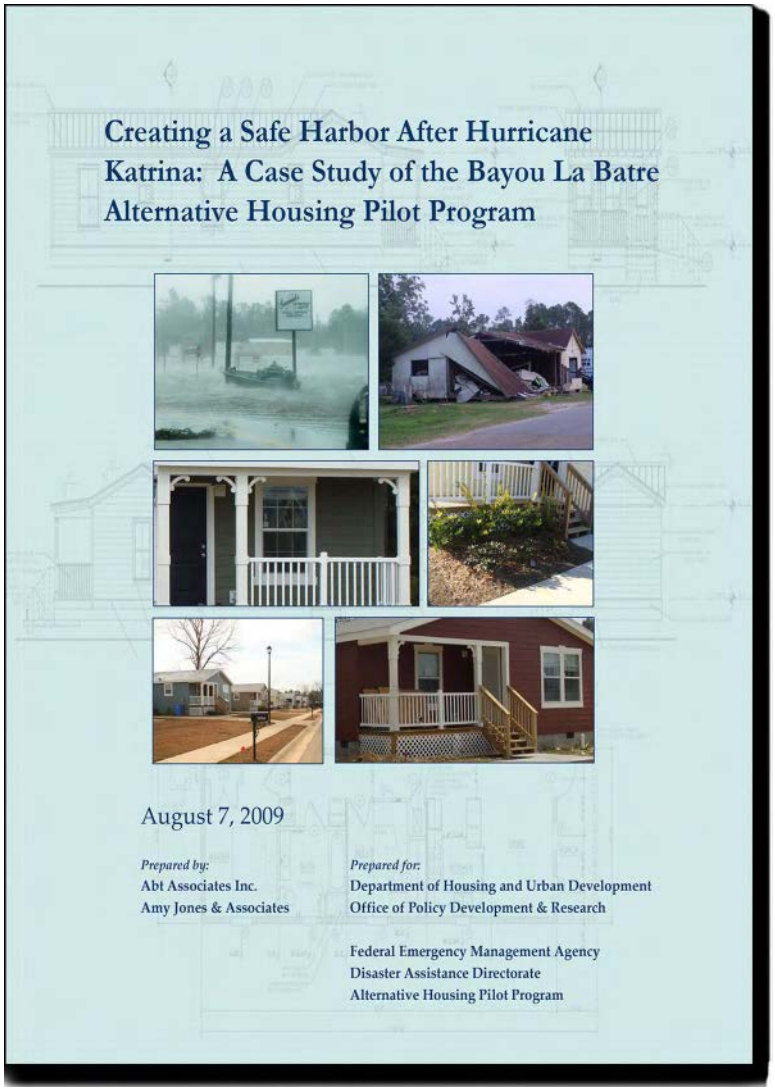
The Back Home program's goal is to test the feasibility of implementing "the large-scale production of replacement housing for victims of federally declared natural disasters." The program began by coordinating with FEMA to discuss the feasibility of deploying permanent housing following a natural disaster. H-GAC then engaged the region's Hurricane Ike Recovery Committee to present the goals and scope of the Back Home program and gather feedback. The next step was conducting research into existing successful rapid housing recovery programs, including the Bayou La Batre Alternative Housing Pilot Program (Alabama) and the Mississippi Alternative Housing Pilot Program. This research provided the basis for the questions asked during the interviews H-GAC conducted with local government staff in the cities of Baytown La Marque, La Porte, League City, Houston, and Santa Fe; as well as Galveston and Harris counties. These interviews provided insight on policy and regulatory barriers to constructing this type of housing in the region.

When the interviews were completed, a Request for Proposals was issued to find a partner to develop the design of the Back Home program. Once a team was selected and contracted, a series of public forums were conducted to understand the community's preferences for recovery housing, including the housings architecture, features and finishes, and layout. These findings were taken into consideration by the Back Home's architects, who produced an initial design. The initial design served as the basis of a work session with local government officials who provided feedback. With this feedback, the design team produced plans for the prototype home, which was constructed to test the feasibility and performance of the design. The public, including potential applicants, local government officials, and the media were invited to view and tour the prototype. With their feedback, and additional insight from the design team, a final design was produced.

Existing Programs Research

Research for the Back Home program began with H-GAC reaching out to the FEMA to discuss how permanent housing could be deployed after a disaster. FEMA provided insight into their past efforts in developing a rapid housing program, including the Bayou La Batre Alternative Housing Pilot Program and the Mississippi Alternative Housing Program.

Example of a home built as part of the Bayou La Batre Alternative Housing Pilot Program (Courtesy of Amy Jones & Associates/Janet Pershing)



Cover of Creating a Safe Harbor After Katrina: A Case Study of the Bayou La Batre Alternative Housing Pilot Program

Bayou La Batre Alternative Housing Pilot Program

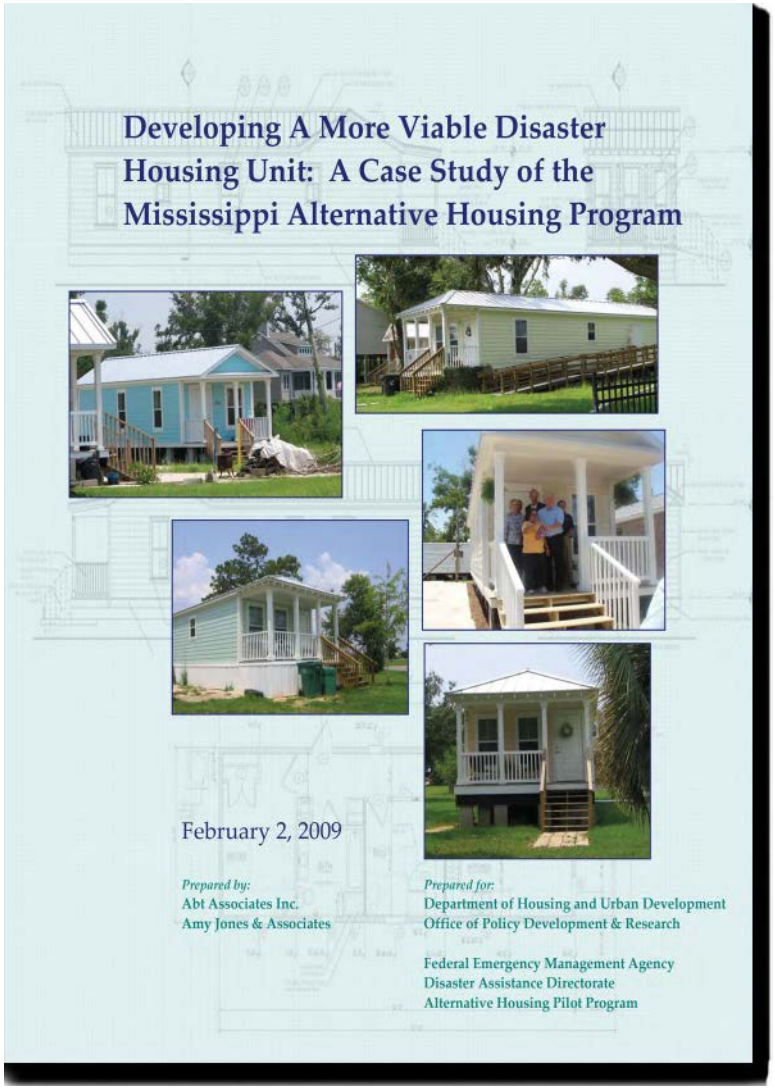
The Bayou La Batre Alternative Housing Pilot Program, was administered by the City of Bayou La Batre, Alabama, and focused on transitioning families directly from post-storm FEMA trailers to permanent housing. One hundred industrialized housing units were built in sites outside of the storm surge area; 90 were placed on permanent foundations, and 10 were designed to be re-deployable. The initial federal cost per unit was $180,000, which included land, infrastructure, unit construction costs, furniture, living kits, project management, and non-project related costs, such as attendance at grantee meetings and participation in program evaluation process. The manufacturer of the homes was Palm Harbor Homes. A key consideration in the production of this housing was on balancing quality with quantity.

The units were designed with wind-resistant siding and roofs and built to withstand winds up to 150 miles an hour. Additional features included mold- and insect-resistant construction materials, such as fiber cement siding for impact, wind, and insect resistance. Energy efficiency was also considered in the design, and the spray-foam used for insulation had the added advantage of increasing rigidity and locking wallboard and studs together. The housing ranged in size from one bedroom and a den units to four-bedroom units; from 820 to 1,360 square feet in size.

Existing Programs Research

The unit size allocations were based on HUD occupancy criteria. To reduce the per-unit cost, the design was changed. The houses went from two full baths to 1¾ baths. The roofing material was changed from standing seam metal to fiberglass shingles. The appliances were downgraded to basic models. The heights of the foundations were lowered, which allowed for the addition of a side door. Costs were further reduced by not providing design choices in terms of interior options, exterior color, or porch design.

One of the greatest challenges of the program was maintaining positive relationships with the surrounding community. The community was skeptical about the housing's quality as it is difficult to remove the stigma of homes that arrive on wheels. To overcome these barriers, the project team conducted outreach by providing a model home, giving community members a chance to see and touch the units. Regular outreach and open lines of communication to the neighbors of the subdivision where the homes were being constructed was maintained. The team found that door hangers were an effective method of communication. Other challenges encountered included contracting issues, weather, approvals, environmental review, procurement requirements and competitive bidding, impoundment of units during transportation, manufacturing, adjusting the specification, and UFAS (Uniform Federal Accessibility Standards) designs. Meeting UFAS requirements was one of the more difficult challenges the team encountered. The team was familiar with Section 504 requirements, but not UFAS.



Cover of Developing A More Viable Disaster Housing Unit: A Case Study of the Mississippi Alternative Housing Program

Mississippi Alternative Housing Program

The State of Mississippi received a grant from HUD to develop and install 3,500 housing units. Designs for the Mississippi Alternative Housing Program (MAHP) homes were based on a planning and design process that was completed soon after Hurricane Katrina. Ultimately, the program produced four home plans. The Park Model, a 396 square-foot, one bedroom, is a direct replacement for the FEMA travel trailer. The two and three bedroom Cottages, ranging in size from 728-840 square feet, came in three designs: the standard model, a handicapped-accessible model, and an eco-cottage with enhanced energy efficiency features.

The Park Model is larger than the FEMA travel trailers and offers advantages in structural design and internal layout, with separate bedrooms and a full size bathroom and kitchen. The cottages are similar in size to traditional mobile homes, but have enhanced quality and durability features and meet higher construction and design standards. Approximately 20 percent of the cottages were designed and constructed to UFAS standards. All models were installed to withstand 150 mph winds. The installation was phased to simulate a post-disaster scenario, from a temporary foundation to permanent piers. The program was designed to be temporary to permanent housing from the outset.

Example of a home built as part of the Mississippi Alternative Housing Pilot Program (FEMA/Jenifer Smits)

Existing Programs Research

Mississippi Alternative Housing Program

The housing was initially provided as temporary housing and then was sold to eligible households, where permitted, or transferred to affordable housing organizations. Due to the volume of housing created, the program was able to create a measure of competition among housing manufactures. At its peak, the program received and installed more than 400 units per month. Although far higher volumes of housing units would be required after a large-scale disaster, this volume suggests that manufactures of industrialized housing can quickly mobilize to meet the demand for housing. The project met with resistance because of the stigma associated with manufactured housing and made the observations about the community acceptance of these homes. The team noted that as more time passed after the disaster local jurisdictions become less willing to waive zoning and permitting processes. Local leaders were influenced by some vocal community members who felt the temporary housing period had gone on long enough. Perceptions about undesirability of trailers and Manufactured Housing Units (MHUs) created resistance to the units. More rural jurisdictions had less restrictive regulations and were therefore easier locations to construct the units. Mississippi Emergency Management Agency executed MOUs (a difficult and time consuming process) with local jurisdictions detailing how cottages would be used, which also helped maintain contact with local governments. The report listed the following recommendations for project implementation:

• A strong, comprehensive communication strategy for local officials and the public is needed. Bringing together political representatives and program staff of each local jurisdiction in a workshop session may be helpful approach.

• Agreeing on unit designs and occupancy policies in advance of a disaster will help foster a sense of control and mitigate future community resistance.

• Future programs should incorporate a stronger human services strategy.

• Group sites met the most resistance. MAHP staff worked with local governments to maximize use of spaces available in commercial mobile home parks.

The MAHP conducted an evaluation of its program based on three questions:

- How viable and livable are the MAHP units, and how did they affect quality of life for those who lived in them?
- How did MAHP's approach to the project and organizational capacity affect implementation and participant outcomes?
- How were units accepted by community stakeholders, and to what extent did community response affect program implementation?

Based on these questions, the Mississippi program made the following recommendations for future programs:

• Technical and quality requirements for units should be established in advance of a disaster

• Unit designs should consider both temporary and more permanent uses

• Emergency housing providers should carefully consider how many different types of units are optimal

• A methodology is needed for determining when enhanced temporary housing units are needed

• Right-sizing of units is an important quality of life consideration

• Many program participants need training on unit features and amenities, such as smoke detectors and microwaves

• A strong, comprehensive communication strategy for local officials and the public is needed

• Pre-disaster planning should include strategies for addressing short- and long-term temporary housing and the use of modular units that could transition to permanent housing

• A combination of disaster response, disaster recovery and affordable housing expertise is needed to successfully administer a similar program

• Future programs should incorporate a stronger human services strategy

Left: Examples of a homes built as part of the Mississippi Alternative Housing Pilot Program (Courtesy of Amy Jones & Associates/Janet Pershing)

Community Interviews and Meetings

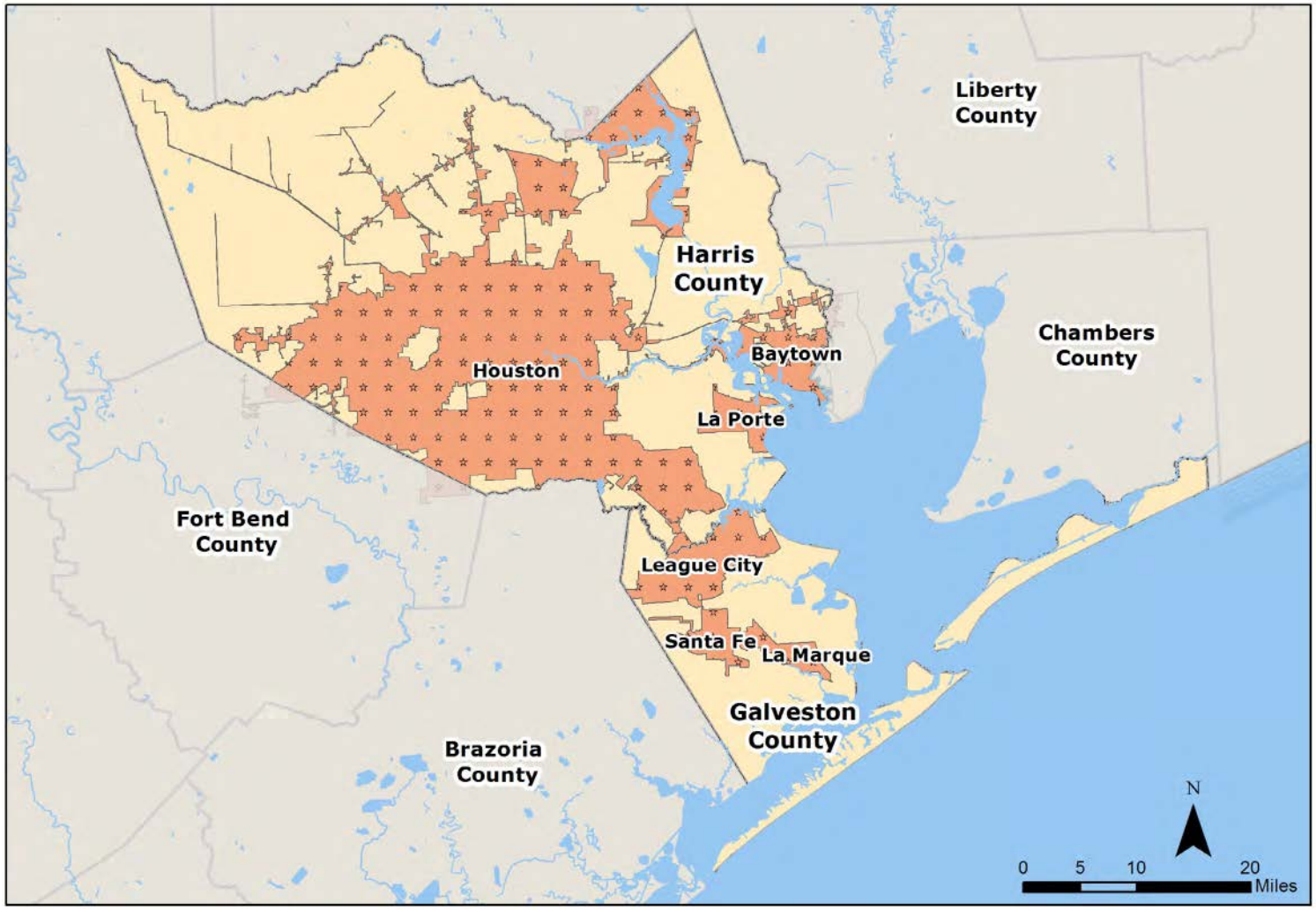
After reviewing the lessons learned by other disaster recovery housing programs piloting temporary to permanent disaster recovery housing, H-GAC began conducting the Back Home program with in-person interviews with local government staff from communities affected by Hurricane Ike to identify potential hurdles to deploying temporary to permanent housing and to understand housing municipal standards and ordinances. H-GAC conducted interviews with staff from Galveston County, Harris County, the City of La Marque, the City of Houston, the City of League City, the City of Baytown, and the City of Pasadena. The questions sought to determine what housing issues were still affecting the community in the wake of Hurricane Ike, gauge the need for this type of housing, and determine what local policies would impact the delivery of the Back Home program housing. These communities were in the midst of housing recovery efforts for Hurricane Ike and were able to provide valuable insight into the state of recovery in their jurisdictions.

While each community had their own issues and concerns regarding disaster recovery housing, there were commonalities among the various jurisdictions. Low-to-moderate income (LMI) populations were particularly affected by Hurricane Ike. Many of these homeowners had pre-existing issues that were exacerbated by storm damage. Another commonality was the complaints received from residents regarding the long-term deployment of FEMA trailers. The interview summaries are presented in the order they were conducted. Based on the interviews, H-GAC coordinated closely with the jurisdictions of the City of Baytown, the City of La Marque, Harris County, and Galveston County on the housing design; because they were the most receptive to the idea of having the Back Home program construct homes in their jurisdictions.

Galveston County

Hurricane Ike made landfall directly on Galveston Island. The LMI population of Galveston County (and the region) was disproportionately impacted by the hurricane. Generally, their homes were older and harder to maintain, further exacerbating the storm damage. A major obstacle in the recovery process was the ability of applicants to obtain the documentation needed for program eligibility. In addition to the issue of documentation, the LMI population had difficulties returning to their communities due to the unsafe conditions of the housing, local business closures or layoffs, damage to temporary housing including hotels and apartments, the time that was needed to set up the administration of the recovery program, and problems with contractors. About five percent of the LMI population in the county was living in manufactured housing units (MHUs). The policy barriers identified for disaster recovery housing included minimum lot sizes, garage requirements, masonry ordinances, Home Owners Associations, and local building codes.

Map of Community Interviews



The above map illustrates the jurisdictions (with municipalities in patterned and counties in yellow) where the community interviews took place

Community Interviews and Meetings

Galveston County

The cost of elevating homes on pilings and providing ramps or elevators can nearly double the cost of constructing a home. Galveston County recognized there is an immediate need for housing to keep people in the community. The coordination of disaster response amongst the agencies at the state, regional, and local level was difficult, and there is no standardization of programs among the different governments. The County noted it may be difficult to convince local governments to build industrialized housing along the coast given the damaged suffered by these MHU's after the storm. The County had the following questions regarding how this program would be implemented beyond the pilot program after a disaster:

- Would there be a duplication of benefits?
- If a resident receives a core unit, will they automatically qualify to receive a build-out?
- Will the eligibility requirements be the same as the other disaster recovery housing programs?
- Who will insure these homes?
- Will the lot sizes of the LMI population be large enough to build these homes?
- How do you determine when the housing will go from temporary to permanent?

City of La Marque

The City of La Marque has an ordinance that allows for modular homes. The city also has ordinances that regulate the minimum lot size, parking, and landscaping. The City of La Marque's biggest challenge in disaster recovery is the economic recovery. The City has a small tax base, and the poor performance of the local school district condition makes it difficult for the City of La Marque to attract and retain residents. However, La Marque did have an increase in households who moved into the city after Hurricane Ike, mostly from Galveston island. At the time of the interview, temporary FEMA trailers were still in use by some households, which caused a negative perception of disaster recovery housing in the community. Staff acknowledged that there was a need to educate the community about the difference between industrialized/modular housing and MHUs.

City of La Porte

The City of La Porte experienced significant damage to its housing stock. More than 500 of the community's homes were under water after Ike, and about 4,000 homes were damaged. The units owned by the LMI population were the most heavily impacted. Three homeowners abandoned their properties, and the City was unable to contact the owners after the storm. The deployment of FEMA trailers throughout the city, many for several years, generated complaints from the community. The homes that were uninsured received a quicker response from FEMA than those that were insured. Many impacted homes throughout La Porte will require significant elevation. The City implemented a registration program for all contactors, which received a positive response.

City of Santa Fe

The City of Santa Fe uses the State of Texas ordinance for modular housing. Like the City of La Porte, the long-term deployment of FEMA trailers caused complaints from the community. The City of Santa Fe suspended the ordinance that allowed FEMA trailers. Only one house had been reconstructed by the disaster recovery housing program in the Santa Fe by the Galveston County disaster recovery program for single-family home-owners. Many of the residents of Santa Fe work in nearby Texas City. Santa Fe, like La Marque, gained residents after the storm. The majority of the LMI population own their homes. Santa Fe has a minimum lot size ordinance of 7,500 square feet for single-family residences. Santa Fe waived construction permit fees during the first six months after the storm. The community received the support of volunteers that aided in disaster recovery by serving meals, removing debris, and making repairs; churches allowed RVs to use their parking lots to aid in disaster recovery. The City would prefer the construction of permanent housing to FEMA trailers after the storm.

City of League City

League City gained 2,000 to 3,000 residents after Hurricane Ike. The City has an ordinance prohibiting industrialized housing within the city, and would anticipate significant community opposition to modular or manufactured housing. There is some desire within the community for "Katrina Cottage" type disaster recovery housing, and City staff noted that there could be some opportunity with the historic district to build this type of housing if it was

Community Interviews and Meetings

City of League City

tailored to the neighborhood. League City had a total of 13 FEMA trailers after Ike, with a strict time period of one year, and routine inspections were performed. After one year the FEMA trailer had to be removed. The City proactively anticipated the need for, and opposition to, disaster recovery housing and found that too often the housing is the lowest common denominator. Education of residents about the potential for high quality industrialized housing after a storm would be needed to avoid significant community opposition.

City of Houston

The City of Houston residents had difficulty returning to their communities because of unsafe housing, school closures, business closures, layoffs, and delays in repairing and reconstructing homes. One of the regulatory issues for disaster recovery housing in the City of Houston is the deed restrictions. There are approximately 20,000 deed restrictions in Harris County; and no centralized database of those deed restrictions. It is difficult to determine which of those restrictions would prohibit industrialized housing, but generally they regulate minimum square footage, materials, height, and architectural style. Houston has minimum lot size standards and occupancy standards and building codes, but no zoning restrictions with the exception of two neighborhoods.

City of Houston staff had the opinion that community members would have concerns about the deployment of modular disaster recovery housing, particularly if design did not fit in with the prevailing style of the community. This is especially the case in areas where brick siding predominates. The interviewees noted that disaster recovery housing needs to be built in areas that outside of flood zones. In Houston, the LMI population is 53 percent homeowners and 47 percent renters. Following a disaster, expedited permitting would be difficult, but could possibly be done with pre-planning. There were community complaints about the use of tarps as temporary roof repairs long after the storm, and complaints about the placement of FEMA trailers.

Community Interviews and Meetings

Harris County

Harris County had an ongoing need for disaster recovery housing, with 786 applicants for housing. At the time of the interview there were still FEMA trailers in the most flood-impacted areas. The County acknowledged some of the difficulties in disaster recovery including the length of time the process takes, poor communication and messaging, and a lack of continuity of staffing at the state level. The LMI population was disproportionately impacted by Hurricane Ike; many homeowners lacked insurance and had pre-existing deferred maintenance issues with the housing. Harris County gained population after the storm with residents displaced from Galveston County. Harris County identified the following regulatory barriers to industrialized housing: deed restrictions, minimum lot sizes, occupancy standards, building codes, and zoning regulations that prohibit manufactured housing. The biggest challenge to acceptance by the community is the appearance of the housing. The final quality of the product is essential as well and should be tightly monitored. The housing must have the elevation appropriate to its location and fit in with the community.

City of Baytown

Baytown experienced significant damage to its housing stock during Hurricane Ike, especially in the area adjacent to Galveston Bay. Baytown no longer had any FEMA trailers at the time of the interview. The major housing issue facing the community after Ike was the difficulty and length of time it took to rebuild or repair homes in the area. The LMI population was not as disproportionally impacted as in some other communities in the region as many of the waterfront and water adjacent homes were occupied by non-LMI households. The community still had homeowners in need of disaster recovery housing, concentrated in a few neighborhoods that were both LMI and adjacent to the waterfront. Baytown has deed restrictions, minimum lot sizes, occupancy standards, building codes, and zoning that prohibits manufactured housing in certain areas. The City also has masonry requirements and architectural standards. Baytown was concerned with the length of time that the FEMA trailers were deployed in the community. Staff noted that permitting could be completed ahead of a natural disaster with a "batch permit" that could then be applied to specific lots, speeding the recovery process.

Community Interviews and Meetings

In addition to the community interviews, H-GAC staff presented to the City of Galveston's City Council. As a low-lying barrier island, Galveston was disproportionately affected by Hurricane Ike, and Galveston has faced challenges in rebuilding its housing stock after the storm. The presentation to the Galveston City Council explained the goals of the program and process by which H-GAC will construct ten pilot homes in Galveston County. H-GAC also noted its aspiration to construct at least one of the pilot homes in the City of Galveston. One of the city council members was concerned about modular home construction in the city. Overall the City Council was receptive to the construction of a pilot home on the island and encouraged H-GAC to coordinate closely with city staff in the planning department to determine where the housing could be built in the city.

Damage from Hurricane Ike was most extensive in coastal Galveston County. (Source: FEMA News Photo Library)

Analysis of Policy Barriers

There are numerous policy barriers that have affected the rapid re-housing of homeowners participating in the Back Home program. These include the following: masonry requirements, garage requirements, minimum square footages, industrialized housing ordinances, zoning ordinances, 'grandfathered' properties, landscaping requirements, unsuitable site conditions, permitting requirements, code compliance, historic districts, Home Owners Associations, deed restrictions, and occupancy standards. Each of these statutory barriers slows housing recovery.

Masonry ordinances are popularly employed to maintain the character of a neighborhood. Masonry is prohibitively expensive to transport due to its inherent weight and is not typically employed in modular construction. Masonry requirements prohibited the construction of the Back Home in portions of one municipality, as the cement-fiber siding did not meet the requirements. In another jurisdiction, the masonry requirements were satisfied by constructing a masonry veneer from the soil line up to the porch. Neighborhoods with masonry ordinances typically employ architectural styles that differ from the Back Home's design.

One of the municipalities in the project area had a garage requirement; every rebuilt home, requires at least a one car off-street garage. The garage was outside of the scope of the Back Home program, and the project team attempted to apply for a variance to this requirement. The zoning board of appeals rejected the application for a variance on the premise that without garages, the home prices of the neighborhood would be negatively impacted. Fortunately, a detached garage was permitted in the ordinance. If an attached garage was required, a significant redesign of the Back Home's plan would be required.

Some of the jurisdictions in Harris and Galveston counties have minimum square footage requirements for new construction. The core unit has a small footprint of 766 square feet. While the completed units range from 984 square feet (for a two bedroom, one bathroom unit) to 1,312 square feet (for a three bedroom, two bathroom unit), the core unit itself would not be able to be constructed under the current minimum square footage regulations in some municipalities. Some municipalities and neighborhoods have 1,500 square feet minimum standards, which would prohibit the construction of this type of housing.

Several of the municipalities also have zoning regulations that prohibited the construction of modular housing outside of zones for manufactured housing, making no distinction between mobile housing units (MHUs), which are not attached to a permanent foundation, and modular homes, which are.

Analysis of Policy Barriers

According to the Texas Department of Licensing and Regulation "a municipality may not differentiate between modular homes built under the Texas IHB program and site built homes." The State regulations regarding industrialized housing trumps local statutes, but the process of formally gaining permission from a municipality that believes they have a valid ordinance prohibiting industrialized housing in areas zoned for single family can be time consuming.

In some jurisdictions in the region, housing replacement is not possible because the zoning ordinance has changed the permitted usage, no longer allowing single family residences. In one municipality, the program had a qualified applicant with storm damage, but we were unable to replace their home because the zoning had changed from single family to light industrial. Landscaping requirements have not prohibited construction of homes in the program, but add cost to make the program compliant with local regulations. Some homeowners, even if they qualify for the program, cannot have their housing replaced because of unsuitable site conditions. For example, some city lots are too small for even the two bedrooms, one bathroom model of the Back Home. Some homes are on lots with well water and septic tanks. These lots need to be of sufficient size to house these systems. Some lots are oddly shaped, have easements or other encumbrances, and are simply not suitable for construction for a variety of other reasons.

While permitting and code requirements are to be expected, these requirements add to the cost of building the home and the time required to complete construction. Industrialized housing is designed to meet state codes and passes inspections on the factory floor. The various codes (fire, wind storm, building energy, etc), while necessary and desired, do create additional cost to the final product. The time that it takes for local inspectors to visit and approve the construction as per the permitting and code requirements also adds to the time needed to deploy disaster recovery housing. Permitting can also significantly delay the construction process; one of the municipalities has a permitting process that averages seven to nine months in duration.

Some of the neighborhoods where the Back Home is being constructed have historical district designation. The Back Home employs a vernacular architecture rooted in the local historical architectural tradition. However, modern materials (e.g. fiber cement, high efficiency vinyl windows) are employed that might not meet a historical district standards. The Back Home's design might have to be altered to comply with certain historical district standards, which increases the costs and time required to construct the homes.

Home Owner Associations can be fastidious and detailed in enforcing their neighborhood's standards. The HOA standards can regulate a wide range of activities, from flag poles to the color of roof shingles. The Galveston County housing program estimated that less than 2 percent of the homes

they have replaced are in areas with HOAs, so fortunately, the LMI populations that the Back Home program serves are often outside of these restrictions. More common in the region are deed restrictions. Like HOA regulations, deed restrictions can limit the type of homes constructed in a neighborhood. Deed restrictions, like HOA restrictions, are also designed to maintain the value of the homes in a neighborhood. Deed restrictions can take the form of conditions, covenants, and restrictions; the housing developer, builder, or home owner association can impose them. Deed restrictions, or HOA standards, would prohibit the construction of the Back Home in neighborhoods with a different architectural style (such as a subdivision of brick veneer homes with attached garages) written into their covenants. If the State of Texas wishes to create a rapid housing program using the Back Home design after a disaster, the State or municipal ordinances would need to be created to override these restrictions. Occupancy standards could affect the deployment of the core units. If a large family has their home destroyed and they receive a core unit as they are waiting for the additional build out modules to arrive, they might not meet municipal occupancy standards for minimum square feet per occupant. If the Back Home model is to be employed after a disaster, policy makers would have to create regulations and ordinances that would permit at least temporary occupation of more than the standard two persons per bedroom. The maximum size for a three bedrooms, two bathrooms, Back Home is 1,366 square feet. A large family, with more than six adults, could surpass the occupancy restrictions of two adults per bedroom.

Recommendations for Future Implementation

The Texas Gulf Coast will experience powerful hurricanes (and other disasters) in the future, along with the associated destruction of housing stock. This is especially true in communities along the shoreline. Preventing damage through the adoption of current building and windstorm codes, especially in unincorporated areas, can do more to enhance community resiliency than any home replacement program. Buying out multiple loss properties, prohibiting construction in the floodway, and requiring elevation in flood zones will also prevent loss and derogation of the region's housing stock. Even with these measures in place, housing replacement will be needed after a disaster, and deploying homes rapidly to speed community recovery should be a disaster recovery policy priority.

Recommendations for Future Implementation

The use of modular technologies could speed the process of rapid housing recovery if policy makers are able to streamline or eliminate the other constrains that impede the timely deployment of disaster recovery housing. Policy makers at the state level would have to address the following constraints to rapid recovery: 1) override local regulations that prevent or delay the deployment of disaster recovery housing (Analysis of Policy Barriers section of this document), 2) fund the construction of the homes in an expedient manner, 3) negotiate with home manufactures to reduce the per unit costs, 4) streamline the process of identifying eligible homeowners, and 5) streamline and coordinate the process for utility connections.

Local Regulations

Local housing regulations have been created to preserve the health and safety of communities, and ensure the protection of the value of the housing stock. If policy makers were interested in adopting the Back Home model as a standard disaster recovery home, they would need to pass laws at the State level to supersede local restrictions to building the Back Home as identified in the Analysis of Policy Barriers section of this document. If such a law is implemented, the Back Home could still face community opposition, specifically because it would flout local conventions. Government funded and modular housing both have the perception of being inferior and driving down the value of homes in the neighborhood. Even though the Back Home was designed with local architectural heritage as a key consideration, it would still not be consistent with the architectural standards found in many newer neighborhoods in the region. Overriding these local controls would be contentious.

Federal Funding of Disaster Recovery Housing

The division between immediate disaster relief and long-term recovery is the current federal paradigm for response to disasters. These tasks are currently divided between two federal agencies, FEMA and HUD. The funding for disaster recovery is then passed from federal agencies through state agencies, then to local agencies, and finally to contractors who build the homes. The expediency at which funding can pass from the government to builders will track with the expediency at which housing is constructed. The delay between the declaration of a disaster and authorization of spending by Congress to the time that builders are funded to construct homes is far greater than any time savings that modular technologies can provide. The cost of building the Back Home is greater than the cost of an equivalent production tract home in the region.

The Back Home program is designed to deliver disaster recovery housing in two phases: a core unit that can be deployed immediately following the disaster and additional modules that can be added as financing, funding, or insurance proceeds become available. While this model mirrors how disaster recovery is funded, it adds significantly to the cost of the home. The Back Home has the additional cost of transportation.

Recommendations for Future Implementation

The Back Home core unit is not a replacement for temporary housing; it cannot be deployed without a foundation, and is not independent of municipal utilities. It is more cost efficient if the entire home (core and build out modules) are transported and constructed at the same time. Additional saving cost savings could be made if purchasing the homes at scale.

Applicant Intake

The time spent identifying and qualifying applicants is a significant impediment to rapid recovery. Qualified homeowners often to not know which of the myriad government agencies is responsible for disaster housing, how to contact them, or how to begin the process of qualifying for a home. It is essential that they be provided with both a telephone help line and a website where they can request assistance, and that both of these resources are widely publicized in the region. These resources should be state-wide, and not divided amongst the various sub-recipients involved in disaster recovery housing. It should be incumbent on the correct sub-recipient to respond to those in their jurisdictions who contact the State, not incumbent on the homeowner to find the correct program for their jurisdiction.

The documentation a homeowner needs to provide in order to qualify to have their housing replaced is extensive. In the wake of a disaster, residents often face the far more immediate needs of finding adequate shelter, food, and water to meet their basic survival needs and are unable to provide documentation needed to qualify for the housing program. Often personal records are destroyed along with the home during the disaster. It would greatly benefit area residents if there was a toolkit that aided in the preparation and safe storage of the documentation needed to qualify for Federal and State disaster recovery programs. Hurricane preparedness public service announcements and emergency evacuation messaging should include encouragement to the public to retain documentation in the event of a disaster. Huricane Federal, State, and local agencies could significantly hasten the process of qualifying homeowners by coordinating access to applicants' financial and personal information. If the agency in charge of qualifying homeowners had immediate electronic access to applicants' tax returns, county tax data, social security data, and identification cards, it could significantly reduce the time it takes to qualify them as eligible.

Utility Connections

Utility disconnection for demolition and re-connection for inspection can take weeks, delaying the construction process. Additional delays can be created when a homeowner applies for utilities in their temporary residence while they are waiting for the delivery of their home. After Hurricane Ike, it took weeks to restore electricity in some neighborhoods in the region. Cutting off electrical service for demolition will not be the utility's top concern after a storm. The current process for disconnecting and reconnecting service is not straightforward; the State could work with utilities to make the process more efficient, especially after a natural disaster.

Contractor Selection

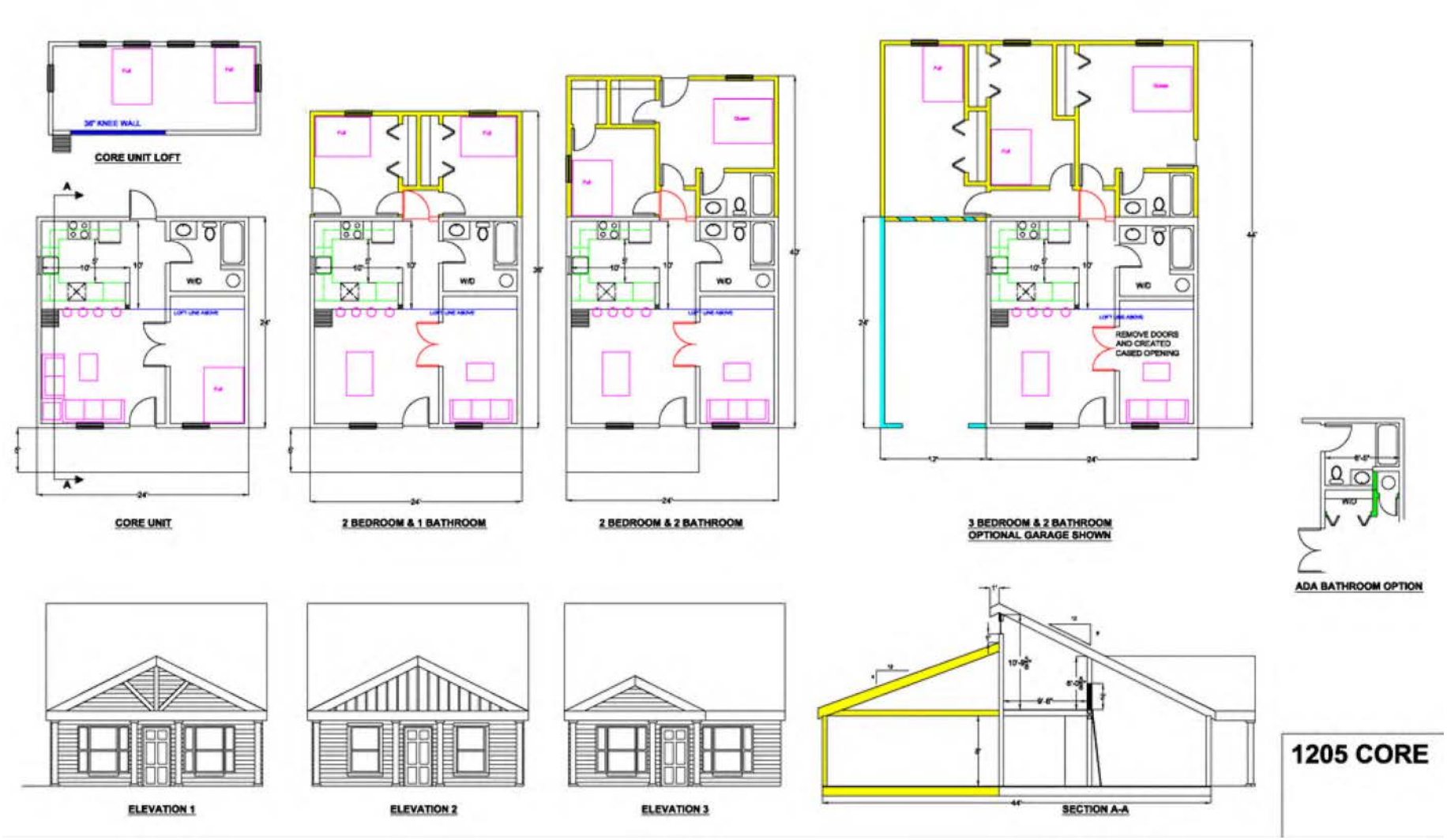
Cover of Tegrity Homes response to the Back Home Program RFP

With the knowledge gained in the conversations held with local governments in the storm impacted areas of Harris and Galveston counties, H-GAC staff developed and released a Request for Proposals (RFP) in January of 2014 to select a contractor to assist in providing innovative housing solutions to rapidly return the region's residents to their communities following a natural disaster. The RFP called for a contractor with public outreach, design services, and construction management experience. The proposals were evaluated on the respondent's capacity to perform, the initial design for a phased disaster recovery home, affirmative marketing requirements, the proposed cost of services, the organization's financial condition, references, key personnel, and related work experience. The scoring of the applications was competitive, and Tegrity Homes submitted the successful proposal to design and build the Back Home housing. Their proposal was developed in partnership with Home Innovation Research Labs, a subsidiary of the National Association of Home Builders. The distinguishing factor in the Tegrity's proposal was the initial design concept presented, which demonstrated their understanding of the phased approach that program required.

Initial Design

Two designs were submitted by Tegrity as part of the requirements of the Back Home RFP. The designs were created to conform with typical lot sizes and configurations found in Harris and Galveston counties. One design was for a 24-by-24-foot core and the other was for a 16-by-36-foot core unit. Each offered 580 square feet of initial, permanent living space on one level. Each core unit offered public area(s), a bath, a kitchen, and a bedroom. In this design, the kitchens could be specified to meet Americans with Disabilities Act (ADA) compliance within the shown footprints, and an ADA compliant bath option is detailed for each core unit. Each core unit provides for private bedroom, and the 24-by-24-foot design can accommodate an additional sleeping quarter or storage in the 240-square-foot loft accessed by a permanently fixed library ladder with handrail. The loft could be eliminated for an ADA compliant version, and a movable curtain in the common area would provide privacy for a sleeping quarter. The core unit designs were developed to incorporate affordable design with innovative details to promote energy efficiency and comfort with visually appealing exteriors and interiors which exceeded HUD's Housing Quality Standards (HQS) and current building codes. Yet, the core units remained sufficiently flexible for modification and usage should the design review process produce an alternative demand.

Initial Design



Floor plans and elevations of 24-by-24-foot initial design proposed by Tegrity Homes in their response to the Request for Proposals from the Back Home Rapid Recovery Pilot Program Request for Proposals.

Initial Design

Floor plans and elevations of 16-by-36-foot initial design proposed by Tegrity Homes in their response to the Request for Proposals from the Back Home program Request for Proposals.

Public Engagement

From the beginning of the program, H-GAC recognized the success of the Back Home program was predicated by the community's acceptance of the housing's design. Gathering public input on the design was a major component of the Back Home program design; open communication and feedback from community members was identified as essential component in the program's acceptance. The program adopted the Back Home branding to give it a unique identity to distinguish it from other disaster recovery housing efforts in the region. H-GAC developed a webpage for the program to better communicate with the public about the program. The webpage contained an online form to gather contact information from potential applicants and to address issues, which proved invaluable in identifying and qualifying potential applicants.

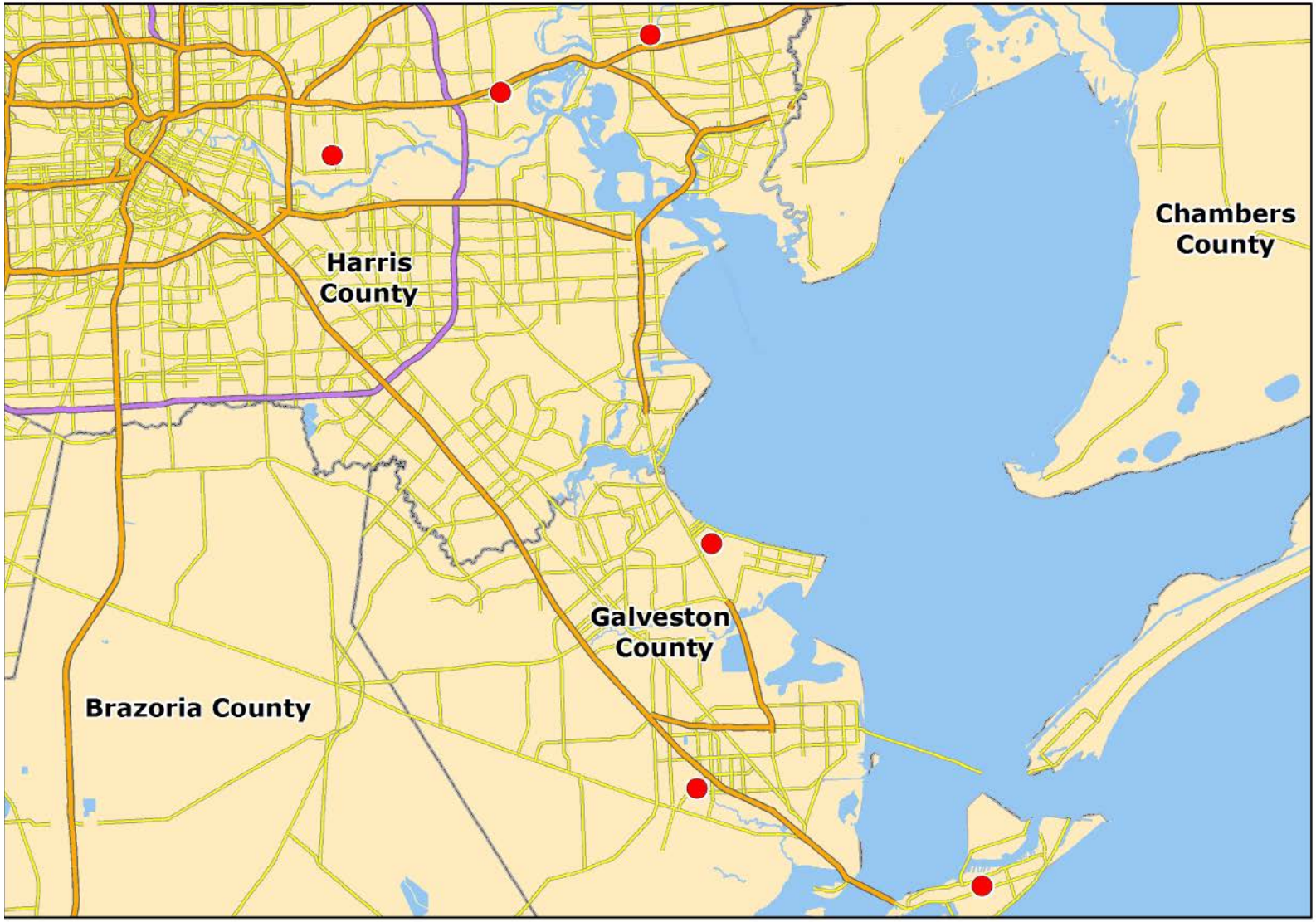
Back Home Public Forums

Committed to an iterative design process, the Back Home program team, consisting of H-GAC, Tegrity, Home Innovation Research Labs, and Architend, hosted six public meetings in June and July of 2014 throughout Harris and Galveston counties to gather feedback on housing design. The forums were held in communities that received the greater portion of the storm damage from Hurricane Ike: Galena Park, La Marque, Baytown, Bacliff, Channelview, and Galveston. The forums were held in community centers in the early evening to maximize the convenience of participation for residents. The events were promoted with press releases, newspaper advertisements, letters to elected officials, the program's website, email communications, newsletters, and posters and flyers placed in prominent locations in the community. The forums were designed to get in-depth, detailed input from the community on their preferences as well as to provide them with information and education on the program's goals and objectives. The public forums were formatted as a series of four stations that the participants passed through and provided feedback.

In the first station participants provided demographic information (age, gender, household size, household income, race and ethnicity, zip code) and information on the impact of Hurricane Ike on their housing (was their home damaged, were they displaced, how long, are they back in their home now). At this station, participants were provided with information on the program's goals and how the housing would be developed and were provided with an explanation of how to participate in the forum. The second station was a visual preferences survey, providing participants with photographs of different exterior elevations to gain insight into visual preferences for exteriors. Images included variations of elements such as entrances, colors, landscaping, siding, windows, rooflines, elevation, etc. Images were organized in groups of four, displayed on six different charts (24 images total). For each of the six charts participants provided feedback for each group of images on what they liked and disliked. This provided insight into elements that most strongly influenced perceptions and acceptance.

Public Engagement

Map of Public Forum Meetings



The above map illustrates the locations of the Public Forum Meetings, denoted by dots

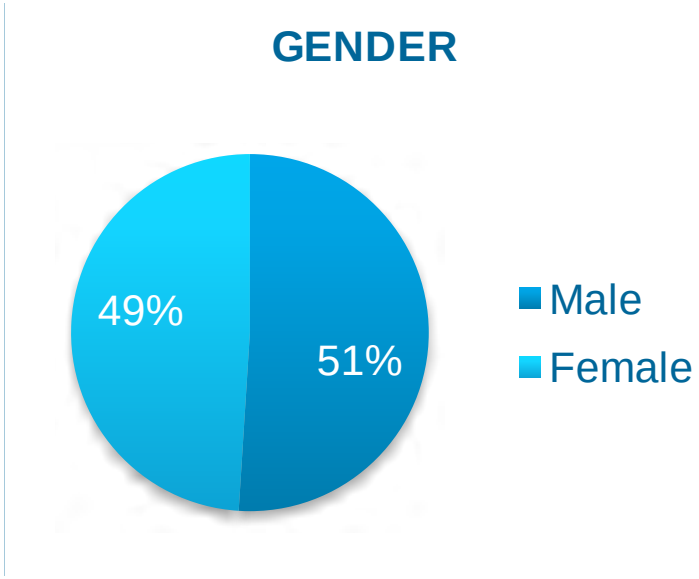
At the third station, participants were provided with a wall section that included a ductless mini-split air-conditioning system, a sink, a cabinet, a window, a cutaway showing the hardware, and a perpendicular wall showing diagonal bracing with note cards detailing design features. In addition to information of the proposed wall section, the participants were presented with a variety of hardware selections, flooring samples, and cabinet and countertop selections. The purpose of this station was two-fold. The first was to underscore the high quality of materials and construction details that were being considered for the homes. This was designed to help in overcoming existing perceptions the low quality of disaster recovery and industrialized housing. The second was to gather feedback on what the participants preferred in the Back Home's hardware and finishes.

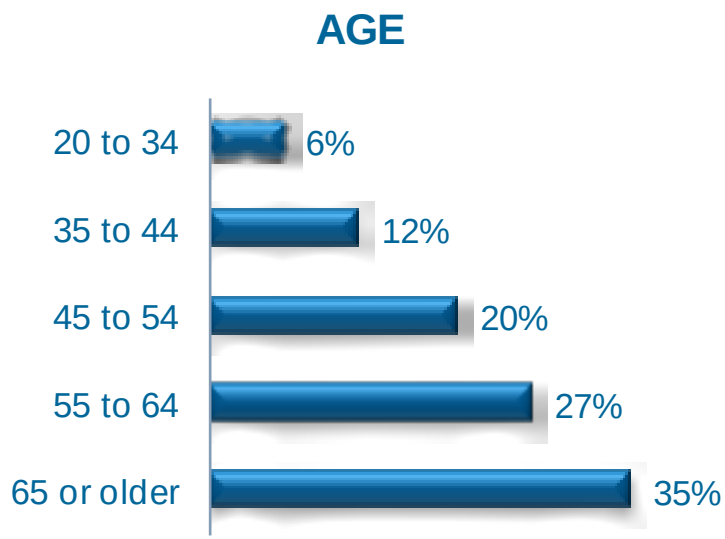
The fourth station provided participants with the opportunity to provide feedback on the layout of the core unit. They were first asked to select which core unit footprint they preferred, based on the initial designs for the core unit (a 24-by-24-foot or a 16-by-36-foot configuration). Based on their response, they were given an art-board scaled to represent the floor plan of the core unit. They were then given stick and peel decals representing the different elements in the core unit (furniture, kitchen appliances, and cabinets, etc.) and asked to lay them out on their floor plan. They were also surveyed as to their priorities in term of floor space. This provided information on how the potential residents would like to have the home laid out and which areas were higher priorities in terms of space.

(From left to right) A participant providing demographic information with the visual preferneces survey in the background, the features and finishes station, and a participant working on her ideal layout of the Back Home.

Public Engagement

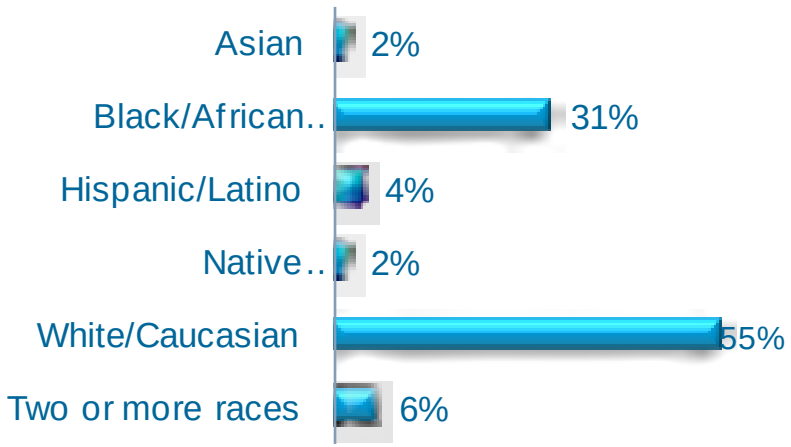
Results of the Public Forums



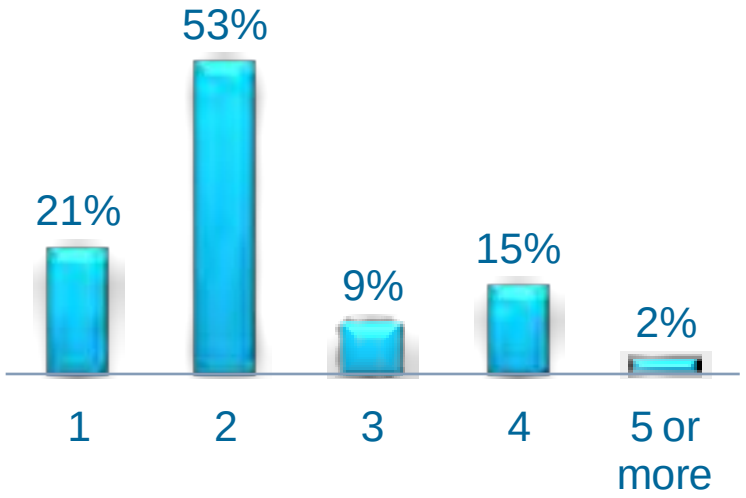


A total 52 participants completed the survey at the public forums. The participants in the forums were a mixture of local residents and disaster recovery stakeholders. The majority of participants received damage to their home from Hurricane Ike, and 41 percent were displaced from their homes as a result of the storm. While displaced, 56 percent lived with friends or family, and 19 percent lived in a rental units. The respondents were evenly split by gender. Over 60 percent of participants were older than 55. The largest group of respondents was Caucasian (55 percent), while African-Americans represented 31 percent of responses. Hispanics (4 percent) and Asians (2 percent) were underrepresented in relation to their proportion of the regional population. Most of the respondents (74 percent) were living in one-to-two person households. The household incomes were concentrated among those earning less than $35,000 annually (33 percent), and those earning more than $75,000 (41 percent).

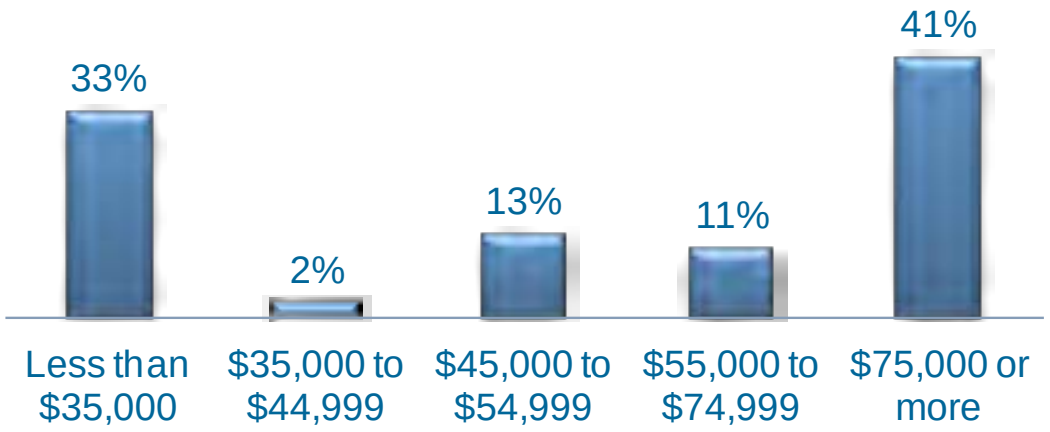
RACE/ETHNICITY



NUMBER IN HOUSEHOLD



HOUSEHOLD INCOME



Public Engagement

Results of the Public Forums

Analysis of the visual preferences survey reveals consistency in elements that influence receptiveness to the houses. Houses with integrated porches were preferred over homes with no porch or porches that appeared to be add-ons. In general, homes in which the architectural elements flowed well together to create a clean, up-to-date style had much stronger appeal than homes in which elements (e.g. columns, porches) did not match the overall style and/or appeared to be added on. Similarly, order within the architectural elements and the landscaping creates a sense of order and stability to the house. In contrast, architectural elements that are out of line or appear to be an afterthought, and landscaping that was overgrown or neglected turned people off because it gave the impression of disorder.

Protection from rising water is important to the area; therefore, houses that were elevated off the ground gave a greater sense of security than ones that were low to the ground. Homes in which the raised foundation was well integrated with the architectural style resonated well. Windows contributed to perceptions of spaciousness. Larger windows, double windows or a greater number of windows contributed to more open, inviting impressions. In contrast, smaller windows, fewer windows, dark/dull window trim, and window placement too close to the door contributed to impressions of the home being smaller, dated and/or weary/dull. Houses that appealed to participants the most had elements that created inviting impressions: covered entryways, integrated porches with railings, well maintained landscaping, clean colors and lines, and larger windows or more windows to allow in light. These houses created warm, inviting connections because they conveyed a sense of life and home. The neat, well maintained appearances gave a sense of stability, as well as being up to date. Covered entryways and raised foundations create a sense of protection from rain/water, which is important in the area.

At the features and finishes station, respondents were asked to give their preferences on which floor type and color, countertops color, and cabinet color they preferred. The participants preferred laminate flooring material for all rooms with the exception of the bedrooms, where carpet was preferred. Of the laminate flooring types, the imitation wood grain patterns were preferred by 74 percent of respondents. The darkest beige carpet color was preferred by 54 percent of participants. In the kitchen, there was no consensus on the color for cabinets, but over half (57 percent) preferred the lightest color of kitchen counter. For the hardware satin nickel was the preferred fixture finish for both the bathroom (65 percent) and the kitchen (61 percent). There was no consensus on interior wall colors. The majority (39 percent) preferred a light tan siding with white trim and a maroon front door. Many of the participants were not familiar with the ductless mini-split air-conditioner, but were responsive to the unit's size, look, and energy savings.

Public forum participants taking the visual preferences survey

Public Engagement

Results of the Public Forums

Participant at the La Marque meeting, developing his ideal floor plan for the Back Home

The space planning exercise demonstrated a preference for a larger public space within the house, with a preference for flexibility. Over 85 percent of participants preferred the side by side (24-by-24-foot) layout for the home. The core orientation, based on the location of the front door, suggested the longest (or widest) elevation face the street. The front door was positioned most frequently near the midpoint of the home. The space planning feedback suggested that homeowners prefer the bedrooms be stacked to one side of the home with the common living space of the dining, living and kitchen to the opposite side. The bedrooms were commonly split by a shared bathroom. Frequently, the common living space occupied over half of the floor plan in an open plan layout with entry into the living room from the front porch. Often, the kitchen provided an eat-in space or countertop, eliminating a formal dining area. Kitchens were frequently designed to include a kitchen island. Participants almost always included the washer/dryer as a side-by-side. Locations varied to include adjacent location/or closet to either the bathroom or kitchen, and rarely were placed in a separate room.

Integrative Design Meeting

To further refine and improve the Back Home's design, H-GAC hosted an integrative design work session was held in late August of 2014. The purpose of the meeting was to explore options to arrive at the best design solution possible based on the principals of integrative design. The goal of integrative design is to enable project team members to work together from the project outset to develop solutions that have multiple benefits. The work session brought together the project's architects, builders, and design consultants, and staff from local and county governments to discuss the project's guiding principles and design.

Guiding Principles

The meeting began by defining the guiding principles of the Back Home program, which guided the development of the design. Many of these principles were contained in both the RFP and Tegrity's proposal. This exercise allowed participants to formalize what the goals and objectives were in terms of the final design and establish priorities:

- *Quick Response*- The housing must be able to be quickly built and placed in communities once the storm debris has been cleared.
- *Lasting Quality*- The housing must be of a quality superior to typical new construction.
- *Permanent Solution*- The housing must be a permanent, rather than temporary, solution to house individuals and families after a disaster.
- *Functional Usability*- The housing must be practical, and provide adequate living, cooking, and sleeping spaces for a family being housed after natural disaster.
- *Safety*- The Texas Gulf Coast is susceptible to hurricanes and other natural disasters; the housing must be able to stand up to its designated wind speed and storm surge requirements for its location.
- *Durable*- The housing must be able to not only withstand natural disasters, but also be a low-maintenance home with fixtures and finishes that are tough and sturdy enough to withstand the wear and tear of everyday use.
- *Efficient*- The target population for the housing is LMI individuals and families, with a special emphasis on serving the elderly and disabled. This population does not have the means to expend a large portion of their resources on utilities. The housing needs to be as efficient as possible with respect to both the water and electrical systems.
- *Aesthetically Pleasing*- The architectural design of the housing must not only be functional, but must also consider the design's proportion, symmetry, balance, contrast, pattern, decoration, and massing in the final composition.
- *Innovative*- The housing should move beyond typical construction. The housing must resourcefully and creatively maximize the building performance while remaining affordable and replicable.
- *Wind Durable*- The housing must be able to withstand wind strengths of 110-130 miles per hour of wind speed depending on its location.
- *Inspirational*- The housing should inspire the community as responding to its environment and the resident's needs.

Integrative Design Meeting

Design Response

In addtion to the guiding priniciples, Architend's proposed design incorporated the following elements to enhance the performance and livaibility of the home:

- *Expandability*-The core unit must be able to accept addition build-outs. In this design the add-ons can be attached to three different sides based on the lot and the preferences of the homeowner.
- *Maximize Daylight*- The orientation of the building affects light that can enter the house. That is why four different elevations have been provided to maximize the penetration of daylight into the living areas. The North windows are up high, and South windows are down low, this allows for air captured low, released high; providing natural ventilation. The build out will be elongated on an east-west orientation (with assumed setbacks of 3, 5, 10, and 30 feet) to maximize daylighting.
- *Maximize Available Space*- The kitchen is 12' in length which, along with a built in booth (dinner style), allows for a front porch. The washer and dryer are designed to be stackable to maximize floor space. The loft area can be used for storage or an additional sleeping platform.

Participants in the Integrative Design Meeting reviewing the findings of the public forums

Integrative Design Meeting

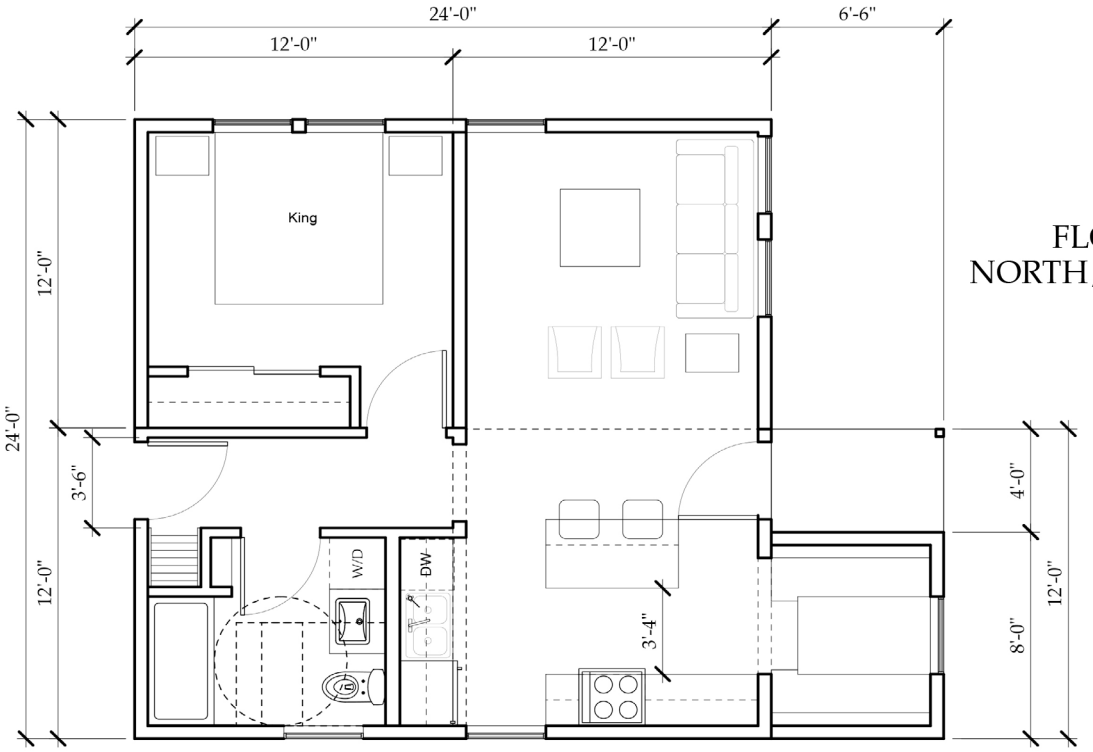
On this page are the renderings of Architend's proposal for the Back Home Program, left is the front elevation, below left is the three-quarters profile, below right is the side elevation.

Integrative Design Meeting

Housing Design Presentation

Tegrity Homes and Home Innovation Research Labs contracted with Architend, a local architecture firm, to develop a design for the Back Home program based on the initial design and the information collected from residents during the public forums. In addition to reviewing the quantitative survey results compiled by Home Innovation Research Labs, Architend's staff participated in the public forums and held qualitative discussions with the participants that helped to inform their design. Architend presented their concept for the Back Home program and on how their design for the Back Home program overcomes the following design challenges:

- *Accommodate Lot Sizes and Orientations* -The size and dimensions of the parcels on which the houses will be built are unknown. The lots could be horizontally or vertically loaded and oriented in any direction. Therefore the design must be able to accommodate a variety of configurations and orientations. Hence, there are two designs: one with the two modules side by side and another with modules arranged an end-to-end.
- *Minimize Waste*- The house was designed as a series of 12-by-24-foot modules. This saves on waste, as sections of many building materials are on 4 or 8 feet in length. By keeping the core dimensions at 24-by-24-feet construction waste is reduced. The 12 foot width of the modules can be transported to the site with a permit from the Texas Department of Transportation.
- *Can be Built Onsite or Modular*- This design was created to be able to be produced as "stick built" (traditional 2-by-4-inch construction built on the final site) or be constructed in a factory off site and shipped to its final destination to be installed (modular construction)
- *Accessible*- The house was design to maximize accessibility in a tight space. The bathroom was designed with a 5-foot turning radius for accessibility. The 42-inch wide hallways and 36-inch wide doorways are also wide enough to accommodate a wheelchair. The door handles are levers for easier operations.
- *Creating Two Sleeping Areas in 600 square feet*- A loft area was created in this design since two bedrooms are not possible in 600 square feet. The loft was located above the kitchen area, and was optional. The loft was accessible by a ladder, and not accessible by an individual who is mobility impaired. This area would also house the full size, 40-gallon electric water heater which would be located in attic adjoining attic
- *Exterior Materials*- The materials used were selected to be able to be transported easily and blend into the context. The materials incorporate a both lap siding and board & batten siding to add complexity and interest to the architecture.



FLOOR PLAN OPTION B
NORTH/EAST/WEST FACING LOT

Above is a sample floor plan from the Architend's proposed drawings for the Back Home Program.

Utility Efficiency

After the design critique there was a further conversation on measures to maximize utility efficiency and accessibility. All of the appliances would be electric, due to unavailability of gas service throughout the region, and would be specified as Energy Star. The house uses compact florescent bulbs or better performing lighting. The home is designed to be constructed with 2-by-6-inch studs (typical construction is with 2-by-4-inch studs) which would give space in the walls for R-19 insulation. (The R value is the measure of a materials' insulative value, its resistance to heat flow. The higher the resistance to heat flow, the lower the heating and cooling costs will be.) The roof cavity would include a radiant barrier (which inhibits heat transfer from thermal radiation), and the insulation would be R-30. If rigid foam could be used on the roof deck, the house would approach R-38 for ceiling insulation.

Integrative Design Meeting

Ductless mini-split air conditioning systems pair an exterior compressor and condenser unit (above left) with an interior fancoil (above right)

Utility Efficiency

Energy efficiency is dependent on a tight building envelope a building that leaks conditioned (heated or cooled) air is less efficient than a building that retains more of its conditioned air. Yet ventilation is important to indoor air quality, so designing the proper amount of air exchange was crucial. The home was designed to undergo three full house air changes per 24 hours to maintain air quality. There would be ventilation in the bathrooms and a kitchen hood to evacuate moisture from the home and maintain air quality. The house was also designed to maximize natural ventilation with operable windows placed to allow for cross ventilation. These windows are placed to take maximum advantage of natural daylighting using a bank of clerestory windows. Beyond its value in reducing energy costs, daylighting has documented wellness benefits for occupants. The windows are specified to be dual-pane, high-efficiency to further drive energy savings.

Ductless mini-split air conditioning systems work more efficiently than traditional air source heat pumps because the cooled or heated air is transferred directly from the heat exchanger to the wall outlet via insulated refrigerant lines without having to travel through air ducts in the attic which can account for considerable heat gain when cooling the home. Like traditional heat pumps and central air conditioners, ductless mini-split systems are available in much higher Energy Efficiency Ratings (EERs) than window units. Yearly savings between $83 and $295 are available with a high-efficiency ductless mini-split systems compared to other air conditioning systems.

Utility Efficiency

In addition to energy efficiency considerations, water efficiency was an important design consideration. The house used WaterSense rated faucets and showerheads. WaterSense is an U.S. Environmental Protection Agency program to identify fixtures that save money and maintain high environmental standards without compromising performance. WaterSense fixtures are priced competitively with standard fixtures. A four person household in the City of Houston could save $233 annually, if using all WaterSense fixtures in their home. While the builders were amenable to WaterSense showerheads and faucets, there were objections from the builder to the use of a 1.28 gallon-per-flush toilet versus the 1.6 gallon per flush toilet because of performance, ongoing maintenance, and home warranty concerns.

Accessibility

The Back Home program will serve elderly and disabled populations, and accessibility is crucial to the livability of the home. The home was designed with a 5-foot diameter turning radius in kitchen and core unit bath; the 42-inch wide hallways, and 36-inch wide doorways. There was a zero step-up entry. The design could accommodate ramps and/or lifts, even when elevated, if the lot size is adequate. The lighting switches and door handles would also be specified for ease of use and accessibility. Additonal considerations could be made based on the homeowner's ability level, such as the installation of grab bars in the bathroom or lower counter tops in the kitchen. The home's accessibility was a major concern during the critique of this iteration of the design, particularly in the discussions about the stackable washer and dryer, turn radius in the bathroom, and the loft space.

Durability

Disaster recovery housing inevitably brings forth questions of the home's durability. Building to the current residential, energy, and windstorm resistance would greatly enhance durability over the existing housing stock built prior to the adoption of these codes. The design of the home took these codes as a starting point and additional durability features were incorporated. The home's fiber cement siding is insect, impact, and rot resistant. It is a low maintenance, long-lasting siding choice that does not expand and contract at the same rate as wood so it is said to hold paint three to four times longer than wood, saving owners the time and expense of frequent re-painting.

Integrative Design Meeting

Durability

An additional weather resistant barrier of nonwoven polyester would be installed under the fiber-cement siding to repel wind-driven rain. Beneath these two layers would be structural oriented strand board (OSB) sheathing. The wax finish on the OSB provides a third layer of defense against water intrusion, and the continuity of the sheet provides a continuous diaphragm to keep the wall square while being buffeted by high winds. In addition to the protection provided by the OSB continuous sheathing, all studs would be connected to wall plates, rafters, headers, and all of the structural components of the home with metal tie-down straps as added security against wind force as required by location.

Exterior walls would be constructed with 2-by-6-inch studs rather than 2-by-4-inch studs like other homes in the area which provide greater strength to resist adverse weather. The robust and redundant flashing details, vapor barrier, and home-wrap would reduce the opportunity for moisture damage, a significant area of concern in the Gulf's hot/humid climate. Solid surface flooring would be employed in the high traffic areas of the home. PVC and weather treated trim also reduces the chances of rot taking hold in the structure. Standing-seam metal roofing and gutters were considered but ruled out due to expense of installation.

Codes and Ordinances

The Back Home program's housing must meet all federal, state, and local codes and ordinances. Another level of regulation is contained in deed restrictions and in Home Owner Associations' (HOA) agreements, which may regulate the size, design, roofing materials, paint color, masonry, and/or height of the home among many other variables. HOAs restrictions are more typical of neighborhoods with high value homes, and are not typical in neighborhoods with a large portion of LMI residents. Deed restrictions are commonly used to regulate housing in the region, especially in municipalities that do not have zoning ordinances to control the type of development that will take place in a neighborhood.

Municipal codes and ordinances regulate many elements of housing. These regulations are intended to maintain the health and safety of the community and preserve the homes values. Many municipalities adopt versions of the International Residential Code (IRC), and the municipality's building codes regulate all aspects of the home's design and construction and may contain regulations pertaining to the structure, placement, size, usage, wall assemblies, fenestration size/locations, egress rules, size/location of rooms, foundations, floor assemblies, roof structures/assemblies, energy efficiency, stairs and halls, mechanical, electrical, accessibility, plumbing, site drainage and storage, appliances, lighting, fixtures standards, occupancy rules, and swimming pool regulations.

Integrative Design Meeting

The Back Home was designed to exceed the minimum design and construction requirements for energy efficiency contained in the International Energy Conservation Code (IECC). Although the home was designed to meet regulatory requirements, specific municipal ordinances in the region that would prohibit the construction of this design included minimum square footage requirements and masonry requirements.

Counties in Texas have little authority to regulate housing in Texas: Harris and Galveston county development permits are primarily concerned with ensuring that housing is built out of floodways and maintain adequate detention and drainage. The Back Home was designed to be able to be constructed on site or in a manufacturing facility. All manufactured housing is regulated by the Texas Department of Licensing and Regulation (TDLR) through the Texas Manufactured Housing Standards Act and the National Manufactured Housing Construction and Safety Standards Act of 1974. The housing was funded through the CDBG-DR program; and was required to meet all pertinent HUD and GLO regulations.

Prototype Development

After the integrative design work session, the project team concluded the design needed to be reconsidered. The small size of the core of the home, at approximately 600 square feet, created constraints in the functionality and accessibility of the unit. There was no way to place a side-by-side washer/dryer in the residence and maintain the accessibility of the bathroom, hallways, and dining area. The height of the structure, while providing a desirable sense of openness and daylighting, proved to be prohibitively expensive to construct and transport. The architectural appearance of the home, while incorporating vernacular elements, was primarily focused on improving the utility performance and livability of the home. The shed roof lines and the clerestory windows were not typically of the architectural features found in the neighborhoods where the homes would be constructed. Based on this feedback, the team went back to the drawing board to create more traditional design with an expanded floor plan and feasible roof pitch for manufactured housing.

In the fall 2014, the project team considered several options for the redesign. All proposed designs incorporated the utility efficiency, durability, and accessibility concerns identified in the guiding principles.

Prototype Development

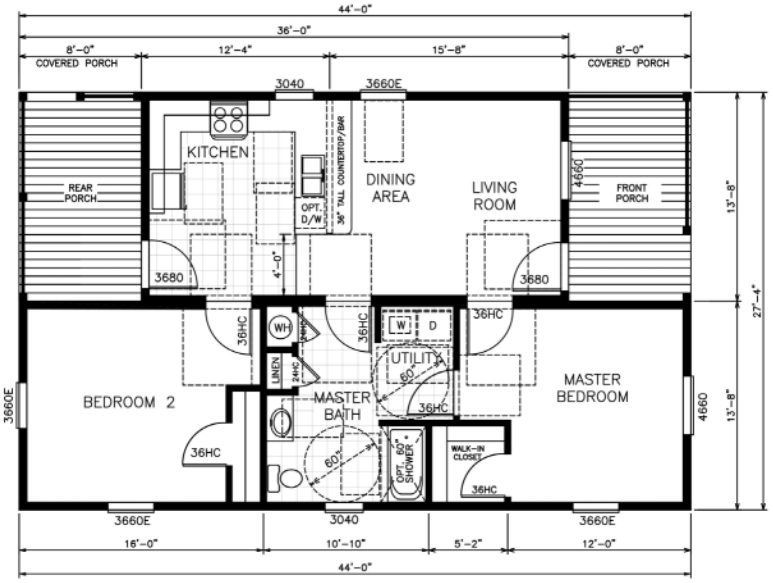
All designs included a façade with a front porch, an essential design element, as supported by the surveys conducted during the pre-design public outreach, allowing for neighbors to interact and providing a shaded outdoor space. This design also provided residents with a back porch, allowing for access directly to the kitchen and creating an entrance that can incorporate a ramp without the aesthetic issues of leading the ramp to the front door. The builder noted that in their experience the primary method for distinguishing a manufactured housing design from the standard format is to have a front room protrude from the façade. Of the options presented, the design with a protruding front room was the design ultimately selected by the project team. The design team continued to work with the factory to further refine the design ahead of the delivery of the prototype.

In December 2014, the prototype was delivered in four sections, two sections that comprise the core unit (the bedroom, bathroom, kitchen, back porch, and living/dining area) and two additional sections that comprise the additional bedrooms and bathrooms. The front porch was built on site. The two units that comprise the core were then "married" (the two sections were mechanically attached), the roof was pitched (the roof pitch is higher than what is transportable and is hinged), and the final onsite construction details were completed. The unit was installed on the Oak Creek Homes' lot to provide access. Once the core unit was completed, the media and local government officials were invited for tours of the unit. The next step in the process was adding the build out of the additional bedrooms and bathrooms that comprised the completed home. The home then underwent testing for its energy performance. Once this process was completed, potential applicants, the media, and local government officials were invited to tour the completed home. This allowed potential applicants to see what the completed home would look like.

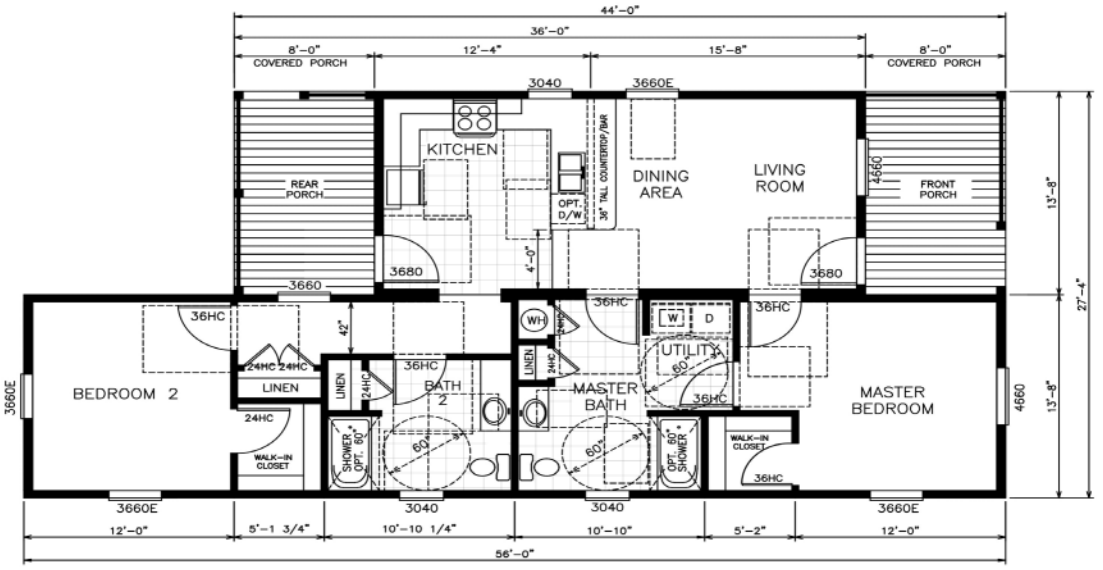
In February 2015, the team reviewed the design to identify potential cost savings and design improvements to the prototype. The greatest cost savings could come from building the homes as two rather than three to four modules (eliminating the phase building approach for the pilot houses as it has been demonstrated and documented in the prototype construction). Additional savings could be realized by replacing the lapstrake siding with paneling on the back of the units not visible from the road and on any wall where an additional module may be attached. The floor plan was revised to provide for additional floor space. The lowest hanging fruit in terms of cost savings would be to reduce the sizing of the dimensions lumber for the marriage wall (there are no benefits to the 4-by-6-inch studs rather than 2-by-4-inch studs, and the larger size will reduce floor space). It was also recommended that the master bedroom façade window be sized to match the window into the living area. Of these recommendations, only the revised floor plan and the replacement of the marriage wall with 2-by-4-inch studs were selected for implementation in production.

Above: The Core Unit prototype for the Back Home program

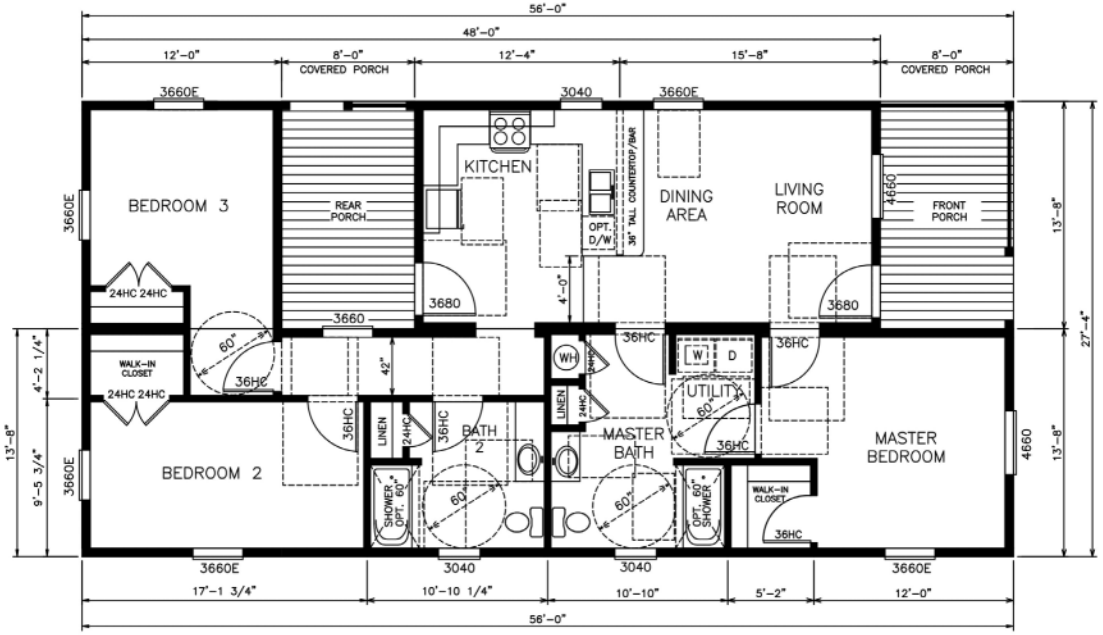
Floor Plans



Two bedroom, one bathroom floor plan



Two bedroom, two bathroom floor plan



Three bedroom, two bathroom floor plan

Construction Process

Tegrity Homes managed the construction process along with the contractor, Oak Creek Homes. The Houston-Galveston Area Council qualified applicants with the General Land Office. Once an assignment was received by Tegrity from H-GAC, the applicant was sent to Oak Creek Homes, to conduct a site visit and to allow the applicant to select colors and features of the home. Oak Creek Homes then created a work write-up based on the specific requirements of the applicants' family and the site requirements (based on the information in contained in the environmental review). Once this write-up was reviewed and approved by H-GAC, Tegrity received a contract signed by the homeowner and a Notice-to-Proceed. The builder applied for a permit from the municipality.

Once the permit was received from the municipality, the builder scheduled a move-out date with the homeowner and the home was ordered from Oak Creek's factory in the Fort Worth area (outside of the potential area for storm damage). Once the homeowner was moved out, demolition of the existing home began, and once complete, the site was prepared for the pouring of the foundation. The Back Home used concrete runners as foundation system, to which the home was permanently attached using piers and strapping. Some municipalities require that the foundation pass inspection. When the foundation passed inspection, the core unit was set, and the roof, which is collapsed for tranport, was pitched to its final 6/12 grade. The interior and exterior were then trimmed out, and a request was sent to the power company for electrical hookup. Once the electricity was hooked up, the air conditioning unit was installed. At this point, water and sewer service was requested and hooked-up. The tie-downs and wall skirting were installed. If required, a ramp was built to the back porch. The front porch and pergola and front steps were then built. Once the home was completed, any parking pad and or sidewalks were installed. At this point, the core was ready for H-GAC to inspect it.

Before the build out modules could be connected, portions of the interior and exterior of the home must be deconstructed. Depending on the lot size and configuration, these additional modules may needed to be craned into place. The electrical was brought over to the modules and plumbing was extended from the core unit as well. The interior and exterior are then trimmed out, and the punch list is completed. After the municipality completes its final inspections, the sod was laid, and a final cleaning was completed. H-GAC conducted its final inspection and the home was ready for key-turn over to the homeowner.

Construction Process

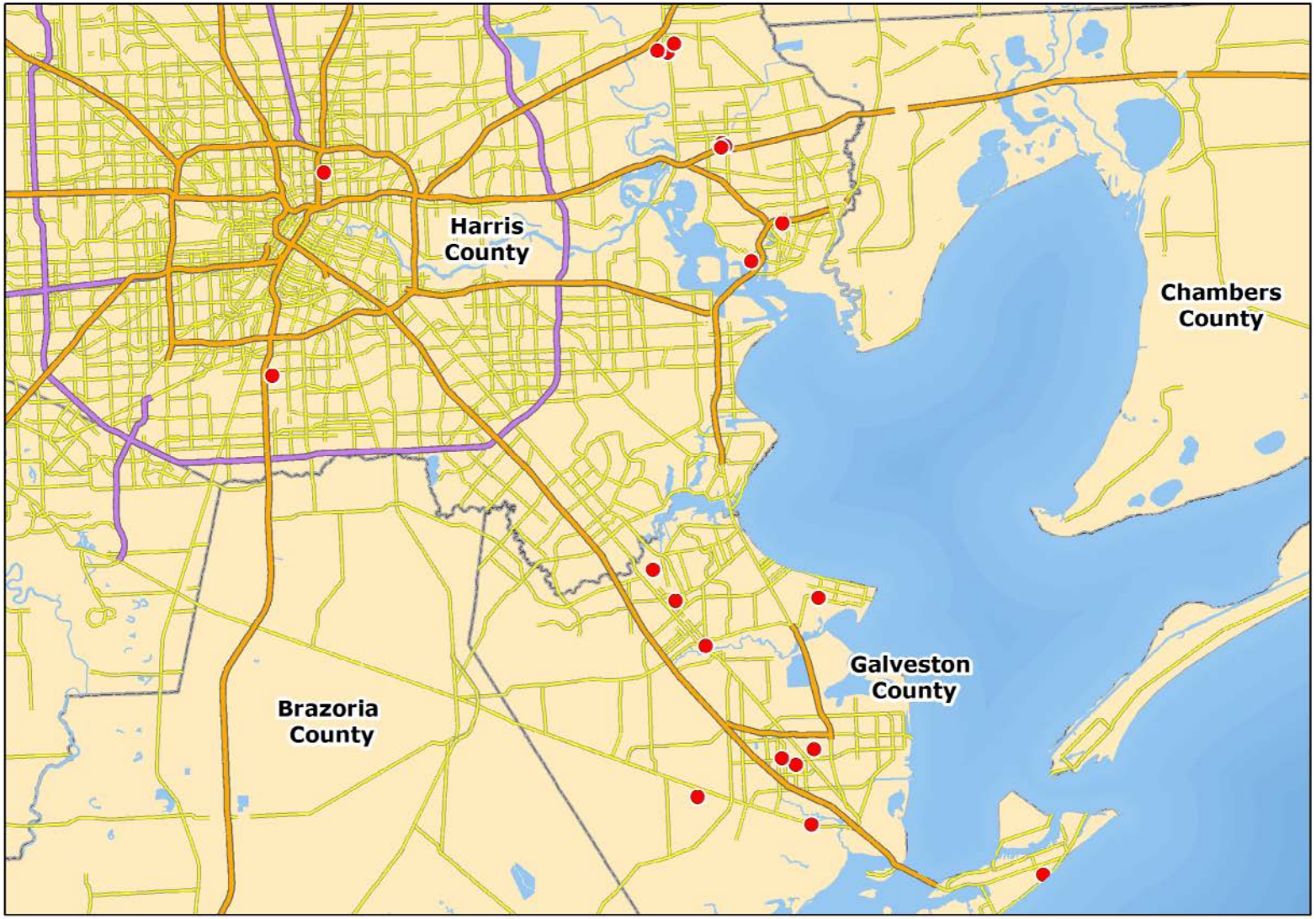
The on-site construction process begins with the home being delivered in modules (opposite, top left and middle left). The modules of the core unit are connected, and the chassis is strapped to the foundation (opposite, bottom left). Once the modules are connected, and attached to the foundation, the roof is pitched (opposite right, top and bottom). Once the roof is pitched, the remaining site work can take place, including installation of the front stairs, pergola, and the side ramp, along with the parking pad and sod installation, as seen in the photo above. On page 50 are images of a crane placing the additional build-out units on to a lot, which is sometimes necessary when the lot size is too small to accomodate them. The following pages contain images of the living area (page 51), kitchen (page 52), bedroom (page 53), bathroom (page 54) and washer/dryer area in the bathroom (page 55) of the core unit.

Construction Process


GROVE

Construction Process

Map of Homes Constructed for the Back Home Program



The above map demonstrates the location of homes costructed as part of the Back Home program (homes are denoted by a red dot)

Conclusion

The Back Home program met its goals of designing a home that was permanent, accessible, durable, and utility efficient. The program's housing design employs locally relevant architecture that responds to the communities' input and can be rapidly deployed after a disaster. Despite the strengths of the design, there are significant barriers to rapid housing recovery that extend beyond the construction methods used that need to be addressed prior to the adoption of modular housing as an alternative to site building after a disaster.