

Using GIS and Innovation to Balance on the NEPA Tightrope

Author: Katie Wingerd

Abstract:

Using ESRI products to develop, analyze, and prepare GIS data for use in Quantm route optimization software, Buchart-Horn, Inc. is assisting the Louisiana Department of Transportation and Development and the Federal Highway Administration in determining the best alternative for a new route providing improved Hurricane Evacuation and system linkage in southeast Louisiana. The route optimization program utilizes environmental, cultural, and community GIS data; combined with engineering design and costing data, to provide many alternative options that meet the design criteria while considering project constraints. Scheduled for completion in the spring of 2006, the project will result in a record of decision by the FHWA of the best route that meets the project purpose and need. This new route will provide a much needed, more effective, and quicker option for the residents of southeast Louisiana to evacuate prior to a hurricane, while providing a link to the interstate system during non-evacuation conditions.

Project Description and Background:

Buchart-Horn, Inc. is currently in the middle of preparing an Environmental Impact Statement (EIS) for the Federal Highway Administration (FHWA) and the Louisiana Department of Transportation and Development (LADOTD). The purpose of the EIS is to evaluate the potential impacts of a proposed limited-access hurricane evacuation and system linkage improvement route in southeast Louisiana.

The National Environmental Policy Act (NEPA) is a decision making process. The EIS is the tool by which the FHWA makes a decision on a preferred alternative balancing impacts, costs, and ability to meet project need. The goal of the EIS, when choosing a preferred alternative, is to minimize impacts to cultural and natural resources, while meeting the project purpose and need.

The new route resulting from the EIS process will connect US 90 in the south to State Route 3127 in the north, providing the Houma-Thibodaux area with a more direct connection to the I-10 corridor via LA 3127 and future LA 3213. The length of the study area is approximately 23 miles. For reference, the project study area is shown in Figure 1 – Location Map, found on the next page.

This proposed roadway would serve the seven-parish area of Assumption, Lafourche, St. Mary, Terrebonne, St. Charles, St. James, and St. John the Baptist parishes. According to the US Army Corp of Engineers, the estimated time for evacuation of these Parishes varies from 14 hours (Lafourche Parish) to 38 hours (St.



John, St. James, St. and St. Charles Parishes), reference 1994 Evacuation Study. The new roadway, when constructed, will provide another, much needed, option to emergency personnel, state, and local police for hurricane evacuation in this southeastern and south-central area of Louisiana.

In addition, this proposed limited access roadway would provide a transportation link between the Houma-Thibodaux area to the I-10 corridor via LA 3127. Currently, the main north-south link between these two areas is LA 20, a narrow, two-lane road with multiple access points. LA 20 traverses the study area through highly developed urban land, farmland and prime wetland areas that include valuable cypress swamps. The proposed new, limited access roadway is a more direct connection between the two areas. Travel time between US 90 and LA 3127 will most likely be reduced because of this alternate option provided to motorists.

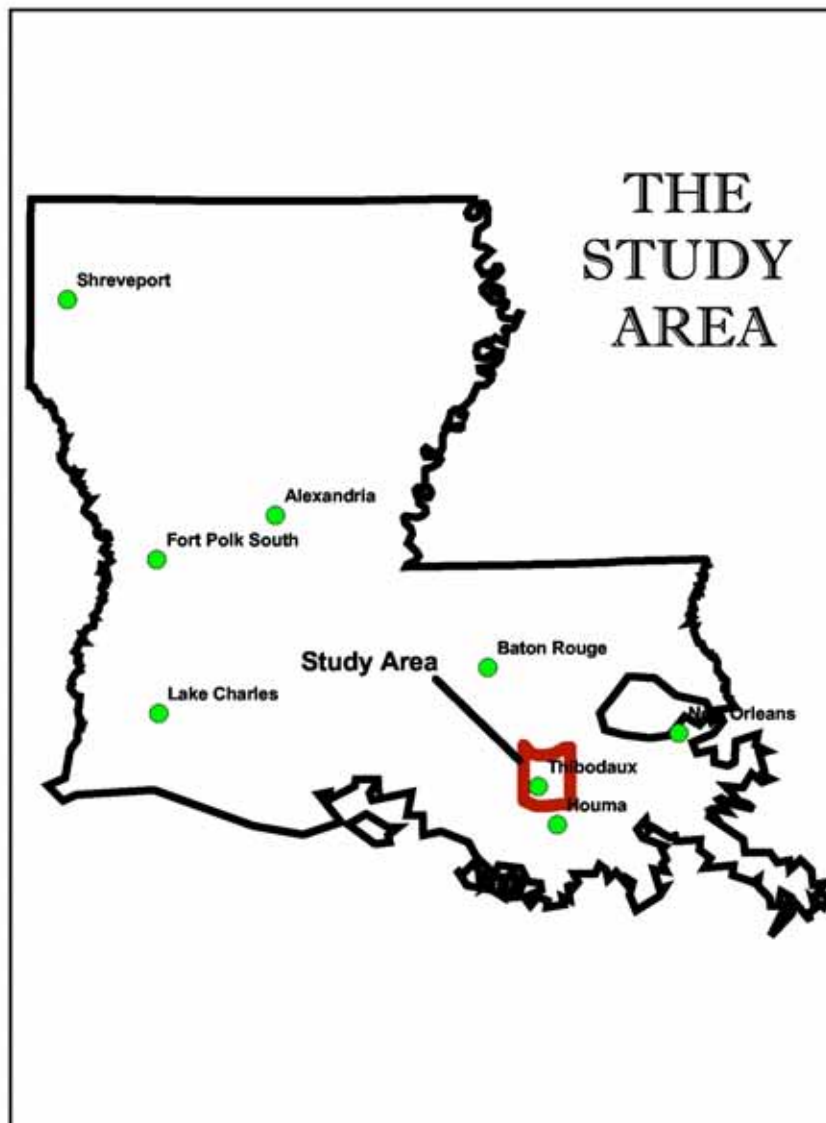


Figure 1. Location Map

Project Area Description:

The project study area is southwest of New Orleans and is rich in cultural and natural resources. There are several historic buildings and plantations that will need to be avoided by the proposed route. Much of the land cover of the area is wetland, including valuable cypress swamps. The wetlands, marshes and swamps in the project area are vitally important to preserving various species' habitats as well as the hydrology of the project area. Several sensitive biological habitats in the project area are of concern to natural resource agencies. These habitat areas include threatened raptors such as bald eagles, rare plants and colony forming water birds. The study area is also rich in farmland, including several areas of prime farmland along Bayou Lafourche. The majority of the farmland is being used to farm sugarcane. The impacts to these cultural and natural resources are carefully balanced with project purpose and need during the EIS process.

The area also contains the urban areas of Thibodaux, Chackbay, and Vacherie. In addition, the corridor along LA 20 between these areas is growing rapidly. Housing developments and business establishments are being built along this route on a regular basis. Nicholls State University is located just east of Thibodaux in the southern end of the project area. This university has a large commuter population and students from the north often use LA 20 to travel to the university. Many of the commuting students would benefit from the transportation link that the proposed new route would provide. Minimizing impacts to housing communities and businesses in the project study area is an important part of the EIS process. Figure 2 – Study Area Resources, is a map displaying the rich resources of the study area.

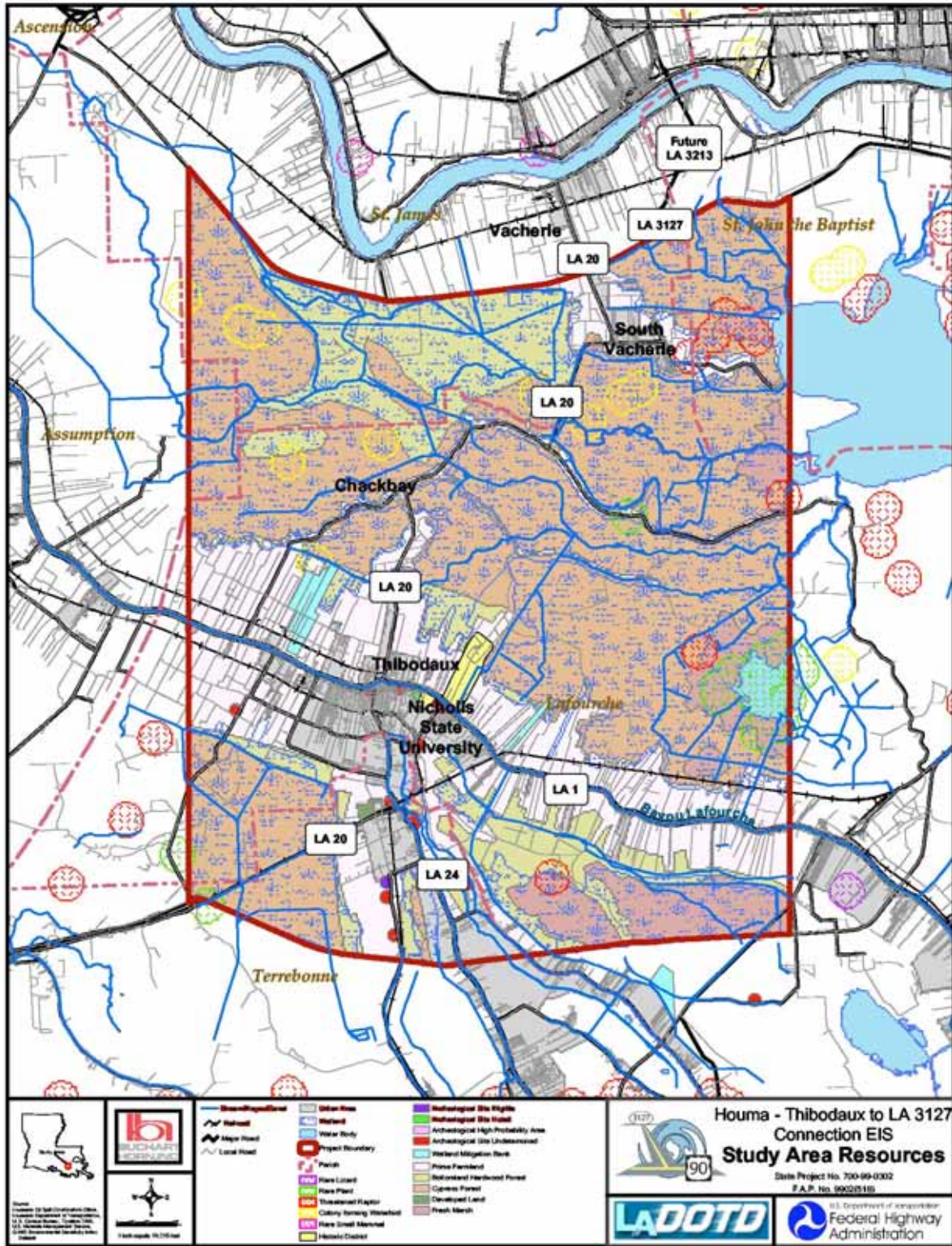


Figure 2. Study Area Resources

Use of GIS and Quantm in the EIS Process:

In order to improve the efficiency of the EIS process of evaluating alternatives on this project, GIS is being used in conjunction with a Route Optimization software named Quantm. ESRI's ArcInfo software and Quantm software communicate with each other through the use of shapefiles and Digital Elevation Models (DEM).

In the absence of a route optimization software, the process of analyzing potential alternatives for the new route would begin with GIS professionals providing base mapping of the project area to transportation and roadway design engineers. The engineers would create several potential alternatives and provide these alternatives to the GIS professionals. GIS would be used to analyze the impacts of the potential alternatives on project constraints such as wetlands, historical sites, etc. This process would be repeated several times until a preferred alternative is chosen based on minimal impacts to study area resources.

By using Quantm software, the process of choosing alternatives that minimize impacts to the project area is automated. The route optimization software uses the GIS data combined with engineering design criteria such as radius of curvature, cut and fill costs, etc. to determine the best route between the starting and ending points of the roadway. The constraints and criteria used in the software to determine the best route can be refined as the EIS process develops to further refine alternative options.

The first step in the process of selecting a preferred alternative using route optimization software and GIS is the data retrieval process. Several sources of data were used in this project. They included state, federal, and local government organizations, online data atlases managed by universities, and private consulting firms that are members of the EIS team. The data gathered included paper maps, CAD files and GIS files. ArcMap was used to combine some of the datasets into single datasets, clip data to the project area, and prepare the data for use in the Quantm software. Quantm requires the data to be in the same coordinate system and since the data obtained for this project was in several different projections, ArcToolBox was used to re-project the layers. The data gathering effort resulted in being able to define "what's out there". This information was not only used in the route optimization process, but also in displays for public meetings.

The GIS data is then transferred to Quantm in the form of shapefiles. The software currently only uses line and polygon features, so any point features such as the location of historic buildings were buffered to create small areas. In addition to using shapefiles to describe the study area in the Quantm software, a LIDAR based DEM was used in the software to help analyze the terrain of the study area and determine the elevation of the roadway.

Using a series of input forms in the Quantm interface, criteria for establishing impacts to the project area are defined. Factors such as whether or not roads, streams, wetlands, etc. are crossed with a bridge, an at grade intersection, or some other structure are established by the user. The elevation at which to cross these features is also set during this step. If

there are certain areas or features which need to be avoided and cannot be impacted, those areas can be marked as avoid using the input forms. For example, historic sites on the National Register of Historic Places are set to avoid. Extra costs associated with impacting certain features, such as mitigation expenses with impacting wetlands, are defined as well. The input forms are also used to set the exact location of the starting and ending points, the limiting grade of the road, roadway width, radius of curvature, cut and fill costs, and other engineering design criteria. Refer to Figure 3 – The Quantm Interface, for a display of the various forms used for setting constraints.

Once all of the data features are entered with their constraint information, the study area is “optimized”, which is what Quantm refers to as the process by which it determines the best route between the starting and ending points that meet the established constraint criteria. Considering the terrain of the area, the design parameters and the constraints defined, the software establishes numerous routes that meet the criteria. The initial optimizing process produces 50 potential alternatives that meet the design constraints at various levels. For example, some of the resultant alternatives may have crossing violations where the alternative crosses avoid areas or some alternatives may not meet the elevation criteria in certain sections of the study area.

During the first round of Quantm runs for this project, the most important result noted was not individual alternatives but corridors or groupings of alternatives that developed. The alternatives the software produced tended to be “grouped” in certain areas due to some of the constraints. The various corridors that developed can be further analyzed in GIS and Quantm to further refine the established project constraints and therefore further refine the alternatives resulting from the Quantm Optimization process.

In addition to the geographical alternative, a table of information containing any violations, the cost of construction of the roadway and other attribute information is included with each alternative. This provides the user with a way of determining which route may be the least expensive to build, which ones contain the least amount of impacts to wetlands, etc. By looking at the geographical location of the alternatives combined with the costing information, the user can begin to get an idea as to which corridors would be the best alternative.

As part of the public involvement process during the EIS, GIS maps were displayed at public meetings. Public participants used these maps to layout their preferred alternatives. These alternatives were converted from paper maps to shapefiles using heads up digitizing in ArcMap. The public drawn alternatives were transferred to the Quantm software and used as seeded alternatives. A seeded alternative is an alternative put in by the user and then optimized by Quantm. During this optimization process Quantm adjusts the seeded alternative slightly to the constraints entered by the user. The result is 20 alternatives that are very similar to the initial alternative but which are adjusted slightly according to the project constraints. Again, these alternatives also come with attributes that include cost, violations, etc.

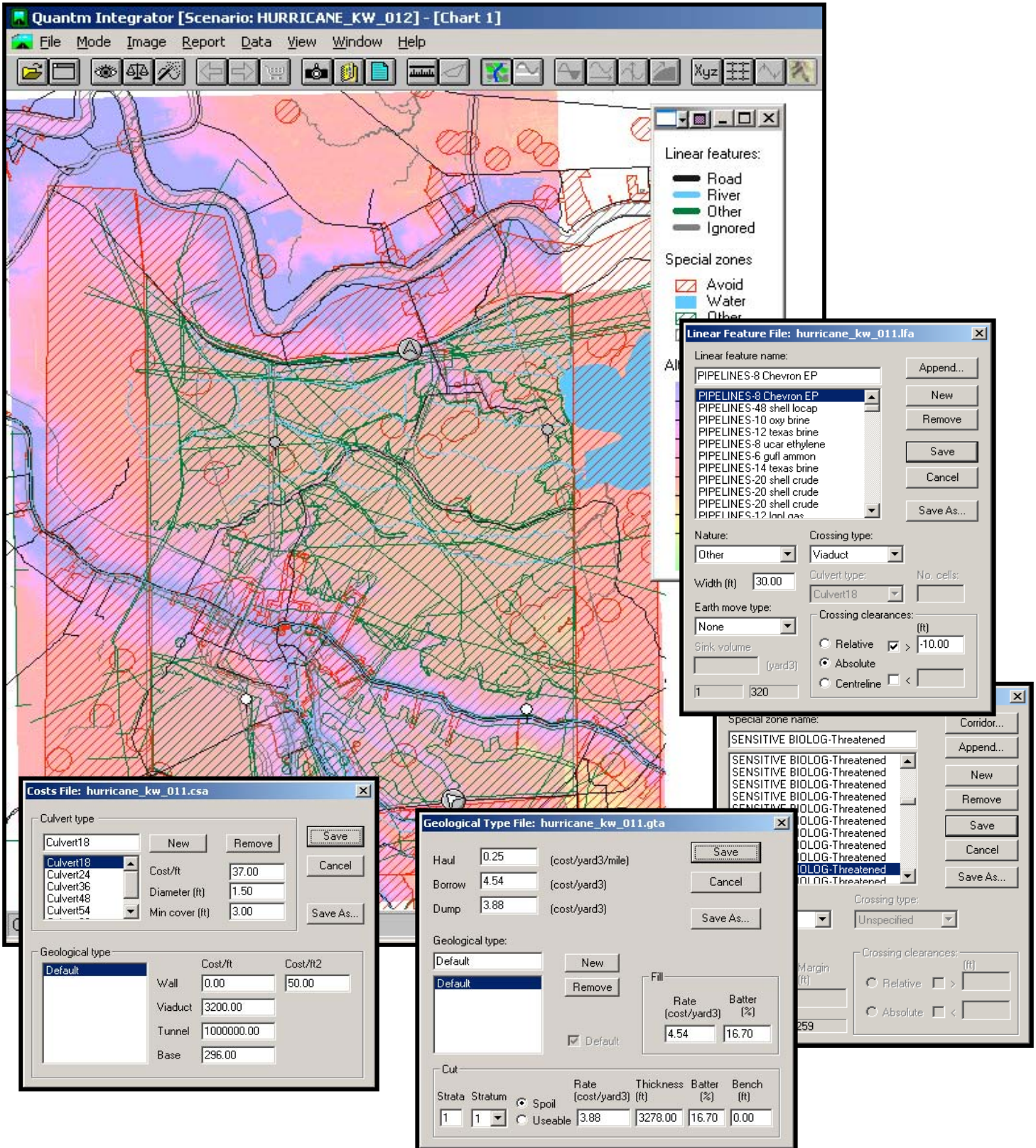


Figure 3. Quantm Interface

By combining the public input alternatives with the initial unseeded runs in Quantm, the users begin to narrow down the potential alternatives into a reduced range of alternatives for further analysis. The alternatives produced by Quantm are exported to shapefile format for use in ArcMap or other GIS software. The alternatives are buffered to develop a corridor of potential impact and this corridor is used to analyze the various data layers available to assist in further refining the alternatives. By exporting the alternatives and displaying them on the GIS mapping, the public and agencies can get a better idea of what types of impacts the potential alternatives may have on communities and natural and historic resources. These alternatives are used with other input such as field investigation, aerial photography, etc. to narrow down the multitude of initial alternative options into a much smaller set of alternatives to move forward in the optimization process.

Currently, the EIS process for this particular project is in the stage of finalizing the reduced range of potential alternatives. GIS and Quantm have been used together to develop a set of potential alternatives to be approved by Federal, State and Local Agencies. Once these agencies have approved the reduced range of alternatives, the alternatives will be presented at public meetings to get the publics input and opinions on the potential alternatives.

Where We Go From Here:

The next step in the EIS and Route Optimization process is further refinement of the reduced range of alternatives. This will involve further GIS analysis and using the reduced range of alternatives as "seeded" alternatives in Quantm. The Quantm constraints may be adjusted slightly based on new or additional information and this will further help to refine and adjust the reduced range of alternatives. GIS will be used to analyze demographic information, detailed natural resource data, as well as more refined cultural resource data to assist in producing reports of impacts to the study area for each alternative. These impact reports and associated data, along with the Quantm results, will be used to refine the reduced range of alternatives into 2 or 3 preferred alternatives. These alternatives will be exported from Quantm as shapefiles and Microstation files. The engineers will use the Microstation files to develop Line and Grade information for the preferred alternative. ArcGIS will be used to provide detailed impact reports on natural and cultural resources.

The Final Result:

The result of the entire EIS process on this project will be the FHWA rendering a record of decision (ROD) that identifies the alternative to be advanced to final design. An EIS document that defines the potential impacts of the preferred alternative options to the study area will be prepared. Line and Grade information will be developed for the preferred alternative. In addition, the EIS and ROD will result in setting the stage for funding and project prioritization as well as final design.

In the process of choosing the best alternative, the project team balances the impacts of the proposed roadway on project area resources with the cost of constructing the roadway and the project purpose and need. The new route will provide the residents of southeastern and south-central Louisiana with a much-needed option for hurricane evacuation, providing them with a more direct connection to areas north of the Mississippi River. During non-evacuation times, the new route will provide a more direct transportation link between the Houma Thibodaux area and the interstate system via LA 3127 and future LA 3213; thus providing the residents of the area with improved transport of goods and services.

Acknowledgements:

The project team consists of the following federal, state, and local government agencies as well as several consulting firms.

The project administrators are the Louisiana Department of Transportation and Development and the Federal Highway Administration.

The following Parishes are involved in the project: Assumption, Lafourche, St. Charles, St. James, St. John the Baptist, St. Mary, Terrebonne.

The consulting team consists of:

Buchart-Horn, Inc. – Overall Project Manager
Consoer Townsend Envirodyne Engineers, Inc. – EIS Manager
Earth Search, Inc. – Cultural Resource Manager
GSE Associates, Inc. – Engineering Manager
Shaw Coastal, Inc. – Natural Resources Manager
Urban Systems Associates, Inc.- Traffic Studies Manager
Quantm Limited – Route Optimization Manager

Notes:

Please note that this project is ongoing. Information provided in this report may change slightly as the project develops further. For updates and additional project information please refer to the project website at www.north-southhurricane corridor.com.

Author Information:

Katie Wingerd
Senior GIS Analyst
Buchart-Horn, Inc.
445 W. Philadelphia St.
York, PA 17405
717-852-1573 (phone)
717-852-1625 (fax)
kwingerd@bh-ba.com