

**Research and Development of a GIS of
Oil and Gas Transmission Pipelines
In Greater New Orleans, Louisiana
Final Report**

by

Louisiana State University
LSU Hurricane Center, and
Louisiana Geological Survey

for

Louisiana Oil Spill Coordinator's Office/Office of the Governor
Louisiana Applied and Educational Oil Spill Research and Development Program



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submitted to the

Louisiana Oil Spill Coordinator's Office/Office of the Governor
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Research and Development of a GIS of Oil and Gas Transmission Pipelines In Greater New Orleans, Louisiana

Abstract

This project is intended to supplement emergency response and planning for hazardous materials spills emanating from transmission pipelines within Greater New Orleans, Louisiana. The estimated 570 miles of pipelines mapped within the study area constitute a major source of possible oil spill emergencies. Assessment of digital petrochemical pipeline data is crucial for effective energy planning, environmental monitoring, disaster prevention, and emergency preparedness. The data developed for this project can be used for emergency response as well as for environmental and urban planning. Accurate pipeline maps and the Geographic Information System (GIS) compiled in this project will enable increased response efficiency by allowing emergency response teams to quickly assess the product, diameter, and operator of specific pipelines. In addition to oil, gas, and refined product transmission pipelines, chemical and other hazardous materials transported by pipeline have been included in the GIS. Emphasis was on transmission pipelines rather than on pipelines associated with gathering or distribution systems. Generally, transmission pipelines are those with diameters of four inches or greater. Documentation on transmission pipelines is difficult to acquire. Most operators feel this data is proprietary and refuse to divulge the data. Those data submitted to the Louisiana Geological Survey (LGS) have been cataloged and digitized. Most of these submitted map documents are not suited for input into a GIS. Either the mapping scales are too small, the aerial photography base images are not rectified, or the maps are merely pipeline system diagrams. In most cases these data have inadequate geospatial accuracy to be useful in a large scale GIS data layer. A method to digitally correct and create pipeline features has been developed by the LGS. Utilizing Global Positioning System (GPS) technology, point data were collected on pipeline witness posts locations that were observed near pipeline crossings of public roads, canals, and levee crossings. The witness posts contain positional data, pipeline operator names, emergency contact telephone numbers, and commodities transported by the pipelines. These data were compared to existing hard copy maps and digital pipeline data. Pipeline data for this project were developed utilizing aerial and satellite imagery, GPS point data, digital data from the National Pipeline Mapping System (NPMS), and reliable third party maps. Through detailed source data research, field investigation with GPS, remote sensing, and GIS analysis, a methodology to develop pipeline features and adjust any spatially incorrect data will result in a comprehensive petrochemical pipeline GIS for Greater New Orleans.

1.0 Introduction

1.1 Background

Recent floods along the Atlantic and Gulf seaboard and elsewhere in the world have demonstrated the complexity of public health impacts from such disasters. These effects include trauma; fires; and chemical, sewerage, and corpse contamination of air and water, which leads to disease. Emergency responders have been unprepared for the extent of these public health impacts. Disease risk in Louisiana during hurricanes and major floods is at least as high as that experienced in North Carolina during Hurricanes Floyd and Irene. Louisiana's vulnerability is due in part to the very high incidence of major tropical storms in this region. Forty percent of the state is in the coastal zone, and 70% of the population resides there. Ninety percent of this zone is near or below sea level. Densely populated areas, such as New Orleans, rank among the highest in the nation with respect to potential societal, mortality, and economic impacts from a major disaster. Recent research reveals that even a slow moving Category 3 hurricane could cause levee overtopping. Under this scenario, floodwaters could reach the eaves of houses and might remain for weeks. The resultant mix of sewage, corpses, and chemicals in these standing flood waters would set the stage for massive disease outbreaks and prolonged chemical exposure.

Recognizing the potentially severe consequences of a major flood in New Orleans, the Louisiana Board of Regents, through its millennium Health Excellence Fund (HEF), has awarded a five year contract to LSU to establish a Center for the Study of Public Health Impacts of Hurricanes. This effort is developing detailed models for assessment and amelioration of public health impacts due to hurricanes and major floods. A multi-disciplinary, multi-campus team has been formed combining the resources of natural scientists, social scientists, engineers, and the mental health and medical communities. Using New Orleans as a test case, this team will develop techniques and models for dealing with public health issues associated with complex disasters such as hurricanes and associated flooding.

Utilizing computer models, storm surges and rainfall flooding will be calculated. Government databases and GIS technology allow documentation of at risk areas. Probable chemical and sewerage release sites will be determined. Computer models will simulate air and water movement of chemical contaminants. Epidemiologists, social scientists, and public health experts will determine public health impacts. During severe floods, injured and displaced animal pets and wild animals become a major concern. Management scenarios for this problem will be developed. All aspects of assessment and remediation will be managed through an interactive GIS.

The value of this project is two-fold. First, it will have a direct positive impact on emergency preparedness and will reduce deaths, disease, pain, and suffering when a major disaster occurs. Second, the model will be exportable nationally and internationally. In fact, our research results will be applicable to other disasters such as tornadoes, chemical spills, or terrorism.

Of critical importance to this study is knowledge of the accurate location of pipelines, their ownership, and products that could be potentially released. To gain this information, the LSU Hurricane Center teamed with the Louisiana Geological Survey. Recognizing the oil spill community's need for such data, the Louisiana Applied and Educational Oil Spill Research and Development Program (OSRADP) has generously provided the necessary research funding for

the pipeline research project. Further research into mapping large diameter (greater than 4 inch) non-transmission pipelines will proceed under the auspices of the ongoing Hurricane Impact Study on Health in the New Orleans metropolitan area.

The Louisiana Geological Survey (LGS) has been compiling a digital pipeline database for Louisiana for many years. Numerous maps and other geographic data concerning pipelines have been collected. Many of these data have been in hard copy format, such as maps and other diagrams submitted by pipeline operators. Unfortunately, many of these data had poor geographic control. Those data with good control were digitized and included in the LGS Digital Pipeline Database.

Other digital data were acquired from the National Pipeline Mapping System (NPMS). Generally, these data have very good spatial control, however, the NPMS will not release or allow the LGS to release any of their data. The LGS uses these data as reference material only. We are developing digital pipeline data uniformly for all operators. Many pipeline operators have not submitted any data to the LGS or NPMS. Cooperation from pipeline operators has varied and is reflected in the available research data.

1.2 Objective

Creating a GIS of hazardous materials pipelines is detail intensive. The initial task was to determine the scope of data contained in-house. Evaluating the existing digital and hard copy data submitted by pipeline operators was a time consuming task. Digital as well as traditional maps were intensively examined to determine spatial integrity. Third party data were useful in determining the location and product of many pipelines. Most of the existing LGS pipeline data needed to be further developed to conform to the digital mapping standards set forth by the Federal Office of Pipeline Safety, National Pipeline Mapping System (NPMS). These data standards were adopted by the LGS for our pipeline mapping efforts. Details on the standards can be found in Section 1.3.

Some data have proven difficult to incorporate into a GIS for lack of adequate geographic control. The various types of data submissions, digital and hard copy, have both displayed multiple problems. The focus of this study was to acquire Global Positioning System (GPS) point data of pipeline intersections of primary and secondary public roadways canals, and levee crossings as well as a survey in Lake Pontchartrain. We then compared these attributes to available digital pipeline data and other maps and aerial imagery to develop a comprehensive pipeline GIS for Greater New Orleans.

The pipeline feature development effort was completed with the use of Global Positioning System (GPS) technology. Field collection of point data on pipeline witness posts observed near pipeline crossings of public roadways, canals, and levee crossings combined with digital orthophoto quarter quadrangle (DOQQ) imagery enabled the development of spatially acceptable data that met the mapping standards.

1.3 Data Standards

The U.S. Department of Transportation, Office of Pipeline Safety created the National Pipeline Mapping System to “support the development of a reasonably accurate digital pipeline

system” (www.npms.rspa.dot.gov). The standards for pipeline data submission created by the NPMS allow for no more than a 500 foot margin of spatial error. The Louisiana Geological Survey has adopted these guidelines for our pipeline GIS. The standards request that data be provided in digital format with accompanying metadata. If digital data are not available, then the operator may submit hard-copy data. All submissions are to contain geospatial data (location data), attribute data (descriptive information), and metadata (description of the content, quality, condition, and other characteristics of the submitted data).

The coordinate system used is based on the North American Datum (NAD) 1983. Projected data that employs a common projection, such as Universal Transverse Mercator (UTM), will be accepted. Digital data that does not employ real world coordinates cannot be accepted. Unacceptable data would include CAD files that have origin points of 0,0. Measurement data can be in metric or English units. Base maps used to develop the digital data should have scales of 1:24,000 to 1:1,200. The spatial accuracy of the digital data should be stated in the accompanying metadata.

The digital submissions should be in one of the following formats: ESRI’s Arc/Info .E00 export files, ESRI’s ArcView shapefiles (.shp), Intergraphs FRAMME and .DGN formats, MapInfo .mif files, and AutoCAD .dwg with required attribute data.

Hard-copy data submissions are accepted, using appropriate base maps, in the formats listed below. USGS topographic maps, 7.5 minute/1:24,000 scales are the preferred base maps. Pipeline inventory and alignment sheets are acceptable if they have a scale between 1:24,000 and 1:1,200 and contain a minimum of four georeferenced control points per sheet. Also, any third party base maps can be used if the above scale and control parameters are followed. These third party maps must also include projection parameters, datum, and graphic scale in order to be acceptable.

2.0 Methods

2.1 Method Outline

- I Data collection route planning
 - A) Study existing data for potential stops (design a route plan)
 - B) Examine aerial imagery for confirmation or other stops
 - C) Review traffic scenarios (try not to be a hazard to the public)
 - D) Determine boat launch sites and sail plan
- II GPS data collection and compilation
 - A) Compile data dictionary
 - B) Complete route plan
 - C) Ensure all data is collected with the proper parameters and documented thoroughly
- III Data projection and conversion
 - A) Upload GPS point data through Pathfinder Office
 - B) Export features as ArcView Shapefile
 - C) Load shapefiles into ArcView Project
- IV Spatial feature GIS overlay and analysis
 - A) GPS point data theme
 - B) LGS digital pipelines theme

- C) NPMS digital pipeline data
- D) DOQQs and other themes from LaGIS CD to aid in analysis
- VII Assess spatial accuracy of digital pipeline data
 - A) Load digital point and linear pipeline data by operator into one view
 - a. GPS point data shapefiles developed per operator
 - b. Pipeline features, LGS and NPMS, per operator
 - c. Analysis unique to each operator and commodity
 - B) Create linear features for missing data utilizing DOQQs, GPS point data, and third party maps
- V Database normalization and quality assurance
 - A) Review digital attribute tables
 - B) Ensure database integrity (Quality Control)
- VI Create CD and hard copy (report and maps)

2.2 GPS Point Data Integration

The use of Global Positioning System technology for the assessment of pipeline data quality and GIS development has been of great value. The LGS has collected GPS point attribute data for pipeline crossings on primary and secondary roads, canals, levees, and in open water locations within the study area. Most of the recorded data were found on witness posts located above the buried pipelines. These include, but are not limited to, operator name, commodity transported, diameter of the pipeline, and emergency telephone number. Most witness posts have the operator, commodity, and phone number clearly listed. However, few of these warning signs list pipeline diameters. GPS data were collected as close as possible to witness post locations. The GPS data are used to verify the existence of the pipelines and to record the operator and commodities. Most witness posts were well labeled.

Typically, the GPS data were collected from within the vehicle utilizing the roof-mounted antenna. This enabled the field crew to reduce the time required to collect data. However, many of the roadways in the study area are without safety shoulders that we could use to stop and collect data. In the areas of congested pipelines and no shoulder access, the vehicle was parked and the crew walked along the road collecting GPS point data. Great effort was taken to place the GPS antenna directly over the pipeline. Three data gathering trips were made by boat on Lake Pontchartrain from the Rigollettes in the east to Port Louis in the west. National Ocean Survey nautical charts, commercial nautical charts, and the proprietary Garmin Blue Chart marine cartography were used to determine pipeline locations. These were then checked using a Garmin GPSMAP 176c for navigation control. Approximately 250 nautical miles of open water were traversed.

Methods for evaluating the spatial accuracy of existing digital data were developed for a standard analysis process. Once a pipeline feature was found to have large spatial error, we explored options for correcting the problem. Efforts to incorporate real time differential GPS technology proved to be redundant and unnecessary. The accuracy of the Trimble Geoexplorer proved to be around five to eight feet.

Digital photographs were taken for reference at each stop. These photos were especially useful in resolving problems with pipeline feature development. The digital photos aid in clarifying areas with pipeline clusters or areas where hazardous data collection conditions exist.

2.3 GPS Setup and Export

The GPS point data were collected using Trimble Geoexplorer III GPS receivers and uploaded to computer via Trimble Pathfinder Office software. Geodetic parameters used were Universal Transverse Mercator (UTM), Zone 15, coordinate system, and the NAD 83 datum. The Pathfinder Office software allowed for the development of a data dictionary, a custom file containing operator name, commodities transported, satellite geometry, pipeline diameters, or any other list data deemed important. This file was scrolled through for data entry when recording data in the field. Collected GPS data was exported from the Trimble Office software as shapefiles, the format used by the GIS software utilized in this study (ArcGIS 8.1, ESRI Inc., Redlands, CA). A strong 95% of the recorded PDOPs (satellite geometry) throughout the field measurements were well within an acceptable error range. Spatial data recorded by the GPS units eliminated the possibility of transcription errors that can occur with hard copy conversion from field forms. However, recording spatial data on hard copy forms served as a backup data source and was important to pipeline analysis. Pipeline attributes were recorded in the GPS and on hard copy forms.

Some data were recorded solely on hard copy field forms. The emergency telephone numbers were difficult to key into the GPS datalogger and were added to the respective themes in the office. Occasionally, encounters with unknown pipeline operator witness posts caused problems with documentation. These had to be recorded in the GPS as unknown and documented on field forms. The data dictionary is constantly revised to reflect all pipeline operators observed. Twenty-one pipeline operators were mapped in Greater New Orleans (Table 6.1). These do not include gathering or distribution systems.

2.4 GPS Point Data Analysis



Figure 2.4.1 GPS Point Data Collected

Upon completion of the field investigation, the collected GPS point data (Figure 2.4.1) were loaded into the GIS for analysis and pipeline feature development. This was accomplished by first creating unique pipeline and GPS point attribute files per operator. Files unique to commodity by operator were also created. However, many pipeline witness posts vary in their specific commodities. Approximately half of the observed witness posts were clearly labeled with a specific commodity, such as natural gas or crude/petroleum. Many posts are labeled LPG (Liquefied Petroleum Gas), HVL (Highly Volatile Liquid), and NGL (Natural Gas

Liquids). These are generic labels applied to commodities such as propane, butane, and butylenes. Primary commodities transported by these pipelines were identified with references, such as the NPMS data and the DTC Industrial Atlas. The differences in transported

commodities between NPMS, the DTC Industrial Atlas, and observed witness posts made estimating pipeline mileage very difficult, especially for commodities. The miles for commodities are presented in Table 6.2.

Views within ArcView 3.3 were created for each operator and populated with requisite aerial imagery, GPS point data, existing digital pipeline data, road data, and other helpful themes. Pipeline features were created utilizing heads-up digitizing technology in ArcView 3.3. Referencing NPMS data, the DTC Atlas, and other hard copy data attributes were carefully populated into the pipeline database.

Not all GPS point data were collected directly above pipelines. Sometimes offset positions were required. Most GPS point data were used to verify existing pipeline data, hard copy or digital. Concern for the safety of the field crew and the time required to complete the point data collection were factors in the time spent at data collection locations. On occasion, poor satellite geometry or other interference would inhibit GPS data collection. This was most apparent when the team was surrounded by buildings, trees, or other obstructions. Multipath interference, or the reflection of satellite signals off obstructions could affect GPS point data quality. Accuracy in point data collection is important when pipelines are clustered in groups. Each pipeline was recorded in the GPS data collection unit; each commodity, emergency phone contact, time, and road/location were recorded on hard copy forms. Efforts to narrow the operator or commodities lists proved very problematic.

Many pipeline systems or segments have been bought or sold, while other segments have been part of corporate restructuring efforts. This is evident on many of the documented witness posts (Figure 2.4.2). Enbridge Energy Corporation has been very active in southern Louisiana. Past pipeline mapping projects, namely Baton Rouge Pipeline GIS, reflected this finding. Pipelines operated by Mid Louisiana Gas Company had been purchased by Enbridge in the Baton Rouge area. Pipelines operated by the Creole Gas Company appear to have been purchased by Enbridge in St. Bernard Parish. There also appears to be one pipeline, of two operated by Western Gas Resources, now operated by Enbridge in St. Bernard. Another example of corporate restructuring involves Equilon Pipeline Company. Several years ago, Shell Pipeline and Texaco Pipeline merged to form Equilon Pipeline. Field observations in the past year, in Lake Charles and New Orleans, show new warning information on posts labeled Equilon (Figure 2.4.3). Apparently, this corporate merger lasted about two years.



Figure 2.4.2 Creole Gas now Enbridge Gas



Figure 2.4.3 Equilon Pipelines revert to Shell Pipelines

3.0 Comparative Analysis Results

3.1 In-House Data Analysis Results

The analysis of the LGS pipeline data revealed many problems with spatial data accuracy. The most notable problems are the result of inadequate data received from operators. Much of the data received prior to the implementation of the NPMS do not meet the standards for operator submissions. Most of the problems encountered were with submitted maps of inadequate scale and detail level. Data digitized at less than 1:24,000 scale led to excessive geospatial displacement. In some areas, this displacement was close to a mile. Also, line work representing pipeline features was often drawn with a very thick line (sometimes wider than the right of way in which the pipeline rests), thus introducing a large spatial error.

Source data gathered by the LGS fell into three categories: large-scale or engineering diagrams with geographic control suitable for digitization, maps of small scale and poor geographic control that were not digitized (useful as reference material), and pipeline system diagrams. Some 1,600 operator submitted maps are cataloged in the LGS inventory. One source of hard copy data, in particular, was very helpful in route planning and pipeline feature development. The DTC Industrial Atlas clearly shows most of the pipeline infrastructure within the study area. The small-scale view and use of cartographic displacement in these maps, however, does introduce errors of up to half a mile in some areas. The atlas's maps are copyright protected and were used solely as reference material. Other hard copy references were out of date and of limited use.

NPMS data has been very helpful in identifying operators and especially commodities. However, these data can conflict with observed witness posts. Operator submitted data is usually very good. After analysis of these data, spatial displacement was found to be well within data standards for most of the operators. These data were also used as reference material only. After the attacks of September 11, 2001, the NPMS will not allow any secondary dissemination of their data. Pipeline safety is a priority, as the Department of Homeland Security considers pipelines to be part of our critical national infrastructure.

3.2 Greater New Orleans Pipelines

Of the 380 Global Positioning System (GPS) data points collected for this project, Gulf South Pipelines (aka KOCH Pipelines) and Louisiana Gas Service Company had most of the point locations. Both of these natural gas transporters have intricate pipeline systems in the New Orleans area. Gulf South, with 128 miles of mapped pipelines, brings gas into distribution points, while Louisiana Gas Service, with 66 miles, primarily distributes gas to residential, business, and industrial clients. Both operators have submitted hard copy data to the Louisiana Geological Survey. These submissions were very helpful in determining the locations of their transmission pipelines. However, the digital data from NPMS shows great spatial errors for Gulf South (KOCH). Many of the GPS point data in Louisiana Gas Service's submissions did not correspond to any mapped data, digital or hard copy. This reflects the large distribution system the company operates.

A new pipeline operator has entered the study area. Atmos Energy has numerous new warning posts throughout the region. These posts have the same emergency contact telephone number as Louisiana Gas Service, reflecting a corporate cooperative effort. Again, the numerous warning posts for Louisiana Gas Service and Atmos reflect the massive distribution systems operated by these companies.

Air Products, with 18 miles of mapped pipelines, transports hydrogen and synthesis gas to the Chalmette Refining facility. Nitrogen, argon, and oxygen are also produced in the liquefaction and distillation process, but are shipped via truck to end users. Hydrogen is produced and serves as fuel for the space shuttle and other users. The natural gas comes from Southern Natural Gas Pipeline Company into the Michoud air separation facility via an 8-inch pipeline. Other air separation operations in the same area are Air Liquide, formerly Big Three Industries, and BOC Gases, British Oxygen Company. Field observations revealed no pipelines leaving these facilities. Natural gas to fuel the air separation process is piped in by NOPSI. No distribution data has been mapped in this effort. The air separation industry plays an integral part in the refining process, from nitrogen to stabilize the air in storage tanks, to oxygen that completes chemical reactions.

Aircraft Services International and Motiva Enterprises supply aviation fuel to Armstrong International and Lakefront airports. These are short pipeline segments running within the airports for aircraft refueling operations. Fuel is trucked into the tank farms from refineries located nearby on the Mississippi River. There are two pipelines that may also bring aviation fuel to these airports, however, one could not be verified and the other is listed as idle on operator plats. The unverified pipeline is operated by Shell Pipeline Corporation and originates in the Shell Norco refining facility. This line runs mostly through wetlands and has no traceable features on aerial imagery. The other "idle" pipeline is operated by Exxon Pipeline Corporation and has an emergency telephone number with "call collect" above the contact number. These undocumented lines will be addressed in the next phase of mapping for the New Orleans Hurricane impact study.

Air Liquide, formerly Big Three Industries, with six miles of mapped pipeline, has a natural gas pipeline running to Cytek (formerly American Cyanamid) from the west of the study area. Warning posts, however, still list the operator as Big Three. As with many of the mapped pipelines in this study, spatial features were extended to a point where future edgematching efforts would be facilitated. Cytek produces a variety of "building block" chemicals that are used by many other facilities along the Mississippi River chemical corridor. Shell Pipeline Corporation has a 6-inch propylene pipeline going into the facility. Also mapped going into this facility is the Kanab Pipeline Company 6-inch ammonia pipeline (formerly operated by Gulf Central). The ammonia line is extended, resulting in mileage extending out of the study area.

Bridgeline Gas Distribution Company, with 38.5 miles of mapped pipelines, has been in business in the New Orleans area for decades. This is evident when observing the warning posts. Many layers of paint are noticeable on these posts revealing efforts to clearly mark the pipeline's right of way. Bridgeline has submitted hard copy maps to the LGS, however, the scale of the maps causes great spatial errors. Through the use of GPS to verify pipeline locations, many spatial errors were resolved. Also, Bridgeline has been selling parts of their pipeline systems, as noted above. Some of these lines are now operated either by Atmos Energy or by Louisiana Gas Service. Documentation of pipeline divestitures is not readily available, making accurate mapping of pipeline features difficult, at best.

The 12 miles of pipelines mapped for British Petroleum Pipeline Corporation were formerly operated by Murphy Oil, which still operates the tank farm in Chalmette. This crude oil pipeline runs from the British Petroleum Alliance Refinery south of New Orleans in Plaquemines Parish. This refinery processes roughly 230,000 barrels of oil a day.

The Chalmette Refining Corporation, formerly Mobil, has a short pipeline running from the Murphy Oil tank farm to their refinery roughly 1.5 miles away. Another short segment of equal length is operated by Moem Pipelines out of Collins, MS. Both pipelines supply 160,000 barrels of crude oil per day to the Chalmette Refining Corp. No ExxonMobil warning posts were observed in the Chalmette area. Apparently, ExxonMobil either sold their pipeline interests to Collins, Chalmette Refining, and Moem Pipelines Companies, or has corporate agreements with these companies.

The 22 miles of mapped pipelines for Collins Pipeline Corporation are labeled as Exxon Pipeline Corporation on other map sources, digital and hard copy. The warning posts are new notices pasted over old, suggesting a new owner/operator. This 16-inch pipeline originates at the Murphy Oil tank farm and goes north northeast into Mississippi.

Enbridge Pipelines (Louisiana Liquids) is a fairly new operator in the region. Their petroleum products pipeline, roughly five miles in length, appears to have formerly been operated by Western Gas Resources. Western Gas has a similar pipeline transporting propane. Research of maps and digital data shows the former product to be natural gasoline. However, the label on the warning post is non-specific as to petroleum products. Many pipeline warning posts are labeled similarly, mostly because different products are transported through the conduit. The database definition reflects these as commodity1, commodity2, and commodity3, with "cmdty_desc" as a description of all products transported through the pipeline.

The 40 miles of natural gas pipelines operated by Enbridge Pipelines have a different emergency contact telephone number than the products pipeline. This suggests a different operations group for these pipeline entities. Field observations and map research revealed the previous operator to be Creole Gas Pipelines. Most operators simply paste new information over existing warning information on warning posts when they acquire pipeline systems.

Another challenging pipeline mapping effort involved Entergy Corporation. Along with New Orleans Power and Light (NOPSI), Entergy distributes natural gas to clients throughout the study area. Maps submitted to the LGS from Entergy reflect the pipeline features created for the GIS. One of these lines brings natural gas in from the Lake Borgne area; the other pipeline interconnects with Gulf South Pipeline and Enbridge Pipeline.

Enterprise Products has over 42 miles of mapped pipelines throughout southern Louisiana. Other mapping projects funded by the OSRADP show Enterprise pipelines in the Atchafalaya Basin, Baton Rouge area, and Calcasieu Parish. The mapped pipeline for this study was formerly operated by Shell Pipeline Corporation. Map documents show this Natural Gas Liquids pipeline running from the Shell Norco facility to the Warren Petroleum plant in Yscloskey, LA.

Over 14 miles of natural gas pipeline were mapped for Evangeline Gas Pipeline Company in this project. This pipeline leads into Entergy's' Nine Mile Power Plant on the Mississippi River. Several large diameter pipelines fuel this 1917 Megawatt electric production facility. This power plant also utilizes oil for fueling furnaces; however, no fuel oil pipelines were documented leading into the facility. On the other hand, research conducted on the levee system reveals pipelines extending from a wharf into storage tanks on the facility grounds.

Further research will be conducted on this and other facilities along the levee system of the Mississippi River in the course of the hurricane impacts project.

Exxon Pipeline Corporation has two pipelines in the study area. The first, labeled as idle on submitted map documents, runs from the Kenner unloading dock on the Mississippi River to Armstrong International Airport. Witness posts suggest that this line is still active, however, it may be operated by Motiva Enterprises. The map submitted by Exxon notes that the dock has been sold; a new operator is not listed. Warning posts around the airport show both operators, with Motiva not having posts far from airport grounds. Further research will be conducted to determine who operates the pipeline in question.

The other Exxon pipeline, roughly five miles in length, appears to be a gathering pipeline. Originating in the Segnette Bayou Oil and Gas Field, this pipeline carries crude oil to the Permian terminal on the Mississippi River. Unfortunately, only one warning post was observed for this pipeline, and map documents do not show the spatial detail needed for GIS feature development. Also, urban density inhibits the usefulness of aerial imagery.

A new pipeline operation, Gulf Liquids (New River Project) Pipeline, runs over 11 miles of NGL from the plant next to the Chalmette Refining Corporation plant north through St. Bernard and Orleans Parishes. This pipeline is not reflected on any existing reference material housed at the LGS. Aerial imagery was useful when combined with GPS point data in mapping the pipeline. Future efforts will include further contacts with this and other operators to clarify spatial accuracy problems.

Southern Natural Gas Pipeline Corporation (SONAT) has over 95 miles of mapped pipelines in the study area. Although second in total mileage, SONAT pipelines were documented to supply only the Air Products facility with natural gas. The bulk of the transported gas runs from the SONAT Toca Station through St. Bernard and Orleans Parishes to the SONAT Lacombe Station in St. Tammany Parish.

4.0 Conclusions

The compilation and spatial analysis of digital pipeline data for the state of Louisiana is a complex process that will take years to accomplish. The quantity and quality of data sources and the unique geographic parameters of each inhibit the rapid development of a complete pipeline GIS for the state. Assessment of digital data, field investigations, and the development of undocumented data are important to the statewide implementation of a pipeline GIS. The most prominent problems with existing digital data are spatial accuracy. Most of the digital data, digitized by the LGS or submitted by the operators, were incorporated into the GIS and displayed numerous spatial accuracy problems. These issues were addressed by developing pipeline features utilizing GPS technology for spatial control. The GPS point data were also used to verify pipeline operators and commodities transported.

There are numerous hydrocarbon commodities transported within pipelines in Greater New Orleans. GPS point counts generally reflect miles of pipelines. Of the roughly 570 miles of pipelines mapped in this study, 70 % of the pipelines, or 398.23 miles, are natural gas. Crude oil or petroleum is next with 72.49 miles of pipeline. Natural Gas Liquids follows with 53.92 miles of pipelines. Labels on witness posts with LPG or Petroleum Products are vague as to the commodity transported. Table 6.2 reflects the mileage of products found in the project.

Data sources conflict as to commodities on several pipelines. Also, the operators of some pipelines are unclear. Many corporate mergers, divestitures, and other corporate restructuring efforts are not well documented and result in data source conflicts.

No data sources have been found to depict the commodities transported via pipelines over the levees of the Mississippi River. Field observations document the lack of warning posts that



Figure 4.1.1 Unlabeled pipelines over Mississippi River levee

indicate commodities within the pipelines (Figure 4.1.1). Further research will be conducted, and the facility managers will be contacted in order to accurately map these pipelines. However, previous studies have encountered a lack of cooperation from these facility managers. In 1997, a study sponsored by the Louisiana Department of Natural Resources contacted and mailed questionnaires to all of the petrochemical plants in the Mississippi River corridor (and then some). The results were dismal at best. Most questionnaires went unanswered as were many of the telephone calls made as part of the study.

LPG was observed on many witness posts. As previously stated, commodity labels on pipeline witness posts are general and rarely reflect the actual commodity within the pipeline. For example, many LPG and Petroleum Products GPS points have been researched and are believed to transport commodities such as propane, propylene, ethylene, and other hydrocarbon derivatives.

The data developed through this and future pipeline mapping projects will eventually provide a comprehensive pipeline GIS for the state of Louisiana. As more operators develop and submit pipeline data and as the LGS and cooperative partners develop pipeline features, this effort will continue to advance. However, no plans exist for the maintenance and update of these critical data. Given the constant rate of corporate restructuring as well as economic growth, these data will need updating on a regular basis.

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6.0 Appendices

The following table lists pipeline operators mapped for the New Orleans, LA vicinity. Also listed are estimated commodities and estimated mileage.

Pipeline Operator	Commodity	Est. Miles of Pipelines
Air Products	SynGas	9.14
Air Products	Hydrogen	9.14
Aircraft Services International	Aviation Fuel	0.16

Big Three Industries	Natural Gas	5.91
Bridgeline Gas Distribution Company	Natural Gas	38.49
British Petroleum Pipelines	Crude Oil, Petroleum	11.88
Chalmette Refining Corporation	Crude Oil, Petroleum	1.34
Collins Pipeline Company	Crude Oil, Petroleum	21.96
Enbridge Pipelines (Louisiana Liquids)	Petroleum Products	4.72
Enbridge Pipelines (Louisiana Liquids)	Natural Gas	40.41
Entergy	Natural Gas	9.31
Enterprise Products Pipeline	Natural Gas Liquids	42.46
Evangeline Gas Pipeline Company	Natural Gas	14.15
ExxonMobil Pipelines	Petroleum Products	1.68
ExxonMobil Pipelines	Crude Oil, Petroleum	5.07
Gulf Liquids (New River Project) Pipelines	Natural Gas Liquids	11.46
Gulf South Pipelines (aka KOCH)	Natural Gas	128.71
Kaneb Pipelines (Anhydrous Ammonia)	Anhydrous Ammonia	8.34
Louisiana Gas Service Company	Natural Gas	66.1
Moem Pipeline Company	Crude Oil, Petroleum	15.14
Motiva Enterprises	Aviation Fuel	0.51
Shell Pipeline Corporation	Crude Oil, Petroleum	17.1
Shell Pipeline Corporation	Petroleum Products	5.46
Southern Natural Gas Pipeline Company	Natural Gas	95.15
Western Gas Resources	Liquefied Petroleum Gas (Propane)	4.72
TOTAL		568.51

Table 6.1. Pipeline operators in the New Orleans area.

This table shows estimated mileage of pipelines by commodity transported.

Commodity	Miles
Natural Gas (NG)	398.23
Crude Oil/Petroleum (CRD)	72.49
Natural Gas Liquids (NGL)	53.92
Petroleum Products (PRD)	12.53
Hydrogen (H)	9.14
Synthetic Gas (SG)	9.14
Ammonia (AA)	8.34
Liquefied Petroleum Gas (LPG)	4.72

Table 6.2 Commodities Transported by Pipeline.