GEOGIS: A WEB-BASED GEOTECHNICAL DATA MANAGEMENT SYSTEM FOR THE
ALABAMA DEPARTMENT OF TRANSPORTATION

by

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A THESIS

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ABSTRACT

GeoGIS is a web-based geotechnical database management system created for the Bureau of Materials and Tests of the Alabama Department of Transportation (ALDOT). The purpose of GeoGIS is to provide a fast and efficient method of storing and retrieving geotechnical information for ALDOT engineers and consultants. A map displaying projects and a document search page based on document attributes provides users the ability to quickly locate information. A document upload page allows documents to be added to GeoGIS. Access to the GeoGIS website is limited to authorized users determined by ALDOT. A four tiered hierarchy of user classifications determines access privileges to various website features. The lowest level, General User, can view the map and retrieve documents. Consultants inherit the privileges of the General User, and have the ability to upload documents. ALDOT Engineers inherit Consultant privileges, and have the ability to approve uploaded documents and initiate projects to be displayed on the map. The highest level, Administrator, inherits all previous privileges and has the ability to manage user accounts. To date, over 4200 documents have been stored in GeoGIS spanning 432 projects across the state of Alabama. The GeoGIS website is live and currently being utilized by ALDOT and ALDOT consultants. GeoGIS improvements continue to add website functionality and documents on a daily basis.
DEDICATION

This Thesis is dedicated to my family, friends, and professors who have helped mold me throughout my life into the person I am today.
ACKNOWLEDGEMENTS

I would first like to thank my parents who instilled in me necessary and important skills and values through their constant support and encouragement. I would like to thank Dr. Graettinger for his guidance throughout my graduate career. I would also like to thank my co-workers Luke Taylor, Brandon Burnett, and Tom Beutler for their support working through issues in GeoGIS. I would like to thank all of my officemates who made working in the lab and enjoyable experience: Stephanie Farrell, Lane Morrison, Blake Doherty, Michael Sherer, Tyler Daniel, Shane Crawford, Ashley Purkey, and Sufal Biswas. Finally I would like to thank everyone with whom I have cultivated meaningful and important relationship with through my college career; Thanks for helping me through.
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1.1 Introduction

State departments of transportation (DOTs) continuously conduct projects that generate large amounts of data related to geotechnical engineering. This data can range from soil survey reports to design drawings to raw subsurface data, and is often associated with a specific location. Finding past reports and data can often be a challenging and time consuming task. The use of location information as a reference to store and display geotechnical engineering data gives interested parties the ability to locate, analyze, and utilize data for design and decision making.

One method to relate geotechnical engineering data and location information is through the use of a geographic information system (GIS). Geotechnical engineering data and documents can be stored in a database while the data location can be easily displayed on a map. This is an effective method of storage that allows for rapid information retrieval. Geographic information systems also provide extensive spatial and non-spatial data analysis tools, and allow users to query the database.

The Geotechnical Geographic Information System (GeoGIS) was developed in the early 2000’s as a geotechnical database for the Alabama Department of Transportation (ALDOT). GeoGIS was desktop based during Phase I of the project, and displayed four features: project
lines, bridge points, foundation points, and soil boring points, on a basemap that consisted of Alabama counties, roads, railways, and bodies of water. Each of these features was associated with manually keyed in attribute data that included a hyperlink to an HTML page displaying scanned documents. Phase II of the project moved GeoGIS from a single desktop location to the web. A four tiered user type hierarchy was created to define levels of access to the website and capabilities for different users. Additional functionality was added in the form of a document search page, document upload page, and document approval page. To aid users in finding related documents and potentially relevant data, the Family Details page was developed to display all documents from a group of related projects together on the same page. The Document Upload and Document Approval pages allowed users to enter documents into the database through the website.

Phase III of GeoGIS focused on increasing the functionality of the GeoGIS website and increasing the amount of stored data. During Phase III an additional 103 projects and 1266 documents were uploaded to the website, greatly increasing the usefulness of the system. Additionally, a number of functionality changes made the website more user friendly. The Search page was updated so an increased number of fields used to define individual projects were searchable. The ability to search on an increased number of fields was an improvement; however the Search page only allowed users to search on one field at a time, and lacked the ability to search on other important fields. The project initiation process was also improved by automating the process and adding the functionality to control which users can upload documents to specific projects. Phase III also included the ability to upload multiple documents simultaneously which significantly decreased the required upload time. The Document Approval page was changed so that documents pending approval with erroneous information could be
edited instead of having to be re-uploaded. These changes significantly increased the usability of the website, but more functionality was required. Projects that did not fall on state routes, interstates, or U.S. highways could not be displayed on the map because the route files used to define project line locations do not exist for routes other than state routes, interstates, or U.S. highways. Also, projects that occurred prior to the creation of the CPMS table, which is used as the basis for defining and displaying projects in GeoGIS, were not able to be uploaded to the website because the projects were not in the table. Additionally, the process of locating specific projects for uploading and viewing already uploaded documents was inefficient because the user had to know a multitude of fields specific to the specific project to accurately locate it.

The need for improved functionality and increased data storage coupled with the success of Phase III led to the development of the Transition phase of GeoGIS. The Transition phase continued the data additions and functionality improvements such as improved searches and mapping of point data and pre-CPMS table projects, as well as prepared GeoGIS for live deployment and use by ALDOT and ALDOT consultants. The Thesis describes the process implemented in the GeoGIS Transition phase to accomplish those tasks.

1.2 Thesis Organization

This thesis is divided into five chapters. Chapter 2, the Literature Review, discusses the history and implementation methods of database management systems in relation to geotechnical engineering. The Literature Review covers geotechnical databases, relational databases, web-based GIS, and data transfer standards. Chapter 3, the Methodology, details the functionality of GeoGIS, and describes how various aspects of the website work together. Chapter 4, the Results, describe the progress and changes made during the GeoGIS Transition phase. Chapter 5, the Conclusions and Future Work, discusses conclusions formed from the Transition phase as
well as planned additional website functionality to be implemented during future phases.

Appendix A, the GeoGIS User’s Guide, is a detailed description of how to use the website.
CHAPTER 2.0

LITERATURE REVIEW

2.1 Background

Decades of detailed record keeping by government and private agencies across the United States has lead to the creation of massive amounts of geotechnical data (Dasenbrock, 2008; Kunapo et. al, 2005). This geotechnical data is often required by both government engineers and consultants to accurately perform new designs and rehabilitations. This data was traditionally stored as physical documents making access to the data difficult and often requiring travel to central locations where the physical documents were stored. This was a time consuming process, and ineffective process. Additionally, the organization systems were often difficult to understand with multiple projects being stored in boxes separated by index cards, and the maintenance processes were often lacking with boxes not being updated when projects were amended. Increasing the difficulty of locating the desired piece of data was the fact that only one copy usually existed for each document, creating a situation where multiple parties could not use the same document at the same time (Descamps et. al, 2006; Doherty, 2011; Okunade, 2010). Occasionally, engineering data was never officially documented due to the difficulty documenting data and the amount of data. Documents were even damaged due to environmental elements based on where the documents were stored (Okunade, 2010). All of these factors combined to form a physical document management system that was often unmanageable.
Government and private agencies began looking at other methods of data storage to solve these problems. The development of computers and increase in computing power has made the digitalization and storage of historic data viable. Many engineering organizations have begun to store historic data electronically in databases management systems which have the ability to store mass quantities of data. Electronic management systems provide the ability for users to quickly and efficiently retrieve data (Raper and Wainwright, 1987). Data is also protected from environmental elements providing a more stable database. Electronic database management systems also provide increased options for data organization, such as organizing and displaying data spatially. A GIS is well suited to display data with spatial attributes on a map. This data is typically displayed in two dimensions even though geotechnical data is often recorded in three dimensions. A relational database can be employed to relate the third dimension of the data that is not represented on the map (Doherty, 2011). Electronic management systems that incorporate a GIS provide many of the solutions to the problems encountered with physical document data storage methods.

2.2 Geotechnical Databases

Increased computing power and the transfer of physical documents to digital data has allowed geotechnical databases to become increasingly viable and commonplace (Descamps et al., 2006). Functionality standards have been set for geotechnical database systems through the development of geotechnical databases in the past. A fundamental capability for the database is to store large quantities of data that are generated through engineering calculations and designs and measurements taken in the field. Updating and managing this data should be a simple and efficient task. All data in the database should be stored in a manner so that data exchange can seamlessly take place between consultants and agency employees. The database should have
protections in place to prevent data corruption as well as unauthorized user access, but should be available to users both in the office and in the field (Doherty, 2011; Kimmance et al., 1999; Markovic and Lekic, 2006). Additionally, any data analysis should be simple to learn, and allow users to apply sound engineering judgment (Doherty, 2011; Kimmance et al., 1999; Markovic and Lekic, 2006). An effective geotechnical database must provide the necessary functionality and capability to make the system an improvement over traditional physical document storage systems.

2.3 Relational Databases

When creating a geotechnical database, relating raw data displayed in GIS and geotechnical documents can be problematic. A relational database can be established and employed to solve this problem. Relational databases can match raw geotechnical data such as pile driving records or lab test results to documents data such as reports, charts, or scanned historical documents (Kimmance et al., 1999; Kunapo et al., 2005; Nigrelli et al., ). Raw geotechnical data tends to be stored in programs such as Microsoft Access, Microsoft Excel, gINT, and Oracle, and can be imported into other programs for analysis. These data storage programs integrate well with a GIS providing increased functionality for a GIS geotechnical database. GeoGIS uses an SQL Server database to store raw geotechnical data such as soil test results and document data such as foundation and retaining wall reports (Chung, 2007; Dasenbrock, 2008; Descamps et al., 2006; Kunapo et al., 2005). Many organizations employ this method of data and document storage even though storing documents is of a document management system rather than a data management system (Doherty, 2011). Overall, relational databases allow for the storage of all data generated during the life of an engineering project.
2.4 Web-Based GIS

An increasing amount of geotechnical data is being managed by GIS software. GIS software provides a number of functionalities that make GIS an efficient and robust tool when applied to geotechnical databases (Wan-Mohamad and Abdul-Ghani, 2011). Information can be stored in the GIS and displayed graphically as long as the information has location data. This information can then be queried using spatially based or attribute based searches. Additionally, the information can be manipulated and analyzed using various tools that a GIS provides (Chang and Park, 2004; Chung, 2007; Doherty, 2011). All of these functionalities combine to form a system that makes managing geotechnical data a more effective and efficient task.

Sharing the information stored in a GIS geotechnical database with all potential users of the database can be problematic when the GIS is desktop based because access is limited to the computer on which the GIS exists. To solve this issue, many agencies have begun using web-based GIS applications as opposed to traditional desktop applications (Chang and Park, 2004; Kimmance et al., 1999; Nigrelli et al., ). This requires the use of a map server such as Arc Internet Map Server (ArcIMS) which is provided by Environmental Systems Research Institute (ESRI) (Chang and Park, 2004; Dasenbrock, 2008; Mathiyalagan et al, 2005). ArcIMS is broken into a three tiered architecture that includes the client side, middleware, and data provider. The architecture is supported by a four component software package. The client viewer provides users with map functions and spatial query support. The application server connector connects the ArcIMS application server to a Web server. The third component, the application server, generates and provides map images and functions from spatial data in the server. Finally, the spatial server acts as a gateway between the application server and a database
management system (DBMS) by querying the DBMS and providing data to GIS software (Chang and Park, 2004; Doherty, 2011).

More recently, ESRI has released ArcGIS Server for improved development of Web applications over ArcIMS (Doherty, 2011). ArcGIS Server provides advanced GIS functionality including spatial data management, data editing, spatial analysis, geoprocessing tools. While the web development capabilities are improved with ArcGIS Server, the spatial analysis capabilities of desktop-based GIS are still more powerful (Han et. al, 2010; Zhao et. al, 2010; Fangli et. al, 2010). Adobe created FLEX to help improve spatial analysis capabilities and developer productivity. Installing Adobe Flash Player allows FLEX software to run on the client side (Doherty, 2011; Wei et. al, 2010). The use of FLEX with a web-based GIS balances the processing requirements between the client side and the data provider side by using client side computing power to process non GIS data, thereby allowing the data provider to process database requests and GIS functions (Xu, 2010; Wei et al., 2010). Arc Spatial Database Engine (ArcSDE) stores data and tables in one central location, and integrates well with FLEX. Overall, FLEX provides an important and efficient bridge between the client side and data provider in a web-based GIS application (ZuKuan Wei et al., 2010). A schematic of a FLEX application is shown in Figure 2.1.
2.5 Standardization for Data Transfer

The standardization of data is required for sharing information over the internet between interested parties (Beach and Lefchik, 2006; Chang and Park, 2004; Sen and Duffy, 2005). To accomplish data standardization, researchers have developed many methods that have been tested by organizations throughout the years. The Association of Geotechnical and Geoenvironmental Specialists (AGS) system and XML format are two methods that are commonly used (Doherty, 2011; Sekulski et. al, 2006).

AGS first published a set of rules in 1992 using the ASCII format (Sen and Duffy, 2005). The ASCII format is a simple format that allows data to be viewed as text files as well as
imported into spreadsheet and database programs. A list of rules and standards govern the structure of data in an ASCII file so that information can be easily and efficiently transferred between engineering parties (Sekulski et al., 2006; Toll and Cubitt, 2003).

Data Interchange for Geotechnical and Geoenvironmental Specialists (DIGGS) was created to set a world-wide standard for geotechnical data, and utilizes Extensible Mark-up Language (XML) format in conjunction with geographical tags (Sekulski et al., 2006; Sen and Duffy, 2005). XML format was created to make web-based data transfer systems more powerful and efficient. XML adds tags to files which are recognizable by XML compliant web browsers. These tags are placed around data to “mark-up” the data and show that data is related to a category. For instance, data related to a bridge could be identified with a start bridge data tag `<bridge> “…”` and end with an end bridge data tag `</bridge>` which is referred to as an “element”. Attributes can be added to the data by placing lines indented beneath the element which is referred to as “nesting” (Beach and Lefchk, 2006; Doherty, 2011; Toll and Cubitt, 2003). Figure 2.2 displays an example of XML format. The elements and attributes are then used by XML compatible browsers to build a database. XML format also allows for the addition of new elements without the restructuring of the database (Beach and Lefchk, 2006; Toll and Cubitt, 2003).

```
< project >
  < name > “Durham University Project”
  < /name >
  < location > “Durham” < /location >
  < identifier > “00001” < /identifier >
< /project >
```

Figure 2.2 XML Code (Toll and Cubitt, 2003)
2.6 Conclusion

GeoGIS was developed to create a digital, more easily accessible document management system for ALDOT. GeoGIS utilizes a geotechnical database to store geotechnical documents and raw data produced by ALDOT engineers and consultants. The documents and data must be in standardized format to aid the dissemination of knowledge between users. Users of GeoGIS are able to access the database through the GeoGIS website, which utilizes ESRI ArcGIS Server functionality and maps to display spatial representations of the documents and data in the database. The geotechnical database and GIS are link through a relational database which provides connectivity between map features and documents and data.
CHAPTER 3.0

METHODOLOGY

GeoGIS is a tool to aid in the storage and retrieval of geotechnical documents for the Alabama Department of Transportation (ALDOT) and consultants working for ALDOT. The creation of GeoGIS has progressed through four phases. Phases I focused on creating a system for data retrieval while Phase II made that system available on the web. Phase III focused on improving the performance of the website, increasing website functionality, and increasing the amount of data stored. The fourth phase of GeoGIS, the Transition Phase, focuses on continued website development and improvements including increased functionality and data storage, as well as deploying the website for use by ALDOT Engineers and Consultants.

3.1 Overview of Transition Phase Progress

During the Transition Phase, many aspects of GeoGIS were improved. Improvements included new and increased website functionality and increased website functionality. Additional search fields were added to the search page, and the searches on the general search page, document upload search page, and project initiation search page were standardized, creating a more efficient, user friendly search process. The document type selection process on the document upload page was adjusted to reduce time required to upload. A Help button was added to GeoGIS as a new functionality and helps users solve issues. The My Projects page provides entirely new GeoGIS functionality, and is a more efficient way to find documents for a
specific project as well as edit documents pending approval. The My-Upload-Ready-Projects button is a similar feature on the document upload page that allows users to quickly find all projects to which they are assigned. Historic project creation is also a new feature that has been added to GeoGIS allowing projects from the pre-CPMS era to be entered into the database and searched by users.

3.2 CPMS Table

The Comprehensive Project Management System (CPMS) table provides connectivity for the various GeoGIS functionalities, and is also used for accounting purposes at ALDOT. The CPMS table fields used by GeoGIS are shown in Table 3.1. The only unique field in the CPMS table is the PJ_REF_ID, also known as the CPMS number. Each CPMS number has an associated project number which is concatenated from the FA_PREFIX_I, FA_RT_ID, and FA_AGRET_N. A specific project number can have multiple CPMS numbers. The three fields of a project number are used to link various phases of a project together. Projects are located using the route id (RT_ID) which identifies the route the project lies on, and beginning mileposts (BEG_MP) and ending milepost (END_MP) which identify the beginning and ending mileposts of the project. Projects on Interstates, U.S. Highways, and State Routes can be displayed on the GeoGIS map as linear events using the route ID and beginning and ending mileposts.

PJ_FAML_Y_I refers to the family id and links related projects. ALDOT assigns different tasks such as geotechnical research and foundation installation on a project to different CPMS numbers, and the family if links these various CPMS numbers together. SCPE_ID refers to the scope of the project which is labeled PE for preliminary engineering or CN for construction based on the phase of the project. PJ_DES refers to the description of the project. For mapping
and uploading purposes, an “Initiated” field is added to GeoGIS to determine whether a project has been initiated in GeoGIS.

Table 3.1 Explanation of CPMS Table

<table>
<thead>
<tr>
<th>Field</th>
<th>Common Name</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>PJ_REF_ID</td>
<td>CPMS Number</td>
<td>Unique identifier of project phase</td>
<td>100004072</td>
</tr>
<tr>
<td>RT_ID</td>
<td>Route ID</td>
<td>Route on which project is located</td>
<td>I020</td>
</tr>
<tr>
<td>BEG_MP</td>
<td>Beginning Milepost</td>
<td>Beginning milepost of project</td>
<td>10.2</td>
</tr>
<tr>
<td>END_MP</td>
<td>Ending Milepost</td>
<td>Ending milepost of project</td>
<td>20.5</td>
</tr>
<tr>
<td>SCPE_ID</td>
<td>Scope</td>
<td>Project phase</td>
<td>PE</td>
</tr>
<tr>
<td>FA_PREFX_I</td>
<td>Project Prefix</td>
<td>Concatenate to form project number</td>
<td>IM</td>
</tr>
<tr>
<td>FA_RT_ID</td>
<td>Project Route ID</td>
<td></td>
<td>I020</td>
</tr>
<tr>
<td>FA_AGRET_N</td>
<td>Project Agreement Number</td>
<td></td>
<td>306</td>
</tr>
<tr>
<td>PJ_FAMLY_I</td>
<td>Family ID</td>
<td>Number assigned to all projects on a route</td>
<td>21694</td>
</tr>
<tr>
<td>PJ_DS</td>
<td>Project Description</td>
<td>Description of work performed</td>
<td>Bridge widening I-20 over SR-4</td>
</tr>
<tr>
<td>Initiated</td>
<td>Project Initiation</td>
<td>Flag column for initiated projects</td>
<td>0 or 1</td>
</tr>
</tbody>
</table>

3.3 Website Functionality

The GeoGIS website can be accessed through the URL: http://geogis.crdl.ua.edu. Users must enter a username and password to access the site. Once a user is logged on, the homepage is displayed as shown in Figure 3.1. The buttons across the top of the page correspond to various functionalities of the website. The following section describes those functionalities as well as which functions are available to various user classifications.
3.3.1 GeoGIS User Classification

GeoGIS utilizes ASP.NET Login View to restrict access to authorized users only. The GeoGIS website relies on a hierarchy of user levels to establish user privileges and capabilities. There are four user classifications in GeoGIS which are General User, Consultant, ALDOT Engineer, and Administrator. General Users have the lowest level of access, and are able to view the map, use the search page, view the family details page, and download documents. Consultants inherit all abilities of General Users, and are also able to upload documents. ALDOT Engineers inherit all privileges of General Users and Consultants, and are also able to approve uploaded documents and initiate projects. Administrators inherit all previously mentioned capabilities, and are also able to manage user accounts. Table 3.2 shows the user classifications and privileges.

Table 3.2 User Classification Privileges

<table>
<thead>
<tr>
<th>User Classification</th>
<th>Privileges</th>
</tr>
</thead>
<tbody>
<tr>
<td>General User</td>
<td>View the Map, Search the Website, Download Documents</td>
</tr>
<tr>
<td>Consultant</td>
<td>Previously listed privileges, Upload Documents</td>
</tr>
<tr>
<td>ALDOT Engineer</td>
<td>Previously listed privileges, Approve Documents, Initiate Projects</td>
</tr>
<tr>
<td>Administrator</td>
<td>Previously listed privileges, Manage User Accounts</td>
</tr>
</tbody>
</table>
3.3.2 GeoGIS Map

The GeoGIS map is available to all user levels and provides users the ability to spatially search for projects. Clicking the map button opens a new window with an ESRI base map centered on the state of Alabama. The map has three base maps: street, topographic, and satellite, all of which are available in GeoGIS. The street view, which is the default view, displays streets, street names, bodies of water, and municipality names. The topographic view displays contours and similar, but less detailed, information as the street view. The satellite view contains only satellite imagery with no labeled features. The three map views are shown in Figure 3.2.
The map currently displays a projects layer which is represented by red lines and points. When the map window is first opened, outlines of the counties in Alabama are displayed, and hovering the mouse over a county shows the county name as shown in Figure 3.3. Once a county of interest is identified, clicking the county will zoom the map to that county, and draw all layers associated with that county as shown in Figure 3.3. Once the layers are drawn, points and lines can be clicked to return the Family Details page which is described in the following
section. Users can zoom and pan within a county to locate projects, or click another county to draw that county’s projects.

Figure 3.3 a) Initial map view displaying counties b) Zoomed in map view of selected county

3.3.3 GeoGIS Family Details Page

The Family Details page is available to all users, and provides an organized way for users to quickly and easily retrieve related documents related to a family of projects. As previously stated, clicking a point or line on the GeoGIS map will take the user to the selected Family Details page for a project. Figure 3.4 shows a typical Family Details page. This Family Details page displays all uploaded and approved documents from all projects that share the same Family ID as the originally selected project. A checklist of the related projects is displayed at the top of the page, and each project can be toggled on and off so that only project specific documents are shown. Listed next to each project is general information about the project including CPMS
number, associated Bridge Identification Numbers (BINs), project number, and project description, and a link to the project on the map. Associated BINs were determined from comparing the beginning and ending mileposts of projects in the CPMS table to the route and milepost of the bridge. Documents are divided into preconstruction documents and construction documents, and are further separated into sub categories called document types.
Family Details

Family ID: 21598

CPMS# 100038689  BIN 18491
Project 4 BR-0012(508) REPL BIN 002670 ON SR-13 (US-43) @ SPRINGFIELD CREEK STR 13-46.21.6.4
BARREL CQ 12X12X32 CONC CULV (SMFF=44.7, STAT=2)

Zoom to project on the map.

Preconstruction Records
- Soil Survey (2)
- Copy of des for geotech.dgn
  BIN 18491
- Sod.mn
  BIN 18491
- Materials Report (0)
- Slope Study Report (0)
- Retaining Wall Report (0)
- Culvert Report (0)
- Other Geotechnical Reports (0)
- Geohydrologic Report (0)
- Geotechnical Data (1)
- Empty M Tablas.doc
  BIN 18491
- Foundation Analysis (0)
- Correspondence (1)
- sumlabresults.doc
  BIN 18491
- Photo (1)
- Sod Sample Test Request.doc
  BIN 18491
- Foundation Report (0)
- Landslide Report (0)
- Sinkhole Report (0)
- Other (1)
- chatta82cover.pdf
  BIN 18491

Construction Records
- Bridge Card Image (0)
- Bridge Identification Number (0)
- Hammer Submittal (0)
- Bearing Curves (PDA Results) (0)
- Test Pile Driving Record (0)
- Drilled Shaft Excavation Log (0)
- Drilled Shaft Pouring Record (0)
- Load Test (0)
- Plan (2)
- Copy of pg2_for_geotech.dgn
  BIN 18491
- pg1_for_geotech.dgn
  BIN 18491
- Correspondence (0)
- Photo (0)
- Field Monitoring (0)
- Other (0)

Figure 3.4 Family Details Page
3.3.4 Search Page

The Search page is available to all user levels and allows users locate documents in the GeoGIS database. Clicking the search button returns the document search page as shown in Figure 3.5. Useful fields from both the CPMS table and the document database are displayed and can be searched in any combination. After filling out the fields, clicking search queries the SQL Server database and returns all documents that match the search criteria. Each matching document has a link to download the document, a thumbnail view of the document, and general information about the document such as project number, document type, and project description. Each document also has a link to both the Family Details page and Document Details page.

![Figure 3.5 Search Page](image-url)
3.3.5 Document Button

The Document button provides easy access to document associated functionality including the document upload page and the document approval page. These pages encompass the workflow of a document through the GeoGIS website. Documents are submitted to the website through the Document Upload page, and subsequently, committed to the database through the Document Approval page.

3.3.5.1 Document Upload Page

The Document Upload page provides the functionality of submitting documents to GeoGIS for users with consultant level privileges and higher. A drop down menu appears on-hover over the document button with one option being document upload. Clicking the document upload link on the drop down menu provides access to the document upload page.

The Document Upload page requires users to first select a project to upload documents to. Users are provided multiple options to identify the correct project. For consultants and ALDOT Engineers who are assigned to a limited number of projects, the simplest way to select a project is to use the My-Upload-Ready-Projects button. Another option for selecting a project is to search for the project based on any combination of the search fields, as shown in Figure 3.6, which mirror the search fields on the general search page.
Clicking the My-Upload-Ready-Projects button returns a page displaying all of the projects permissible for upload by the user. A similar page is displayed for searches using specified search fields; however, those search results can include projects the user does not have permission to upload to. The user can then choose the project of interest from the list by clicking the radio button next to the correct project and clicking the begin uploading button. Figure 3.7 shows a typical results page for both the My-Upload-Ready-Projects button and the search on fields query.
Once a project has been selected, the user is prompted to choose a document to upload. Clicking the choose file button brings up a window allowing a user to browse a computer for files to upload as shown in Figure 3.8.
Once a file is chosen, clicking the add button allows a user to attribute the document in various categories. Figure 3.9 shows the attributable categories for a document.

![Document Attribute Assigning Page](image)

**Figure 3.9 Document Attribute Assigning Page**

The CPMS number box and at least one document type box are required to be checked for a document to uploaded. The CPMS box is automatically checked if only one CPMS number is available. The user must manually select the correct CPMS number if more than one is
available. Bridge Identification Numbers (BINs) can be associated with documents on the Document Upload page. Users can choose to add BINs from a list of bridges that are in the vicinity of the project line, or manually input BINs that are not listed.

Selecting the correct document type is a crucial step for maintaining organization of the database. There are two lists of documents types, as shown in Table 3.2, which include preconstruction and construction. One of the two lists will be automatically displayed based on the designation of the project as pre-engineering (PE) or construction (CN). Each CPMS is labeled either PE or CN. The displayed list can be changed by selecting the radio button next to the desired list, as shown in Figure 3.9 below the BIN entry box. The user selects all of the document types that apply by checking the boxes next to the document type name. If a document does not fall into one of the categories listed, the document can be listed as “Other” in either the preconstruction or construction categories. Once the document is approved and displayed on the Family Details page, the document will be listed under each document type selected on the document upload page.
Table 3.3 List of Document Types

<table>
<thead>
<tr>
<th>Preconstruction</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Survey</td>
<td>Bridge Card Image</td>
</tr>
<tr>
<td>Materials Report</td>
<td>Bridge Identification Number</td>
</tr>
<tr>
<td>Slope Study Report</td>
<td>Hammer Submittal</td>
</tr>
<tr>
<td>Retaining Wall Report</td>
<td>Bearing Curves (PDA Results)</td>
</tr>
<tr>
<td>Culvert Report</td>
<td>Test Pile Driving Records</td>
</tr>
<tr>
<td>Other Geotechnical Reports</td>
<td>Drilled Shaft Excavation Log</td>
</tr>
<tr>
<td>Geohydrologic Report</td>
<td>Drilled Shaft Pouring Record</td>
</tr>
<tr>
<td>Geotechnical Data</td>
<td>Load Test</td>
</tr>
<tr>
<td>Foundation Analysis</td>
<td>Plan</td>
</tr>
<tr>
<td>Foundation Report</td>
<td>Correspondence</td>
</tr>
<tr>
<td>Landslide Report</td>
<td>Field Monitoring</td>
</tr>
<tr>
<td>Sinkhole Report</td>
<td>Photo</td>
</tr>
<tr>
<td>Correspondence</td>
<td>Other</td>
</tr>
<tr>
<td>Photo</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

Multiple documents are easily uploaded at the same time. The user simply chooses a new document to upload and adds the document to the page. The new document can be attributed the same as the previous document or adjusted to meet the specific document attributes. Each document that is uploaded will display a low resolution thumbnail view of the document as well as a link to download the file. Clicking the submit button stores the document in a temporary database table which is referenced by the Document Approval page.

3.3.5.2 Document Approval Page

The Document Approval page allows users with ALDOT Engineer privileges and higher to review uploaded, pending documents. Uploaded documents are not displayed on the family details page until after the documents have been approved. The document approval page is accessible from the document button drop down menu. Clicking the document approval link
returns a list of uploaded documents that are pending approval. ALDOT Engineers are only shown documents from projects to which the engineer is assigned while Administrators are shown all documents pending approval. All pending documents have a link to download the document, as well as general information such as CPMS number, BINs, document type, document phase, and when and by whom the document was uploaded, as shown in Figure 3.10. Document approvers have the option to approve, edit, or delete the document. Clicking edit will bring the user to a page similar to the document upload page shown in Figure 3.9 where documents can be attributed. After edits have been made, clicking the submit button will commit the document to the GeoGIS database.

![Figure 3.10 Document Approval Page](image)
3.3.6 My Projects Page

The My Projects page allows users to quickly find documents from projects to which they are assigned, and is available to users with consultant level privileges or higher. Clicking the My Projects button returns a page, as shown in Figure 3.11, displaying all projects to which the user has been assigned, similar to the page displayed by the My-Upload-Ready-Projects button.

![Figure 3.11 My Projects Page](image)

To access documents from a specific project, the user checks the box next to the project of interest and clicks the view documents button. All documents that have been uploaded to the project are displayed, and are divided into pending documents and approved documents as shown in Figure 3.12. Document details and general information displayed are similar to those described on the Document Approval page. Approved documents are permanently in the
database and can only be modified or deleted by system administrators. Pending documents however, can be edited or deleted by the user who uploaded the document.

Figure 3.12 My Projects Documents Page

3.3.7 Administration Button

The Administration button provides users the ability to manage user accounts and display which projects are displayed on the map. A drop down menu under the Administration button allows users access to the Account Administration page, Manage Users page, Project Initiation page, and Create Historic Projects page, based on the user level required to access each page. Only links to accessible pages are displayed.

3.3.7.1 Account Administration Page

The Account Administration page allows users to change personal email addresses and passwords, and is available to all user levels. The page displays username, current email address, and user level, as shown in Figure 3.13. New passwords are effective upon the subsequent login after the password has been changed.
3.3.7.2 Manage Users Page

The Manage Users page allows users with administrator privileges to create, edit, and delete user accounts. Creating a user account requires the administrator to input a new username, password, email address, and assign a user level. Editing a user accounts allows the administrator to change a user’s password, email address, and user level. Deleting an account permanently removes the user account from GeoGIS. The manage users page is shown in Figure 3.14.
3.3.7.3 Project Initiation Page

The Project Initiation page is available to users with ALDOT Engineer privileges and higher. Initiating a project displays the project line or point on the map, and allows documents to be uploaded to the project. A search page, shown in Figure 3.15 and the search results page shown in Figure 3.16, allows users to find the project of interest for initiation.
Once a project is chosen, users are then assigned to that project as shown in Figure 3.17. Users are assigned by checking the boxes next to the user names, which then gives the selected users the ability to upload to that project. Projects that are assigned to users will be displayed on the My Projects page and the My-Upload-Ready-Projects page as previously discussed in Section 3.3.6 and 3.3.5.1 respectively.
Initiated projects are separated from non-initiated projects in the relational database by a “flag.” When a project is initiated, the “Initiated” field in the database is changed from zero to one. This flag allows only initiated projects to be displayed on the map.

3.3.7.4 Create Historic Project Page

The Create Historic Projects page allows users with ALDOT Engineer privileges and higher to add historic projects to the GeoGIS. Historic projects include all projects that occurred before the CPMS numbering system was implemented. To incorporate these projects into GeoGIS, the projects must be assigned a CPMS number. An historic project is created by adding the project Route ID, Beginning and Ending Milepost, Route Type ID, Scope ID, and Project Description as shown in Figure 3.18. The GeoGIS system automatically assigns the project a new CPMS numbers starting at 900000000 and incrementally increasing with each additional
historic project added. Once the historic project has been assigned a CPMS number, the project then has the same functionality as all other projects in the database.

![Historic Project Creation](image)

Figure 3.18 Historic Project Creation Page

3.3.8 Help Button

The Help button is available to all user levels and provides users with trouble-shooting assistance. A drop down menu is displayed on-hover and allows users to either report a problem or download the GeoGIS User’s Guide.

The report problems button allows a user to report an issue with the website via email. Clicking the report problems button displays a pop-up box, shown in Figure 3.19, which prompts
the user to enter an email address for reply messages and provides an area for the user to describe
the problem. The message is then sent to GeoGIShelp@Gmail.com, which is monitored by site
administrators.

![Report Problem Pop-up box](image)

Figure 3.19 Report Problem Pop-up box

3.3.9 Hummingbird Link

The Hummingbird button provides a link to the ALDOT database where engineering and
business documents are stored. This database is separate from GeoGIS and requires a user to
have a separate username and password provided for Hummingbird. The Hummingbird link
takes a user to the login for Hummingbird.
3.5 QA/QC

The main motivation behind GeoGIS was for ALDOT Engineers and consultants to have the ability to quickly and efficiently locate relevant geotechnical data and documents. This goal would not be met if documents in GeoGIS are uploaded to incorrect projects or labeled as incorrect document types. The Transition Phase implemented two approaches to ensuring documents and data are accurate.

3.5.1 Optical Character Recognition

Optical Character Recognition (OCR) software has the ability to search PDFs for user specified words. Within a document type or project in GeoGIS, specific keywords will commonly appear. Using an average keyword frequency, document types can be checked. For example, if a document is labeled as a Foundation Report, but does not say Foundation anywhere in the document, the document may be labeled incorrectly and require attention. OCR is also used to verify if a document is uploaded to the correct project. For example, if a document is uploaded to a project over the Black Warrior River, but the document repeatedly refers to the Tennessee River, the document may be uploaded to the wrong project and require attention.

3.5.2 Document File Type

Another method of QA/QC is to study the file types of documents. Certain file types are more commonly associated with specific document types. For instance, most documents labeled as photo are typically .jpg or .tif files. If a documents is labeled a photo and is a .doc or PDF format, the file may be labeled incorrectly and require additional attention. Table 3.4 shows the expected file formats for each document type.
### Table 3.4 Typical File Types for Each Document Type

<table>
<thead>
<tr>
<th>Document Type</th>
<th>.PDF</th>
<th>.doc</th>
<th>.tif/.jpg</th>
<th>.zip</th>
<th>.txt</th>
<th>.xls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Survey</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials Report</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slope Study Report</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retaining Wall Report</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culvert Report</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Geotechnical Reports</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geohydrologic Report</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geotechnical Data</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundation Analysis</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Foundation Report</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landslide Report</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinkhole Report</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge Card Image</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge Identification Number</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hammer Submittal</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearing Curves (PDA Results)</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Pile Driving Records</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drilled Shaft Excavation Log</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drilled Shaft Pouring Record</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load Test</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Plan</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Field Monitoring</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Correspondence</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Other</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

#### 3.6 Conclusions

GeoGIS provides a crucial service to ALDOT and consultants by hosting a database that efficiently stores and retrieves geotechnical documents. GeoGIS provides document storage by allowing users to upload documents through the use of the project search and my upload ready
projects functions, document upload pages, and document approval pages. The historic project creation function also allows for document storage by providing a method for pre-CPMS table documents to be stored. Documents are retrieved by spatial searches using the map or by attribute searches using the general search page. Documents displayed from search results are downloadable, and related documents can be easily viewed through the Family Details page. Chapter 4 discusses the enhancements made to GeoGIS from Phase III to the Transition Phase and the increase in the amount of data stored in the database.
CHAPTER 4.0

RESULTS

A number of improvements, changes, and augmentations resulted from the work performed during this phase. The work was focused on transitioning GeoGIS from a test platform to a live platform as well as improving the site. Increased functionality and data availability were key aspects to overall site improvements, and were instrumental in the smooth transition to a live platform.

4.1 Documents Uploaded

At the completion of Phase III, 1266 documents had been uploaded for 103 projects from 41 counties. These documents originated from Material and Test’s digital archives dating to years 2010 and before. During this phase, ALDOT submitted additional, current documents from the digital archives to bringing the GeoGIS database up to date. After review of the complete digital archives, 4262 files have been uploaded to 432 projects from 54 counties across the state of Alabama. Figure 4.1 and 4.2 show thematic maps of the total number of digital projects uploaded for each county and the total number of documents uploaded for each county respectively. The number of documents stored in the GeoGIS has significantly increased during this phase.
Figure 4.1 Number of Projects Uploaded per County
Figure 4.2 Number of Documents Uploaded per County
4.2 GeoGIS Deployment

Deploying a live, useable version of the GeoGIS to ALDOT was a main goal of the Transition Phase. To aid in deployment of the GeoGIS, two training sessions were held at the ALDOT headquarters in Montgomery. Over 60 people attended including ALDOT personnel from multiple division and ALDOT consultants who will be directly working with the website. Login credentials have been given to 69 users of the GeoGIS website.

4.3 Site Improvements

The Transition Phase incorporated numerous site improvements that enhanced both functionality and usability. Additional methods of locating projects were created for the purpose of both uploading and retrieving documents. New methods were developed to display projects on the map that were previously unable to be displayed, and users were provided troubleshooting options.

4.3.1 My Projects Page

The My Projects page was created to assist consultants using the GeoGIS website in finding documents uploaded to current projects. The My Projects page displays all the projects that the consultant has permission to upload to, and selecting a specific project returns a page that displays all of the documents uploaded to that project. The documents are divided into documents that have been approved and documents that are pending approval. Consultants have the ability to edit and delete personally uploaded documents that are pending approval, or view documents that have already been approved. This functionality allows consultants to quickly find relevant documents, and edit or delete personally uploaded documents.
4.3.2 My Upload Ready Projects

The My-Upload-Ready-Projects button was added onto the document upload search page, to allow consultants to view all the projects that they have permission to upload to. Clicking the My-Upload-Ready-Projects button displays a similar page to the My Projects page which displays all projects associated with that consultant. Selecting a specific project takes the user to the document upload page, allowing the user to choose documents to upload and attribute. Since consultants will have a limited number of projects available to upload to at one time, the My-Upload-Ready-Projects page simplifies and expedites the upload process.

4.3.3 Historic Project Creation

Historic projects include all projects that occurred before the CPMS numbering system was implemented. Documents and files exist for these projects, but do not have a matching CPMS number, preventing them from being uploaded to the website. The Create Historic Projects page allows ALDOT Engineers to initiate an historic project. The website automatically assigns projects new CPMS numbers starting at 900000000 and systematically increasing with each additional historic project added. Once the historic project has been assigned a CPMS number, the project then has the same functionality as all other projects in the database. This functionality allows the amount of data stored in GeoGIS to be significantly increased by establishing a method for pre-CPMS table documents to be uploaded.

4.3.4 Map Improvements

As projects have been added to the GeoGIS database, the amount of time required to draw project lines and points on the map has increased significantly. To decrease the loading time of the map, currently no project lines or points are initially drawn when the map is loaded. Only after a user selects a specific county of interest are any project lines and points drawn, and
only project lines and points within the selected county are drawn. Additional map display improvements include county name on-hover to assist users attempting to locate counties of interest, and color coding county outlines based on function.

A number of projects in the CPMS table have values for beginning milepost but not ending milepost. When mapped, the project line start at the point designated by the beginning milepost and continues until the route ends, despite the fact that the files associated with the project pertain to only a specific section of the route. A separate shapefile was created with fields similar to the county and local routes shapefile, and the projects with no ending mileposts were then mapped as points instead of lines, based on the starting point of the project given in the beginning milepost field. This procedure more accurately displays projects with no ending milepost on the map.

4.3.5 County and Local Routes

In previous phases of this research, county and local routes could not be mapped in GeoGIS because a route file for these roads does not exist. The county and local route projects could be initiated, and have documents uploaded to them, but the projects could not be displayed on the map. To display the projects on county and local routes, a shapefile was created that included the CPMS number (PJ_ROUTE_ID), Family ID (PJ_FAMILY_I), latitude, longitude, project description (PJ_DES), and the fields that concatenate to form the project number. The latitude and longitude are manually determined as the point of most importance along the project (i.e. bridge, intersection). The county and local route projects are then displayed on the map as points that when clicked, display the family details page, and provide the same functionality as project lines used to represent State Routes, U.S. highways, and Interstates. The County Projects
shapefile currently must be manually updated when new county and local route projects are initialized.

4.3.6 Project Initiation Refinement

At the beginning of this phase, initiating a project allowed the project to be displayed on the map, and allowed users to upload to that project. Additional functionality was added to project initiation page by allowing user to be assigned to projects. This functionality restricts consultants and engineers to only uploading documents to projects to which they are assigned, and restricts engineers to only approving documents from projects to which they are assigned. The additional project initiation refinements help prevent clutter for the user, and make locating, uploading, and approving the correct documents a simpler and more user friendly process.

4.3.7 Help Button

The addition of two options under the Help button has provided users of GeoGIS with the ability to personally solve minor problems and communicate with system administrators about other issues. In the case where a user lacks knowledge of site functionality, downloading the GeoGIS User’s Guide, shown in Appendix A, will provide detailed descriptions of all site functionality. The other option under the help button, the Report Problems button, allows a user to report an issue with the website via email as discussed in section 3.3.8. Such problems include mislabeled document types, documents uploaded to the wrong project, broken document links, and user account issues. Administrators can then respond to the reported issue by using the return email address field provided by the user.
4.3.8 Improved Searches and Queries

The three pages with search functionality, the general search page, document upload page, and the project initiation page were dissimilar in Phase III. A uniform search page was created that had common fields across all three pages and mimicked the CPMS table searches used by ALDOT engineers. Additionally, the queries were refined and optimized to decrease the time the website required to perform searches. The new additions standardize searching on the GeoGIS website, provide users with greater power when performing searches, and increase the user-friendliness of GeoGIS.

4.3.9 Increased Administrative Functionality

In Phase III, administrative functionality was limited to users with administrative privileges creating and editing user accounts. To increase functionality, site administrators were given the ability to remove user accounts from GeoGIS, and all user levels were given the ability to edit personal accounts. This includes changing personal passwords and email addresses. Additionally, three new fields were added to the user table including first name, last name, and company name. These new fields simplify the process of choosing which users are assigned to projects on the Project Initiation page.

4.4 Conclusions

The increase in amount of documents stored in GeoGIS and the improved website functionality during the Transition Phase have increased the usefulness and capabilities available to users. The increased number of documents available to users has made the website more effective for researching upcoming projects, a primary goal of this research project. In addition, locating and uploading documents has been simplified to improve user interactions with the website.
CHAPTER 5.0

CONCLUSIONS AND FUTURE WORK

5.1 Conclusion

The Transition Phase of GeoGIS successfully improved website functionality, increased the amount of documents stored in the database, and deployed GeoGIS as a spatially-related fully functioning document management system for ALDOT. ALDOT Engineers and Consultants were given login credentials and are currently using the GeoGIS website for both locating documents and uploading new documents. The number of documents in the GeoGIS database increased by more than three times over what was in the database at the conclusion of the previous phase.

Additionally, the functionality of the GeoGIS website was increased providing more user-friendly processes. Searching capability for documents on the general search page, document upload page, and project initiation was increased to allow users the ability to create more powerful queries. The amount of time required to find document associated with assigned projects was decreased through the addition of a new “My Projects” page. In addition, changes to the Document Upload page now allow users to more efficiently choose document types. Finally, the Help button was updated to provide options for users in need of assistance. A
downloadable GeoGIS User’s Guide and a Report Problems button to send emails to the system administrators are now parts of the help button.

5.2 Future Work

The main goal for the next phase of this project is continued deployment and support of the GeoGIS website for ALDOT and its consultants. This includes increased website development as suggested by ALDOT and users of the website, increased data availability in the form of documents from historic projects, and the addition of Environmental and Materials data to the database. Additionally, GeoGIS will be positioned to be installed at ALDOT at the completion of the next phase. Tasks involved in the future work for GeoGIS are listed in the following section.

5.2.1 Preparing GeoGIS for Installation at ALDOT

To prepare the GeoGIS website for installation at ALDOT, the UA team will work with Computer Services and begin to make changes to the site to facilitate future transfer. During the monthly GeoGIS meetings, Computer Services will provide input on ALDOT standards and suggest changes to the site. Code and database changes will be made by UA to conform to ALDOT standards. A formal website transfer plan will be developed to include source code modifications to accommodate future installation at ALDOT, system documentation to assist in site transfer, and installation and level-of-effort plan to move the GeoGIS site to ALDOT.

5.2.2 Addition of Environmental and Materials Data

ALDOT is requesting an expansion of the GeoGIS application by incorporating documents from the Environmental and Materials groups within Materials and Tests.
Incorporating these new groups into GeoGIS will require an integrated approach to maintain the ease and straightforwardness of the current data entry and retrieval process. Increased programming and development of the GeoGIS site will include additional website and map functionality as well as increase the amount of data stored in the system.

New functionality will include the addition of Environmental and Materials map layers which can be viewed in any combination with the existing Geotechnical map layer. Projects in the new layers may be displayed as polygons in addition to points and lines traditionally displayed on the map. Additionally, new environmental and materials document types will be added to the Family Details page while certain current document types will be shared among the groups. This will require a common naming system and links between all three groups. Changes will also be made to the project initiation process so that each project can be initiated separately by any of the three groups.

5.2.3 Manual Project Location

Projects that are on county and local routes cannot be automatically mapped in GeoGIS. Instead, a shapefile must be manually created with user determined location. Additionally, historic projects are not in the CPMS table and must be manually mapped. Currently, any project can be initiated even if the project is not able to be mapped. A check will be placed on the Project Initiation page to prevent projects without map-able location information from being initiated. If a project is selected that is either on a county or local route or does not have location data, the project initiator will be prompted to manually enter the location of the project. The project location can be entered as X&Y coordinates, mileposts along a known route, or drawn on the map depending on what information is available and most appropriate for the project.
5.2.4 Additional User Level

Currently, all documents in the database are accessible to all users. ALDOT and ALDOT consultants have expressed liability concerns regarding the ability of any user to download a live document such as spreadsheet created by another user, use the document in design, and have the liability reside with the original creator of the document. To solve this problem, consultants and general users will only be allowed to view PDF documents. This will require all live documents uploaded to the website to be converted to a PDF and stored as both a PDF and live document. Additionally, a new GeoGIS Approver user level will be created. This new user level will have the same privileges as the current ALDOT Engineer user level. The ALDOT Engineer user level will no longer have the privilege to approve uploaded documents or initiate projects. Instead, it will have the same privileges as the consultant user level with the exception that it can view and download live documents. Table 5.1 describes the proposed user levels and privileges.

Table 5.1 Proposed User Classification Privileges

<table>
<thead>
<tr>
<th>User Level</th>
<th>Privileges</th>
</tr>
</thead>
<tbody>
<tr>
<td>General User</td>
<td>View the Map, Search the Website, Download PDF Documents</td>
</tr>
<tr>
<td>Consultant</td>
<td>Previously listed privileges, Upload Documents</td>
</tr>
<tr>
<td>ALDOT Engineer</td>
<td>Previously listed privileges, Download any type of document</td>
</tr>
<tr>
<td>GeoGIS Approver</td>
<td>Previously listed privileges, Approve Documents, Initiate Projects</td>
</tr>
<tr>
<td>Administrator</td>
<td>Previously listed privileges, Manage User Accounts</td>
</tr>
</tbody>
</table>

5.2.5 Map Functionality Improvements

To increase the usefulness of the map, a number of improvements are required. Displaying the CPMS number, project number, and project description when the mouse is hovered over a project and distinguishing stacked project lines will assist users in locating a specific project of interest. Additionally, functionality will be added to allow users to manually specify the location of a project during project initiation in the instance that location data is not
available from the CPMS table. This will require the capability for users to click a point, draw a line, or determine the extents of a polygon on the map to correctly place the project. This data location information will then be stored in a table, and the user prescribed point, line or polygon displayed on the map after the project is initiated.

5.2.6 Increased Data Availability

The amount of data available in GeoGIS will continue to increase through the addition of new data from current projects and newly digitized historic geotechnical data. Consultants and ALDOT Engineers will upload documents from current projects, while UA will work with ALDOT interns to upload historic geotechnical data. Optical Character Recognition (OCR) software will be used a form of QA/QC. Historic geotechnical data will be scanned at 300+ Dots per Inch (DPI) so that OCR software can be utilized. Newly uploaded documents from consultants and ALDOT Engineers will automatically be OCR compatible if the documents are converted to PDF from a .doc format.
REFERENCES

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Sekulski, E. M., Chadwick, N. C., & Pickles, A. C. (2006). Data transfer and the practical application of geotechnical databases. (pp. 1) American Society of Civil Engineers. doi:10.1061/40803(187)110


APPENDIX A

GeoGIS User’s Guide

Alabama Department of Transportation
University of Alabama
October 21, 2012
1.0 Introduction

This guide will describe the process of using the GeoGIS site, beginning with the privileges given to the general user, followed by consultant privileges, ALDOT engineer privileges, and finally administrative privileges. Each section of this Users Guide will explain the tasks that can be performed by each user type. This guide will also explain how to add and edit projects in the GeoGIS using SQL Server and ArcGIS. The User’s Guide was originally written during Phase II of GeoGIS. The User’s Guide has been updated to keep up with changes to the website during Phase III and included in this thesis.

1.1 GeoGIS User Types

GeoGIS is a structured system that allows users of different classifications to perform different operations depending on their user type. There are four user types: general user, consultant, ALDOT engineer, and administrator. These are listed in order of increasing privileges. Each classification has privileges that allow users to perform certain tasks. Each higher classification can perform all the tasks of the lower classifications. The general user can view the map, view and retrieve documents and document details, and search for data. These are the only tasks the general user can perform. The purpose of the consultant user is to allow outside consulting firms the ability to upload documents to a temporary storage space where the data awaits approval. The consultant can also view the map, documents, and search the system. The purpose of the ALDOT engineer user is to approve documents. An ALDOT engineer can also upload documents and perform the other tasks related to the lower level users. In addition, the ALDOT Engineer can initiate a project, which places the project on the map and allows documents to be uploaded to the project that has been initiated. The administrator can create or change user names, passwords, and privilege levels for GeoGIS users. The administrator can
also initiate projects, as well as perform any action that can be performed by the lower level
users.

2.0 General User Type

The GeoGIS website requires a valid login ID and password. Only a user with
administrator status can create a login ID and password. Contact the administrator for a login
ID and password. This section will discuss the privileges associated with the general user. A
general GeoGIS user is restricted to a “view only” status and therefore cannot edit, add, or delete
any information in the system.

2.1 Login Page

The GeoGIS website is located on a secure server. At the time of this Users Guide, the
GeoGIS is located at the following link http://geogis.crdl.ua.edu/. Navigate to this address using
a web browser to bring up the GeoGIS Login Page. Figure A1 below shows the Login Page.
Before logging in, the buttons across the top of the page will not function.

Figure A1 - GeoGIS Login Page
As mentioned previously, a valid login ID and password must be created for each user of the GeoGIS. After a valid user name and password is entered, the user can click the Login button and the GeoGIS homepage will appear.

2.2 GeoGIS Homepage

The GeoGIS homepage is shown in Figure A2. This page is the starting point for a GeoGIS user. The page has several buttons including Map, Search, Document Upload, Document Approval, Hummingbird, Logout, Help, and Administration. From this page, a user can select any function, but the user can only perform the functions that are within the privileges of the user type.

![Figure A2 - GeoGIS Homepage](image)

2.3 GeoGIS Map

Clicking the Map button will open a new window containing the GeoGIS map. The map initially displays outlines of the counties in Alabama with county names appearing on hover. Figure A3 shows the map for Alabama with Jefferson County highlighted on hover.
Figure A3 - GeoGIS Web-Map Displaying Counties in Alabama

To search for a project, a user selects the county that contains the project of interest. Clicking the county zooms the map to that county and draws all project lines and points within the county. Figure A4 shows the map zoomed to Montgomery county with red lines and points representing projects.
Figure A4 – Montgomery County Projects

To move around the map, a user can simply click, hold, and move the map to pan. Clicking a point on the map will “grab” that point and move the map with the cursor. This will let a user easily locate an area of interest. To the upper left of the map is a grey vertical bar that looks like a ruler, this is the zoom feature. The small sliding arrow that points at the ruler represents the scale of the map being displayed (i.e. when the arrow is low on the ruler, the scale is small and the map shows a larger area, when the arrow is high on the ruler, the scale is large
and the map shows a smaller area). To zoom in incrementally, the user can click the plus button at the top of the ruler or slide the arrow upwards. To zoom out, the user can click the minus button at the bottom of the ruler or slide the arrow downwards.

The quickest way of zooming in and out of the map is by using the mouse wheel. Moving the mouse wheel forward will zoom in to the cursor. Moving the mouse wheel back will zoom the map out. The mouse wheel allows quick and accurate zooming, and reduces the need to pan the map. Figure A5 below is a zoomed view of the street map.

Figure A5 - Zoomed View of the Street Map
There are three different basemap views available in the GeoGIS: Streets, Topo, and Imagery which are shown in Figure A6. Figure A6 (a) shows the street view map layer containing roads, road names, water bodies, and shaded relief. Figure A6 (b) shows the Topo option that is USGS topographic maps, which include roads, water bodies, elevation contours, townships, etc. The Imagery layer shown in Figure A6(c) shows a detailed aerial view. All map view options will display the GeoGIS project layers as seen in Figure A6.

Figure A6 Streets, Topo, and Imagery Views in GeoGIS

Geotechnical projects that are included in the GeoGIS have four potential features: a project line, bridge points, foundation points, and soil boring points. A project line is represented as a thick red line showing the linear extent of a project as shown in Figure A6. This line represents the stretch of road that the project encompasses. A bridge location is
represented as a green star. Each star represents a point on a bridge and is used to identify a single bridge. There may be several bridges within one project. Green circles represent the location of foundations which can be driven or drilled and typically support a bridge. Smaller yellow dots are the soil boring locations. These dots represent the point where a soil boring was drilled. Figure A7 shows a zoomed in view of a pair of bridges associated with one project. Each set of features for a project represents the location of project data. However, the purpose of the GeoGIS is to provide a spatially explicit method for organizing geotechnical documents. To access documents, a user can simply click any of the GeoGIS features on the map for a particular project. The map will become the inactive window, and a window containing the Family Details page will appear.

Figure A7 - Shapefiles for a Single ALDOT Project

2.4 Family Details Page

The Family Details page, shown in Figure A8, is the main page to access project information and related documents. The page consists of the project number, available Bridge
Identification Numbers (BINs), a brief description of the project location from the CPMS database, and the list of documents. The Family Details page contains two general types of documents: Pre-construction documents (left side) and Construction documents (right side). The documents in each document type are displayed in alphabetical order. Figure A8 displays the Family Details page for an example project. The project ID and a short description of the project location are listed underneath the “Family Details” title. To the right of the project number are BIN(s) for the project in red. The globe icon in front of the project number is a button to jump to the map and zoom to a project extents.
There are eleven documents associated with the example project in Figure A8. The documents are shown in blue, underlined, and listed under specific document types. It can be seen in Figure A8 that some document types do not have any documents listed under the type.
The Family Details page shows a user exactly which documents and document types are available. Many projects in the GeoGIS will contain a bridge and have a BIN. This number helps the user identify which bridges are associated with a project. If a document is specific to a certain BIN, that BIN is also placed in red underneath the document name as seen in Figure A8.

There are several options for a user to use to view a document. Hovering over a specific document on the Family Details page will bring up a thumbnail, as shown in Figure A9 below. The thumbnail view in the GeoGIS is a powerful tool to quickly scan through project documents. The ability to thumb through digital documents without opening each document is a common request from document management system users. The GeoGIS was specifically designed to contain this valuable functionality.

<table>
<thead>
<tr>
<th>Preconstruction Records</th>
<th>Construction Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Survey (4)</td>
<td>Bridge Card Image (0)</td>
</tr>
<tr>
<td>soil_boring_100.jpg</td>
<td>Bridge Identification Information (0)</td>
</tr>
<tr>
<td>soil_boring_102.jpg</td>
<td>Hammer Submittal (0)</td>
</tr>
<tr>
<td>soil_boring_98.jpg</td>
<td>Bridge Foundation Report (0)</td>
</tr>
<tr>
<td>soil_boring_99.jpg</td>
<td>Bearing Curves (PDA Results) (0)</td>
</tr>
<tr>
<td>Materials Report (0)</td>
<td>Test Pile Driving Record (1)</td>
</tr>
<tr>
<td>Slope Study Report (0)</td>
<td>test_pile_record.pdf</td>
</tr>
<tr>
<td>Foundation Investigation</td>
<td>BIN 10773</td>
</tr>
<tr>
<td>Retaining Wall Report (0)</td>
<td>Pile Driving Record (4)</td>
</tr>
<tr>
<td>Coal Analysis Report (0)</td>
<td>pile_driving_record_1.pdf</td>
</tr>
<tr>
<td>Culvert Report (0)</td>
<td>BIN 10773</td>
</tr>
<tr>
<td>Other Geotechnical</td>
<td>pile_driving_record_2.pdf</td>
</tr>
<tr>
<td>Geohydrologic Report (0)</td>
<td>BIN 10773</td>
</tr>
<tr>
<td>Geotechnical Data (0)</td>
<td>pile_driving_record_3.pdf</td>
</tr>
<tr>
<td>Soil Sample Test Request (0)</td>
<td>BIN 10773</td>
</tr>
<tr>
<td>Summary of Lab Tests (0)</td>
<td>pile_driving_record_4.pdf</td>
</tr>
<tr>
<td>Foundation Recommendations (0)</td>
<td>Drilled Shaft Excavation Log (0)</td>
</tr>
<tr>
<td>Foundation Analysis (0)</td>
<td>Drilled Shaft Pouring Record (0)</td>
</tr>
<tr>
<td>Drilled Shaft (0)</td>
<td>Load Test (0)</td>
</tr>
</tbody>
</table>

Figure A9 - Document Thumbnail View on Family Details Page
Clicking on a document name will open up a dialog box that allows the user to download or open a selected document. Figure A10 shows the dialog box that opens when document thumbnail or name is selected.

Figure A10 - File Download Dialog Box for a Soil Boring Document

The selected document in Figure A10 is a soil boring sheet, which is normally in a JPG file format. There are also PDF file formats, Microsoft Word Documents and many other file formats used in GeoGIS; to download and view PDF files, Adobe Acrobat is required (Acrobat is available for free from Adobe).

Another way to view a document from the Family Details page is by clicking the information symbol that is displayed below each document. This will direct the user to the Document Details page, which is discussed in the following section.
2.5 Document Details Page

The document details page lists database information about a document and displays a low resolution image of the document on the left side of the screen. If a document contains more than one page, only the first will appear in the thumbnail. Figure A11 shows the Document Details page for a plan sheet. A document can be downloaded by clicking the name of the document at the right of the Document Details page.

Figure A11 - GeoGIS Document Details Page
The document details page allows a user to see information such as upload and approval dates, the users that uploaded and approved the document, the type and size of the document, the family and project details, and the applicable BIN.

2.6 Search Page

The search page is designed to allow a user to search the GeoGIS database based on a CPMS number, a BIN, a document name, a document type, a concatenated project number, any of the fields used in concatenation of the project number, or any keyword associated with a document or project. Figure A12 shows the GeoGIS search page.

![GeoGIS Search Page](image)

Figure A12 - GeoGIS Search Page

If a user wants to find all documents that are associated with the CPMS Number 100001736, for example, the user enters “100001736” into the text box labeled “CPMS #” on the
Search page (shown in Figure A12), and clicks the “Search” button. The results of this search are displayed on the Document Search results page shown in Figure A13.

Figure A13 - GeoGIS Search Results

The result of the search is a list of documents that met the search criteria. The list contains a thumbnail view of each document, a hyperlink to the document through the document name (which can be used to download the document), the database field the search matched (in this example the search had a “Description” match for each document), the document type, the project ID, project number, project description, applicable BIN(s), and links to the Document
Details and the Family Details pages. One document is shown as a result of the search based on the CPMS number 100001736. If a user had typed in a project number or BIN, all documents associated with that search criteria would have been displayed.

2.6 Hummingbird

ALDOT maintains a document management system called Hummingbird that contains both current and historic documents. The Hummingbird document management system is for all types of transportation and project documents, while the GeoGIS is specifically designed for geotechnical documents for projects at specific locations. The GeoGIS uses a proprietary document database that is different than Hummingbird. To allow efficient movement between the two systems, a link to the Hummingbird system is in the GeoGIS. The link can be seen in Figure A14.

![Image of GeoGIS homepage showing Hummingbird link]

Figure A14 - GeoGIS Homepage Showing Hummingbird Link

In order to access the Hummingbird system, a user must obtain a separate username and password specifically for Hummingbird. Clicking the Hummingbird link will open an internet browser and connect to the website http://www.aldotweb.dot.state.al.us. A login box will
appear requesting a valid username and password for Hummingbird. Once logged in, a user can browse through the documents that are in the Hummingbird system.

2.7 Account Administration

The Account Administration page is designed to allow users to modify personal user accounts. Users can utilize the Account Administration page to change the password and email addresses associated with personal usernames. The page is shown in Figure A15

![Site Administration](image)

Figure A15 – Account Administration

2.8 User Help Menu

The help button provides two options for users via a drop down menu. Clicking “GeoGIS User’s Guide” will prompt the user to download the GeoGIS User’s Guide in PDF format. Clicking Report a Problem” will open the Report Problem pop-up window. This window asks the user for
a description of the problem and a reply email address. Clicking the “Submit” button sends an email to geogishelp@gmail.com, which is managed by site administrators. Figure A-16 shows the Report Problem page.

![Report Problem Page]

Figure A16 – Report Problem Page

3.0 Consultant User Type

The consultant user type was created to allow a user to upload documents, but not approve documents. The consultant user type may include geotechnical firms, contractors, and
other agencies that may own or create documents that are important to ALDOT. This user type can provide more efficient upload, since the consultant can upload the document as soon as the document is created, rather than sending the document to ALDOT for upload. The documents uploaded by this user type will still require approval from an ALDOT engineer user with higher GeoGIS privileges. It should be noted that in addition to document upload, a consultant has all the privileges of a general user.

3.1 Document Upload Page

The Document Upload page is designed to facilitate quick and accurate uploads of geotechnical information by consultants. Figure A17 shows the Document Upload page before any information has been entered. To upload documents for a project, the project must exist in GeoGIS and be initiated by an ALDOT Engineer. In addition the user uploading the documents must be assigned to the project by an ALDOT Engineer. Once initiated, the project is available for document uploads. Creating a new project in the situation that a project does not exist in GeoGIS is explained in the Administrator User Type section of this Users Guide.
In order to select a project the consultant enters the all known information into the fields provided in Figure A17 or clicks the “Show My Upload Ready Projects” button. All projects that match the criteria are compiled in the Project Search Results Page shown in Figure A18.
After a project is selected the Consultant then clicks the “Begin Uploading Button”. This takes the Consultant to a page where documents can be browsed and added in order to assign document types. When the documents of interest have been added they appear in the Document Upload page as shown in Figure A19.
From the Document Upload Page the Consultant then selects the CPMS number, applicable BINs, and the correct document types. Several document types can be entered into the GeoGIS. Table A1 shows the Preconstruction and Construction document types in the GeoGIS.

Table A1 Document Types in GeoGIS

<table>
<thead>
<tr>
<th>Preconstruction</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Survey</td>
<td>Bridge Card Image</td>
</tr>
<tr>
<td>Materials Report</td>
<td>Bridge Identification</td>
</tr>
<tr>
<td>Retaining Wall Report</td>
<td>Hammer Submittal</td>
</tr>
<tr>
<td>Culvert Report</td>
<td>Bridge Foundation Report</td>
</tr>
<tr>
<td>Other Geotechnical Reports</td>
<td>Bearing Curves (PDA Results)</td>
</tr>
<tr>
<td>Geohydrologic Report</td>
<td>Test Pile Driving Record</td>
</tr>
<tr>
<td>Geotechnical Data</td>
<td>Pile Driving Record</td>
</tr>
<tr>
<td>Foundation Analysis</td>
<td>Drilled Shaft Excavation Log</td>
</tr>
<tr>
<td>Correspondence</td>
<td>Drilled Shaft Pouring Record</td>
</tr>
<tr>
<td>Photo</td>
<td>Correspondence</td>
</tr>
<tr>
<td>Other</td>
<td>Photo</td>
</tr>
<tr>
<td>Foundation Report</td>
<td>Other</td>
</tr>
<tr>
<td>Landslide Report</td>
<td></td>
</tr>
<tr>
<td>Sinkhole Report</td>
<td></td>
</tr>
</tbody>
</table>

To specify which document type is being entered into the GeoGIS, select either the Preconstruction or Construction radio buttons, and then check the boxes of all the document types that apply. Many projects in the GeoGIS will contain a bridge and have a BIN. This helps users identify which bridges are associated with a project. After the document type is selected, the BIN should be selected. If the BIN is not known, or there is not a BIN associated with the
project, the BIN check box should be left blank. Click the “Submit Documents” button at the bottom of the page to upload and submit the document for approval. As discussed previously, the uploaded documents can be viewed on the Family Details page; however, documents cannot be viewed on the Family Details page until they have been approved by an ALDOT engineer. The Document Approval page is only available to an ALDOT engineer user type or the site administrator.

3.2 My Projects Page

The My Projects page is designed to assist a consultant in rapidly finding documents that the consultant uploaded. Clicking on the “My Projects” button displays a page with all of the projects to which the consultant is assigned. To find a document, the consultant then checks the box next to the project of interest and clicks the “View Documents” button. Figure A20 shows the My Projects Search page.

![My Projects Search Page](image)

Figure A20 – My Projects Search Page
All of the documents associated with the project that the consultant has personally uploaded are displayed. The documents are divided into two categories based on approval status. Documents under “Pending Documents” have not yet been approved by an ALDOT engineer and may still be edited or deleted by the consultant. Documents under Approved Documents have been approved by an ALDOT engineer and are permanently in the system. Figure A21 shows the My Projects Document page.

Figure A21

4.0 ALDOT Engineer User Type

The ALDOT engineer user type is designed for ALDOT personnel to initiate projects and approve documents if the documents are valid for specific projects within the GeoGIS. The ALDOT Engineer has all the privileges of a consultant and general GeoGIS user and can also initiate projects and approve documents. The next section describes the Document Approval and Project Initiation pages.

4.1 Document Approval Page
An uploaded document cannot be used in the GeoGIS until the document has been approved. Figure A22 shows the Document Approval page with several documents awaiting approval.

![Document Approval Page with Several Documents Pending](image)

All pending documents are listed on the document approval page and show the document type, the associated project and description, the user that uploaded the document, the date/time the document was uploaded, and a link to preview the document. The ALDOT engineer or administrator can choose to approve or deny the document by either clicking the “Approve” button or the “Deny” button. In addition, an ALDOT engineer can use the “Edit” button to edit
a document that has been uploaded. The edit page is shown in Figure A23. At the edit page an engineer can correct the erroneous document attributes and send it back to the Document Approval Page. After a document is approved or denied and the page is refreshed, the document will no longer appear on the Document Approval page.

Figure A23 Document Edit Page

4.2 Project Initiation
The Project Initiation function is available to users with an ALDOT Engineer classification or higher. This page allows projects to be shown on the map, and enables documents to be uploaded to the project. When the engineer clicks the Project Initiation button, the Project Search page shown in Figure A20 is displayed.

![Figure A24 Project Search Page](image)

The Engineer then enters all known information into the fields shown in Figure A24 and clicks the “Search Projects” button. All projects that match the information entered are compiled in the Project Search Results Page shown in Figure A25.

![Figure A25 Project Search Results Page](image)
After selecting the project to be initiated the Engineer then clicks the “Set Users” button. This takes the Engineer to the page shown in Figure A26 where users are assigned to the project. Checking the boxes next to consultant user names assigns the consultants to the project allowing them to upload to the project. Once the engineer has assigned users to the project and clicks “Initiate” the project will appear on the map and be available for uploading documents. If users need to be added or edited the same process can be repeated and the engineer can then manage users for a project on the “Set Users” page. (NOTE: Please contact the UA GeoGIS team to add projects without CPMS numbers to the GeoGIS)
Figure A26 Assigning Users to a Project

5.0 Administrator User Type

An administrator user has all the privileges available to an ALDOT Engineer, consultant, or a general GeoGIS user, plus additional management privileges. The main privilege of the administrator is the ability to create, delete, and modify user names, passwords, and user types. A GeoGIS user must contact the administrator to create a user name and password.

5.1 Administration Page
The Administration page allows an administrator to create, edit, and delete users. Figure A27 shows the Administration page.

![Administration Page](image)

Figure A27 - Administration Page

The Administration page contains three sections that the Administrator can use to manage users. The first box, at the top of Figure A25, is used to create a new user. The Administrator will enter a user name, password, and user role; the new user must provide a valid, unique email address. Once this information is entered, clicking the “Create User” button will add a new user to the GeoGIS system. The second box is for editing an existing user. The “Username” box is a drop-down box that lists the existing users in the system. The username cannot be edited, only the password, role, and email address of an existing user can be changed. To change a
username, a new user must be created. Once changes to a user have been made, click the “Save Changes” button to save the changes. The third box is for removing users from the system. The “Username” box is a drop-down box that lists the existing users in the system. Once the username has been chosen, click the “Permanently Delete User” button to delete the user.

5.2 Adding a Project to GeoGIS

This section describes the procedures to add a new project to the GeoGIS. Adding a project is sometimes necessary when the project in question does not exist in the CPMS table. The basic structure of the system and the programs that are needed for adding a new project are also described.

5.2.1 Structure of the GeoGIS

To add a new project to the GeoGIS both the database that stores the documents and attribute data, and the feature class in SDE that stores the project location, need to be updated. The database is an SQL database that is accessed through the Microsoft SQL Management Studio. Both the SQL Server and ArcGIS SDE need project records for a new project to be active. Once a project is active the project can be initiated at the project initiation page allowing the GeoGIS Map to display the project and documents to be uploaded to that project. Initiation is made possible through ArcGIS SDE. All shapefiles are stored in ArcGIS SDE and displayed on the GeoGIS Map through ArcGIS Server and Flex.

When a document is uploaded or a new user is created using the GeoGIS website, the website communicates with Microsoft SQL Server Management Studio. The SQL Server manages the tables that pertain to both GeoGIS users and the GeoGIS database. The SQL
database stores GeoGIS tables including a copy of the CPMS projects table used by GeoGIS, the GeoGIS users and user types tables, and the uploaded and approved documents tables.

Although the SQL database is for attribute data management, the real power of the GeoGIS is the ability to display and search geotechnical data through a map interface. The GeoGIS map is managed, stored, and updated through a suite of GIS products produced by ESRI. It was determined that desktop edits to features that exist in SDE, that in turn are automatically updated on the GeoGIS map interface was the most efficient way of managing GeoGIS. Both updating the SQL database and the GIS features are explained in the following sections.

5.2.2 Adding New GeoGIS Projects to the SQL Database

The SQL database contains a copy of the CPMS_ProjectsLine table. This table currently contains approximately 10,000 records. The CPMS_ProjectsLine table stores both recent and current ALDOT projects; therefore, most projects in the GeoGIS will be in the CPMS_ProjectsLine table. Historic projects may not be in the CPMS_ProjectsLine table and therefore may not be available to the GeoGIS. To check the CPMS_ProjectsLine table for a project reference ID, open the SQL database with a database program and search the CPMS_ProjectsLine table. This can be done with a standard SQL query:

```
SELECT * FROM [GeoGIS].[dbo].[CPMS_ProjectsLine]
WHERE pj_ref_id = “New GeoGIS Project ID”;
```
This query tells SQL to “select this row and all columns from this table where this column is equal to this value.” Once the query is entered, simply click the execute button. If the project record exists in the database, then the project is available to accept GeoGIS documents.

For projects that are not in the CPMS_ProjectsLine table, a new record must be created. Most likely these are historic projects that do not have an official project reference ID or a new project that has not been assigned a CPMS number. At a minimum, five fields of data for a new project need to be inserted into the CPMS_ProjectsLine table. These are shown in Table A2.

Table A2 - Required Fields for a New GeoGIS Project

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Column Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pj_ref_id</td>
<td>Project Reference ID (a 10-digit number starting with 9000000…)</td>
<td>9000000009</td>
</tr>
<tr>
<td>Description</td>
<td>Description of project location</td>
<td>Bridge over Raging River</td>
</tr>
<tr>
<td>Rt_id</td>
<td>Route ID</td>
<td>AL1111</td>
</tr>
<tr>
<td>Beg_MP</td>
<td>Beginning mile post</td>
<td>111.1</td>
</tr>
<tr>
<td>End_MP</td>
<td>Ending mil post</td>
<td>112.0</td>
</tr>
</tbody>
</table>

By convention, new GeoGIS projects will be referenced with a pj_ref_id starting at 9000000000 and increasing in consecutive order. In this way, GeoGIS modifications to the CPMS data can be easily identified. The project description shown in Table A2 should be a written description of the project. The route ID and beginning and ending mile post data will be used to automatically create a line feature on the map at the correct location.

Once the attribute data for a GeoGIS project is determined, a record needs to be inserted into the CPMS_ProjectsLine table. The “INSERT INTO” command will allow an administrator to insert a new record (i.e. project) into the database. Figure A23 shows the “INSERT INTO” command syntax.
After the SQL command “INSERT INTO” shown in Figure A23, the user should specify the argument, which is “[GeoGIS].[dbo].[CPMS_ProjectsLine]”, the database name and table name. The next several lines in Figure A23 are the column names, in parentheses and brackets and separated by commas. After the column names have been specified, the next line should read “VALUES,” followed by the data to be inserted into each column. Be careful to place each column value in proper order before executing the command. If any data is out of place, the location of the subsequent data will be incorrect. Character strings such as route ID and descriptions need to be in single quotes. Click the “Execute” button and the new record will be added to the CPMS_ProjectsLine table.

5.2.3 Adding a New Line Feature to the CPMS_ProjectsLine Shapefile

If a brand new project is being added, then the project line will not exist in the CPMS_ProjectsLine feature class in SDE. In this case, the project feature class can be edited to allow the feature to be drawn or created through a linear event. To draw on or edit a feature, the
Editor toolbar must be activated. Right-click in the tool space (the empty area next to the toolbars), and click the “Editor” label to activate the toolbar, a checkmark should appear next to the label. Once the Editor is activated, click the “Editor” button on the left side of the toolbar, and select the “Start Editing” command from the menu that appears. A dialog box appears that contains two boxes: the box on top contains all sources that are referenced by this map, and the box below shows a list of the features from each of the sources. Click on the source that contains the GeoGIS Project line feature, click OK, and then click “Start Editing”. The user is now in Editing mode. It is important that the Project line feature selected is the feature class that is located in SDE that is being used by GeoGIS.

On the ArcGIS map, locate the area where the project line will be drawn. Once the area is located and the project line is ready to be drawn, click the sketch tool button to begin drawing. Look at the Editor toolbar to be sure that the project shapefile name is in the “Target:” box. Since the shapefile being edited contains only lines, the drawing tool will automatically draw lines when editing this file. To draw a line, click the location where the line should begin. Then, digitize along the project path. Each click adds a point, and these points are connected by a line; therefore, the more points added, the more accurate the line will be, especially along curved sections. When the last point of the line has been placed, right-click on the map and then click “Finish Sketch” to end the drawing session. If a point is out of place, the point can be moved by double-clicking on the line, and simply dragging the point to a new location. When the edit is completed, click the “Editor” button and “Stop Editing.” A dialog will appear asking if the edits should be saved, click “Yes.” Figure A24 shows a line that has been drawn using the Editor toolbar.
If information for the route, beginning, and ending milepost is available for a new line feature, it may be more accurate to display linear events rather than drawing. To do this a database file will need to be created. One of the easiest options for creating this file is to use Microsoft Excel. Create an excel file with the column headings shown in Table A2. Enter the project information into the fields in the Excel table. This table can then be saved and added to ArcMap. Right click on the newly created database file and choose display route events. Specify the correct route shapefile, and the correct event table. Choose line events and use the beginning milepost as the from measure and the ending milepost as the to measure. Click OK to display the linear events. This new shapefile will then be appended to the CPMS_Projectsline.
shapefile. To append the shapefile first launch the ArcToolbox application shown in Figure A25.

![ArcToolbox Button](image)

**Figure A25 ArcToolbox Button**

Click the plus sign beside “Data Management Tools” followed by the plus sign next to “General”. Double clicking on “Append” will launch the Append tool. Select the newly mapped linear event file for the “Input Dataset”, and the CPMS_Projectsline file for the “Target Dataset”. Select “NO TEST” from the “Schema Type” dropdown menu and click the OK button. The new project is now included in the CPMS_Projectsline shapefile. Since the shapefile has been altered it is necessary to republish the map to the web. Now that the new project exists it will need to be initiated at the Project Initiation page to be available on the map, and accessible to upload documents.

5.3 Appending Point Shapefiles

In addition to the project line shapefile, other relevant features may be added to the GeoGIS as well. These features include: bridge location points, foundation points, and soil boring points. It is important to note that when editing these features, the feature class being edited must be the feature class in SDE that is being used by GeoGIS.
Similar to the procedure to add a new project line discussed in the previous section, bridge points can be entered using the same procedure. A shapefile that locates every bridge in Alabama exists at ALDOT. Bridges from the ALDOT Bridge shapefile can be selected and appended to the GeoGIS Bridge shapefile following the same procedure used for appending the project lines. If the bridge cannot be located, then the user can edit the GeoGIS bridge shapefile, using the same edit procedure as discussed in the last section.

For foundation and soil boring points, the locations of these should be recorded in a file by the consulting firm that performed the work. These files should be in Excel format. Preferably, the coordinates for the individual points will be in the file in latitude-longitude format. If this is the case, the creation of the graphical points in ArcGIS is relatively simple.

The Excel file should have columns containing headings that specify which columns represent the latitude and longitude for the points. In ArcGIS, click “Tools” then “Add XY Data”. This will open a dialog as shown in Figure A26. At the top of the drop-down box, specify the location of the Excel file and which sheet in the file contains the coordinates. Specify the columns containing the X and Y coordinates of the points. If the columns are titled “Latitude” and “Longitude” or something similar, then those columns will be in the X and Y drop-down boxes. Be sure that the columns specified in these boxes are correct, X should be longitude, and Y should be latitude. The coordinate system used by the map is GCS_North_American_1983 and should appear in the coordinate description box. Finally, clicking OK will generate an event shapefile for the points.
The points will be added into ArcGIS as an “event” shapefile. This is a file that contains only the points that were just added. Since this is not the GeoGIS shapefile, these points need to be appended to the GeoGIS shapefile. Locate the “Append” command in the ArcToolbox under Data Management, then General, then “Append”, and enter the “event” shapefile as the input dataset. The target dataset will be the relevant GeoGIS feature class. Select “NO_TEST” under “Schema Type” and click OK. Once the append command executes, the points will be a part of the GeoGIS feature class. If desired, the temporary “event” and export files can be deleted because the features are now located in the GeoGIS feature class.

Points can be added manually to the GeoGIS using the Editor toolbar if a file containing the coordinates does not exist. Be sure to select the correct GeoGIS shapefile when beginning
an editing session and remember to save the edits. A frame of reference such as roads and rivers is not required when drawing new points, but existing spatial data will help improve accuracy.

Once the points are in the GeoGIS, depending on the way the points were added to the map, they may not contain the necessary attribute data to associate them with a specific project. To ensure points are associated with the necessary data, an Editing session should be started. In the edit session, the attribute table should be opened and the values of the records should be changed. Be sure to enter in all relevant data such as project reference IDs and BINs to match the information for that project. Once the new features have been added the map must be republished. It is important to note that new point shapefiles should not be added unless a project has previously been initiated.

5.3.1 Adjusting the Coordinate System

It is preferable to have a data file with coordinates in latitude-longitude format. However, some consultants may provide coordinates in northing-easting. If this is the case, the addition of points into the GeoGIS requires an additional step. The conversion from northing and easting to latitude and longitude is complex, so programs exist to automate the process. A program called Corpscon6 created by the Army Corps of Engineers can be downloaded and used to convert coordinate data from one system to another. Corpson6 can be downloaded at:


The Corpscon file to be downloaded is called corpscon_complete.exe. Install the application by following the on-screen instructions. After installing and starting Corpscon, the main Corpscon page will open as shown in Figure A27.
From this screen, there are several options for converting points to a desired format. Northing and easting coordinates are in State Plane and need to be converted to Geographic format. To set up Corpscon for this conversion, click the “Setup” button in the top-left corner of the screen, beneath the “File” menu button.

Select the “Input/Output” tab, shown in Figure A27, on the Corpscon Setup page. The conversion is from State Plane to Geographic, so those should be selected for the input and output systems, respectively. The datum for each should be 1983 - NAD 83(86), unless there is a different datum specified. Other specifications for the input are: the zone, which in this example is Alabama West but may also be Alabama East depending on where the project is located; and the units, which should be US Survey Foot, unless otherwise known. Figure A28 shows how the Corpscon Setup page should look.
Once the setup has been completed, the Excel file containing the point coordinates must be converted into a text file because Corpscon cannot read an Excel file. To save an Excel file as text, open the Excel file, click “Save As”, and for the file type, select “Text” file, followed by “Save”. Close the file once it has been saved in text format. The coordinate file is now ready to be converted.

Click on the “Input File” button in Corpscon to bring up the User Defined Input File page. This page requires an input text file and an output file. The output file can be the Excel file containing the Northing and Easting coordinates. The output will be in text format, but the output can be opened with Excel. Figure A29 shows how the User Defined Input File page should look when all input and output information is entered.
Figure A29 - User Defined Input File Page in Corpscon6

The top of the page contains an Input Filename text box and an Output Filename text box. For the Input text box, browse to the text file containing the coordinate information. For the Output text box, enter the Excel file as the output. Just beneath the Output text box, check the “Send Results to User Defined Output File” checkbox.

The Convert User Defined Data File dialog box has two main areas, the left is for the input fields and right is for the output fields. For both the input and output files there are two columns entitled “Name” and a second column entitled “Field.” For the input file side (left), the “Name” label represents the column name in the text file, and the “Field” is the numerical value for the column in the text file. The numbers assigned to these columns represent the order of the columns in the file. For example, in Figure A29, the “Point Name,” “Northing/Y,” and
“Easting/X” columns are represented in the input file by the column names “POINTID,”
“NORTH,” and “EAST.” These are the first three columns in the file in that order, so the
columns are given the values 1, 2, and 3, respectively. If the order or position of the columns is
not known, the names are displayed just above the Input box in a textbox labeled Input File Line.
In the example in Figure A28 the box contains the text “POINTID NORTH EAST
DATE_DRILL…” This is the order of the columns in the input file.

The right-hand box in Figure A29 is the Output file format with several rows in the box.
The format is the same as the left-hand box, there are just more possibilities for the output file.
Since the output file is the same Excel file that created the input text file, the output data will be
appended to this file, and not replace the original data. The Corpscon6 program allows the user
to “carry over” up to 50 user-defined fields. This is useful, because as long as the input file does
not contain more than 50 columns, the new latitude-longitude coordinates can simply be added to
the original table. In the example in Figure A29, the original Excel file had 11 columns, so the
“Input Field 1” through “Input Field 11” will be the numerical values of these columns. The
“Latitude Out” and “Longitude Out” columns will be given the subsequent values, in this case,
12 and 13. The rest of the columns should be left at zero unless other output information is
desired.

Finally, the coordinate format and the delimiting criteria must be specified. The
coordinate format should be Decimal Degrees, “Tab” should be selected as the input delimiter,
and “Comma” should be selected as the output delimiter. The point coordinates data can now be
converted.
Click the “Convert” button and a message box will appear stating that the output file already exists. It provides three courses of action: Append, Replace, and Cancel. Since all columns were set up to “carry over” to the output file, click “Replace.” If everything was entered correctly, a screen will show up that says the conversion is complete.

Navigate to the Excel file, open the file, and click “Yes” when the dialog box appears. The text will be in a single column in the Excel file. To delineate the text, highlight only the first column, click the Data tab at the top of the page, and click the “Text to Columns” button. A window will appear asking how the data should be delineated; click “Next,” click the checkbox next to “Comma” and then “Finish.” The text will now be separated into columns. The column names for the latitude and longitude columns will be numbers, so change those names to “Latitude” and “Longitude.” Also, the longitude values should be negative so multiply the longitude values by negative one.

The coordinates are now converted from State Plane to Geographic format. This Excel file can now be used to input XY data into ArcGIS following the same procedure as described in the Appending Point Shapefiles section of this Users Guide.